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PREFACE

World Environmental Conservation Conference (WECC) is an annual organized event by members of The Nigerian Environmental Conservation Organization (NECOR) and Environmental Conservation Club (ECC).

This year event is the second of its kind with the view to afford academia, researchers from various institutions, corporate organizations, students, members of non-governmental organizations, staff of relevant ministry, department and agencies to present articles in line with the theme of the conference: transition pathway to SDGs ; integrated landscape approach, economic wellbeing and inclusive climate resilience"

The theme of the conference is conceived as a pathway/view to appraise our contribution towards addressing some pertinent sustainable development goals that centre on sustainable production (Goal 12), economic wellbeing (Goal 8) and climate change (Goal 13).These are considered as prevalent environmental challenges confronting the world. We hope to plan towards addressing other SDGs goals before year 2030.

In view of the success recorded at the maiden edition of the WECC in 2018, this year edition of the conference has received collaboration from Department of Agricultural Production and Resource Economics, Technical University, Munich, Germany. This international recognition and collaboration has actually boost our morale in our drives to ensure environmental sustainability.

Nigerian Environmental Conservation Organization with the students arm Environmental Conservation Club is a non-profit and Non-Governmental Organization is aimed at effective information dissemination, involvement and inclusive integration of relevant stakeholders toward proffering solutions to increasing environmental challenges.

There are over 30 manuscripts that were blindly reviewed, accepted and published in this year 2019 conference book of proceedings.

These manuscripts cover the following thematic areas of the sub-theme;

1. Water , sanitation and Health (WASH)
2. Sustainable integrated fisheries, Aquaculture and Agricultural Production Systems
3. Sustainable landscape development
4. Sustainable tourism practices in landscape management
5. Green technology/ecofriendly technology
6. Climate resilience and adaptation strategy
7. Ecosystem valuation and social economic wellbeing
8. Soil, water and environmental outcome.

The **free** training workshop on **Data modelling and research in agriculture production and resource economics** organized by the Department of Agricultural Production and Resource Economics, Technical University of Munich, Germany is posed to broaden knowledge of the participants and improve their skills on modern modelling techniques of data analysis and interpretation in the field of Agriculture production and resource economics.

Nigerian Environmental Conservation Organization sincerely appreciates the Vice Chancellor Professor J.A Fuwape for his support towards making this year conference a success. We thank Professor B.N. Ejidike, Head of Department of Ecotourism and Wildlife Management for hosting this conference. The Local Organizing Committee also thanks our lead speakers Professor T. T. Amos, Dean School of Agriculture and Agricultural Technology (SAAT) and Professor J. Sauer, Chair Department of Agricultural Production and Resource Economics, Technical University, Munich, Germany. We also commend Dr. Emmanuel Benjamin, Department of Agricultural Production and Resource Economics, Technical University, Munich, Germany. We appreciate the support of National Park Service, Honorable Commissioner for Environment, and Honorable Commissioner for Natural resources for their unalloyed contributions. The untiring efforts of local organizing committee are highly commendable.

It is hoped that researchers, students and policy makers will find the papers in this book very useful. Even though all the papers were reviewed and edited, the content and opinion expressed remain essentially that of the authors and not necessarily that of Nigerian Environmental Conservation Organization.

Dr Oladeji. S.O

President Nigerian Environmental Conservation Organization

Convener World Environmental Conservation Conference.

TABLE OF CONTENT

GROUNDWATER POTENTIAL MAPPING OF ENUGU STATE USING REMOTE SENSING AND GIS TECHNIQUES

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Abstract

Groundwater forms part of the natural water cycle and is present within underground strata. Groundwater constitutes an important source of water for various purposes, such as domestic, industrial and agricultural needs. In the Hydrological cycle, groundwater occurs when surface water from rainfall seeps into the earth and fills the soil pores and rock fragments. Groundwater flows in the aquifer layer toward points of discharge, which include wells, rivers, lakes and ocean. The geology of Enugu consists of mainly alluvium soil, granite, limestone, and sandstone, hard rock formation. In this study, application of Remote Sensing techniques was used to produce Groundwater potential Map of Enugu. Various maps were prepared (Landuse, slope and Drainage, Lithology, Lineament, Elevation, Soil types, and Rainfall gauges) from LandSat7 satellite imagery, and other ancillary data. These maps were integrated to produce the groundwater potential zones map of the study area based on the modified DRASTIC model. The Groundwater Potential map produced comprised five categories of groundwater yield –Very High, High, Moderate, Poor or Very Poor. It was found that all the alluvial plains and sandstones have high and low drainage densities respectively.

Keywords: *ArcGIS, Groundwater, Remote Sensing, Mapping.*

INTRODUCTION

Groundwater accessibility in Enugu has been. Groundwater may appear at the surface in the form of springs, or it may be tapped by wells. Groundwater forms part of the natural water cycle and constitutes a major portion of the cycle and includes all water found beneath the surface of the Earth. It is derived primarily by percolation of atmospheric or surface water and contained in pore spaces of permeable reservoir rocks (Ayoade, 2003).Groundwater potential mapping has been used over time by groundwater techniques using geological techniques. Over the years, the cost of drilling of boreholes is high as a result of some factors;

i. The challenge of coaldeposits, rocks and hills in Enugu State.
ii. The trial n error is accessing groundwater by drillers.

iii. The high cost of engaging the services of the geologist in determining groundwater potential and the dept to hit groundwater.

As a result of the above mentioned challenges, the need to employ the use of GIS & Remote Sensing techniques to map the groundwater Potential zones of the study.
DRASTIC Modelis an empirical model developed by U.S. Environmental Protection Agency (EPA) which is widely used for evaluating relative groundwater pollution susceptibility by the use of hydro-geological factors (Aller *et al.*, 1985). It evaluates the Intrinsic Vulnerability (*IV*) of groundwater by considering factors including Depth to water table, natural Recharge rates, Aquifer media, Soil media, Topographic aspect, Impact of vadose zone media and hydraulic Conductivity. It is an acronym for the seven (7) most important hydro-geological features affecting groundwater pollution, which are:

Groundwater Potential = D+ R+ A+ S+ T+ I+ C **. . .** (1)

Where D= depth to water table, R= net recharge, A= Aquifer media, S= Soil media
T= Topography, I= Impact of vadose zone media, C= hydraulic conductivity of aquifer

This study is thereforean attempt to use modified drastic model to map the groundwater potential zones of Enugu using Remote Sensing & GIS techniques.

MATERIALS AND METHODS

Study Area

The study area is Enugu State which lies within the Latitude 6^{o} 20”N and 6^{o} 30”N and Longitude7^{o} 20”E and 7^{o} 30”E and is bounded by several other states; in the North by both Benue and Kogi States, in the South by Abia and Imo States while in the west and east Anambra and Ebonyi State. The Official population figure of Enugu urban area from the 2006 population census stands at 722,664 (NPC, 2007).
The location of Enugu puts it firmly within the tropics; as such radiation is high all year round. Rainfall over Enugu, isassociated with the presence of moist tropical maritime (MT) and the location of inter topical discontinuity (ITD). Rainfall inEnugu is of two major types, conventional and rainfall associated with disturbances. The mean annual rainfall is heavy;varying 1200mm to 1800mm while temperature ranges from 27^{o}to 29^{o}C and in severe cases is up to about 32^{o}C. The relativehumidity of the study area ranges between 50% and 80% while surface pressure is about 985.5 hpa.Irem (1999). The 2006 censusrecorded the population of Enugu to be 722,664 accommodated in 28 residential layouts. The human activities in the studyarea lie predominantly characterized by administrative Ofomata (2002).

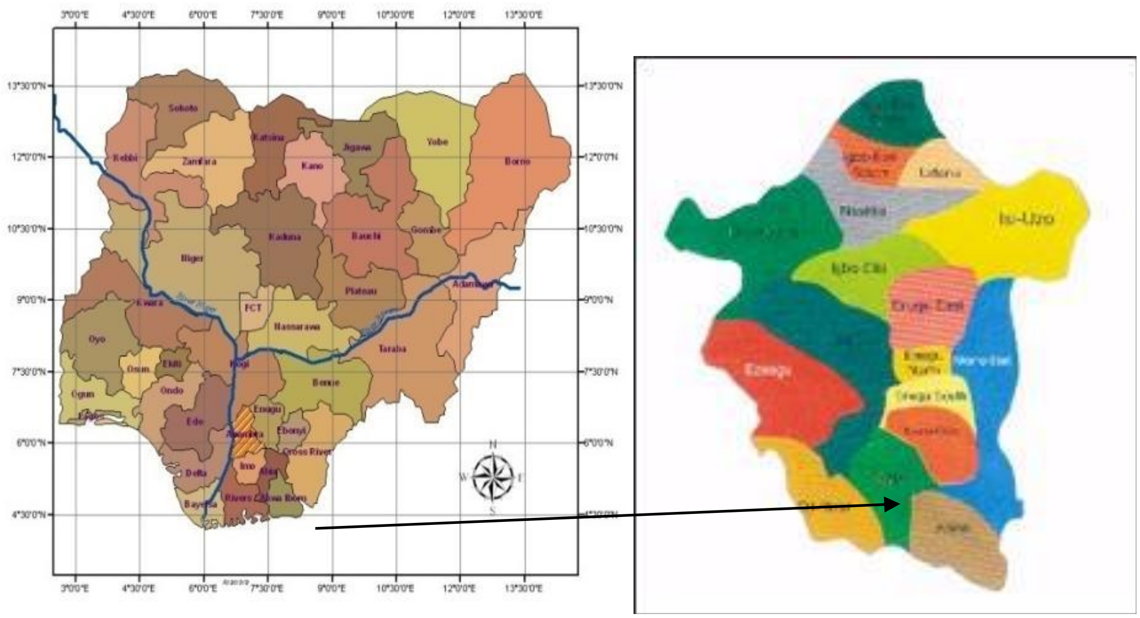

Figure 1: Enugu State Map

Data Products

Table 1. Primary /Auxiliary Data

S/No	Data	Scale	DataSource
1.	SRTM/DEM	30m	Surveying & Geoinformatics department, FSS, Oyo.
2.	Rainfall data New_LocClim software	-	Surveying & Geoinformatics, FSS, Oyo.
3.	Satellite imagery 2001 (Landsat-7ETM)	30m	Surveying & Geoinformatics, FSS, Oyo.
4.	Geology map of Nigeria	1:250,000	Surveying & Geoinformatics, FSS, Oyo.
5.	Soil Map of Enugu		Digital Soil Map and Soil database of Nigeria. Nkwunonwo U.C (2009).

Groundwater Model (DRASTIC)

In this project, the modified DRASTIC model of Khairul Anam *et al,* 2000 was adopted to estimate the groundwater potential.

Groundwater Potential = Rf + Lt + Ld + Lu + Te + Ss + Dd + St **…...**(2)

where

Rf= annual rainfall, Lt= Lithology, Ld= lineament density, Lu= land use
Te= topography elevation (Contour), Ss= slope steepness, Dd= drainage density, St= soil type

In order to demarcate the groundwater potential zones of Enugu State eight (8) different thematic maps were prepared from Primary /Auxiliary in Table 1. The Figure 2 below gives the methodology flowchart for this project.

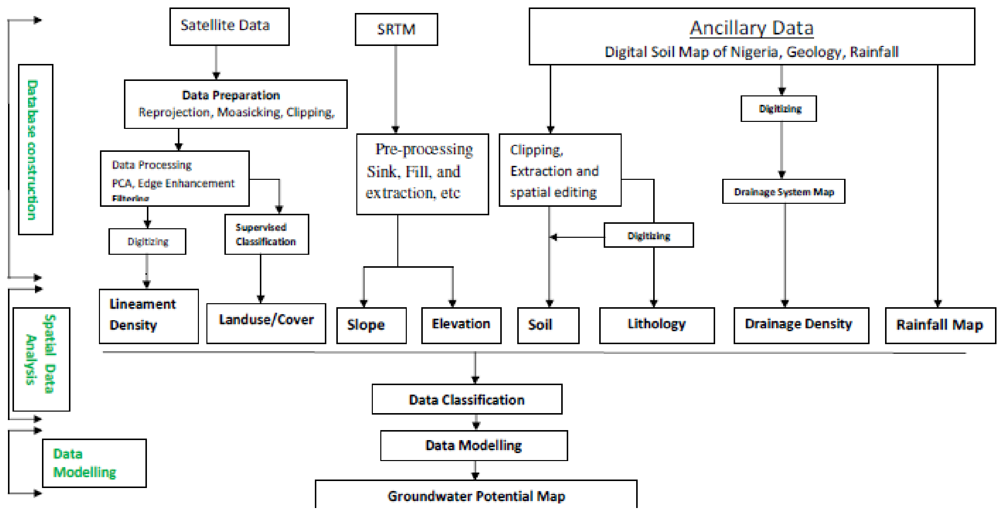

Figure 2: Methodology Flowcharts for Groundwater Potential

Approaches

Lithology map as shown in Figure 3below was prepared by digitizing each Lithologic unit/ rock type in ArcGIS from geology/Soil maps and each lithologic unit or rock type is classified based on the legend available on the geology map.

The operation consists of the delineation of lineaments. The sequence of operation is the application of filters for image enhancement, geo-referencing using map coordinates. The edge enhancement of the satellite image, 3*3 Laplacian filter, high pass filter and gradient filter in X direction were applied with visual interpretation. The processed image was imported into ArcGIS to digitize the lineament features in the image. The lineament density map was then prepared using the Spatial Analyst **Tool|Density|line** option.

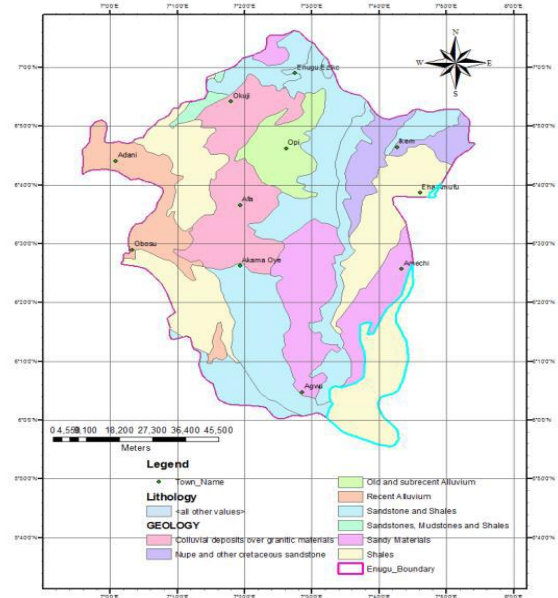

Figure 3: Lithology Map

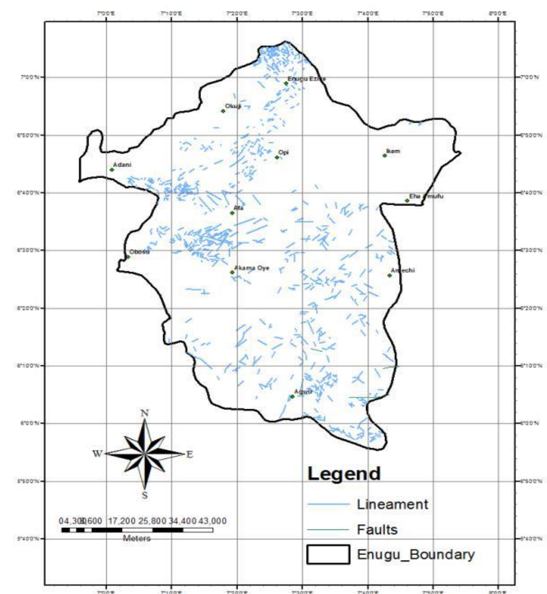

Figure 4: Lineament Map

The slope map of the Study area was extracted from the prepared SRTM /DEM of the Study area using ArcGIS(Figure 5). The SRTM was imported into the ArcGIS using the Add button and the slope wascalculated using the Spatial Analyst Tool.

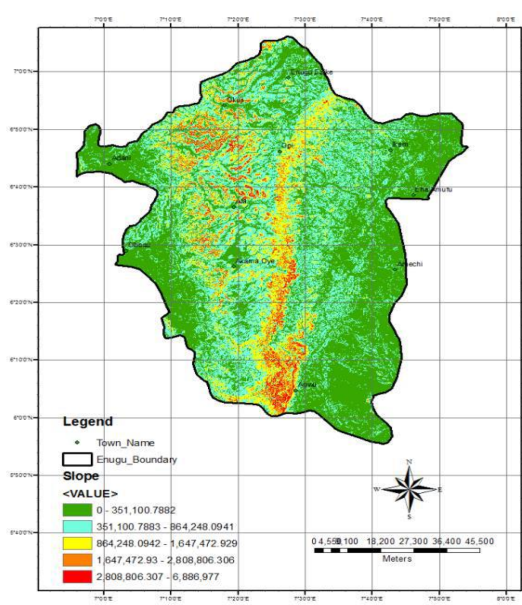

Figure 5: Slope Map

The LandUse/Cover Map was prepared using the LandSat7-ETM image coverage of Enugu. The image was enhanced using various filtering algorithms edge enhancement, PCA, Band Rationing etc. Supervised classification was used with some GCPs for proper Sample Set preparation. The Maximum Likelihood Method was adopted to generate the landuse-cover information.

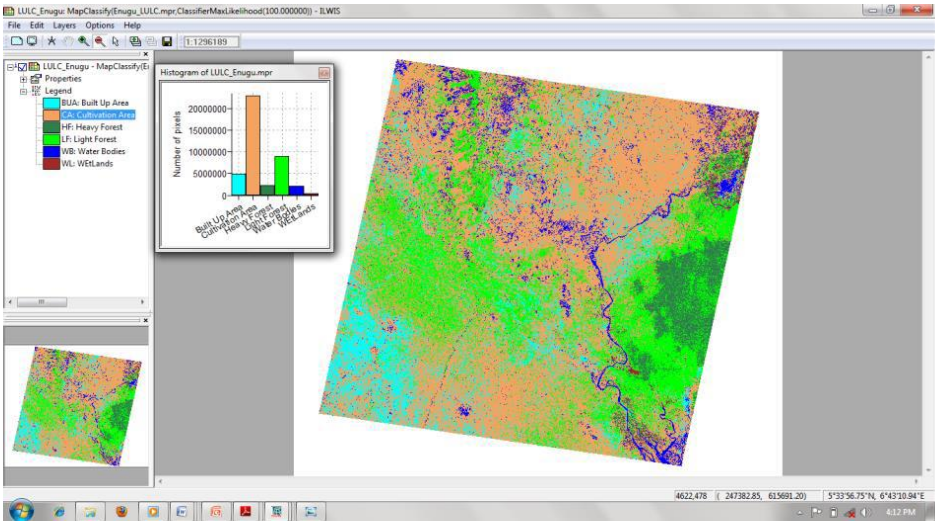

Figure 6: Landuse/cover Map

The Annual Rainfall data precipitation was generated using the New_LocClim software. The rainfall coverage was prepared by importing the annual rainfall data into ArcGIS. The rainfall coverage was then interpolated using the ***Spatial Analyst Tool|interpolation|Kriging***method was used to produce Rainfall Coverage Map.

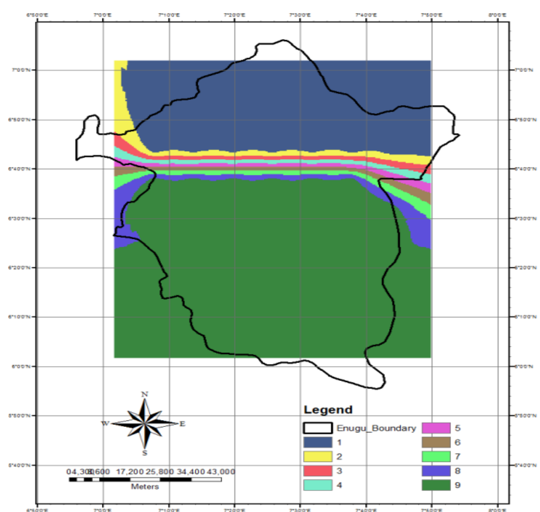

Figure 7: Rainfall Krig Map

The Geology Map of Nigeria was scanned which was imported into ArcGIS. The geology map was georeferenced. The Rivers within the study Area was digitized which was used to prepare the drainage Map. The Drainage Density Map was then performed using the ***Spatial Analyst Tool|Density|Line****in ArcGIS.*

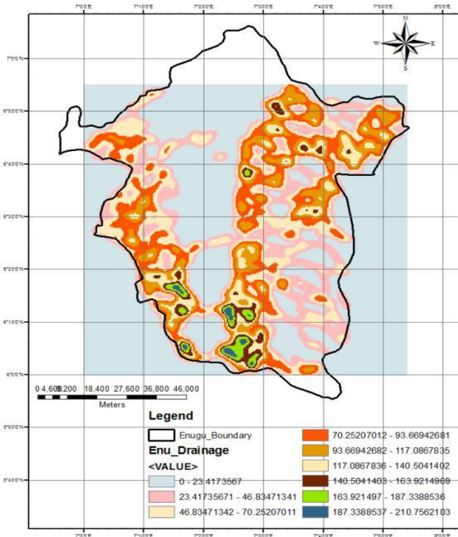

Figure 8: Drainage Density Map

The Elevation of the study area was extracted from the SRTM using ArcGIS. The SRTM was imported into ArcGIS and the SRTM was cleaned from arbitrary sinks (fill) due to random errors in the data. These sinks prevent flow algorithms to follow a complete flow path to the watershed's outlet. Then the Fill function was done and ready to use. The Elevation Map was then prepared using the ***Spatial Analyst|Surface|Contour*** with 50m interval for the generation of the contours.

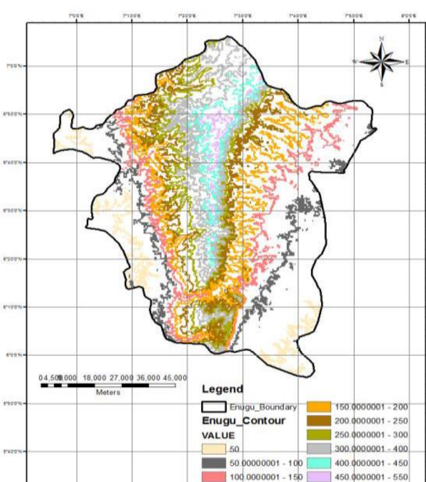

Figure 9: Elevation Map

The Soil map of Enugu was extracted from Nkwunonwo (2009), "Digital Soil Map and Soil database of Nigeria" by clipping the study area Enugu using ArcGIS Data management **Tool|clip.**

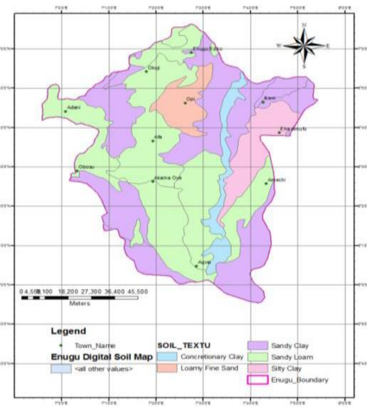

Figure 10: Soil Map

Groundwater Potential Map

The various thematic maps prepared were integrated with their weights respectively, overlay weighted method in ArcGIS was used to produce groundwater potential (Table 2).

Each thematic map was assigned a weight on a scale of 1 to 9 depending on its influence on the groundwater development (both storage and movement of groundwater). The weight for respective thematic maps was calculated based on weight normalization using the principal component analysis followed by pair-wise comparison matrix using Saaty's analytical hierarchy process (Saaty 1994).Through the weighted overlay analysis process, knowledge-based ranking and weightage of different class for each thematic layer has been given based on their contribution toward groundwater potentiality/development. Based on calculation, groundwater potential index for the study area ranges from 0.06 to 0.30 with a standard deviation of 0.04. Then, natural-break classification scheme using Jenk's optimization method was applied for mapping (Jenks 1967). The GWPI was grouped into four classes: high, very high, moderate, poor, and very poor (Table 2).

Table 2. The weighting of the Eight (8) thematic Maps

S/No	Theme	Description	Scale (1 To 9)	Weight %
1	Lineament Density (km/km2)	0 - 3 4. 1 6 5	3	2.25
		34.165 – 68.330	3	
		68.330 – 102.494	4	
		102.494 – 136.658	6	
		136.658 – 170.823	8	
2	Drainage Density(km/km^2)	0 - 3 9 – 1.15	8	19.17
		39.115 – 78.223	7	
		78.223 – 117.344	3	
		117.344 – 156.460	2	
		156.460 – 195.574	1	
3	Soil Type	S a n d y c l a y	5	4.55
		Sandy Loam	2	
		Silt Clay	7	
		Concrete clay	6	
		Loamy fine clay	4	
4	Lithology	i.) S hales	5	34.87
		ii.) Sandy materials	2	
		iii.) Nupe and Other	5	
		cretaceous	6	
		iv.) Sandstone /shales	7	
		v) Recent Alluvium	5	
		vi) Old recent Alluvium	7	
		vii) Colluvialdeposites	3	
		viii) Sandstone,shales /Mudstones and shales		
5	Slope	0 – 1	5	9.05
		1 – 2	4	
		2 – 3	3	
		3 – 4	2	
		4 – 5	1	
6	Elevation	0 – 5 0	6	1.56
		50 – 150	5	
		150 – 250	4	
		250 – 350	3	
		350 – 450	2	
		450 – 550	1	
7	Rainfall	1 – 2	2	9.05
		2– 5	3	
		5– 7	5	
		7– 9	8	
8	Landuse/cover	Built up Area	1	19.17
		Bare surfaces	1	
		Wetlands/water bodies	7	
		Heavy Forest	3	
		Light forest	4	

Source: Saaty 1994 and Jenks 1967

RESULTS AND DISCUSSION

The result showed that the zone of very High GWP was found in favourable biophysical environment: water bodies, vegetation, and wetlands located in flat to rolling with elevation of <50m having underlying alluvium and very low annual rainfall. Zone of very low GWP is however characterized by unfavourable conditions: very low annual rainfall; urban and cultivated area; low lineament density; sandy loamy; elevation exceeding 150m above mean sea level; low lineament density and slope exceeding 5 from the slope table.

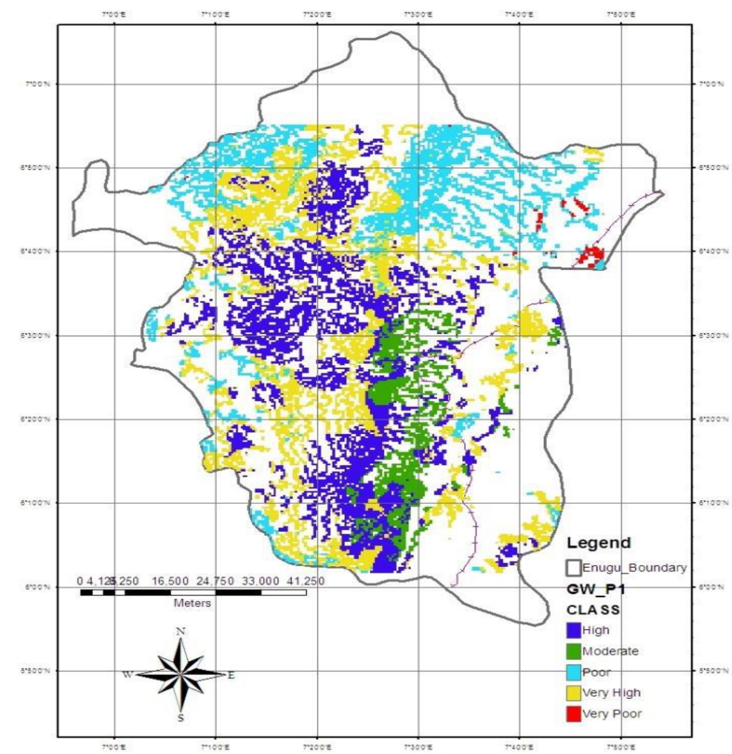

Figure 11: Groundwater Potential Map

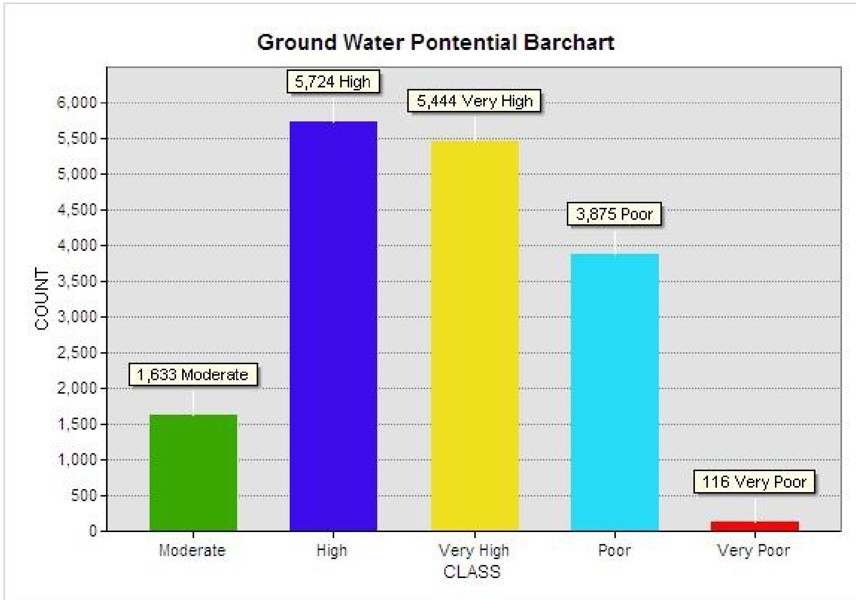

Figure 12: Groundwater Bar chart

The result showed that the groundwater potential zones were divided into five, such as High (47.40% of the area), Very High (28.21% of the area), Moderate (6.87% of the area), Poor (14.20% of the area), and Very Poor (3.32% of area). The best groundwater potential zone is concentrated in the south-western and north-western regions of the study area due to its almost flat terrain nature with high limestone and dense forest land having high infiltration ability. Rain water is chiefly accountable for the groundwater recharge in the study area.

CONCLUSION

In this project, an attempt was made to map the groundwater potential zones of Enugu State with the available data using Remote Sensing & GIS. It was concluded that combination of remote sensing and GIS is a useful technique for the groundwater exploration and has aided the successful delineation of groundwater potentials. It also can be considered as a time and cost-effective tool for delineations and identification of high ground water potential target area. The result of this study can serve as guidelines for planning future artificial recharge projects in the study area to ensure sustainable groundwater utilization.

REFERENCES

Aller, L., Bennett, T., Lehr, J.H., and Petty, R.J. (1985). DRASTIC: A standardized system for evaluating ground water potential using hydrogeological settings. USEP, Ada Oklahoma.

Ayoade, J. O. (2003).Tropical Hydrology and Water Resources. Macmillan Ltd. 2003; p. 276.

BeritaHarian (2005).“Kering”. Chong, F.S., Ang N.M., (1976).“The Bukit Arang Tertiary Beds as a source of groundwater in Chuping, Perlis”, Annual Report of the Geological Survey of Malaysia.

Essays, U. K. (2018). Rainfall Pattern in Enugu State, Nigeria. Retrieved from https://www.ukessays.com/essays/statistics/analysis-of-rainfall-pattern-in-enugu.php?vref=1

Igbokwe, J. I. (1997.“Mapping of Land cover/landuse changes using Remote Sensing. Environmental review”. Vol. 1,pp.26-36.

Irem D.O. (1999). Weather forecasting and its utility in saving the future of our environment, Paper present at ESUT Auditorium on worldmet day, Enugu.

Jenks G. F. (1967). The data model concept in statistical mapping. Int. Yearb Cartogr 7:186–190

Khairul A., Juhari M.A., Ibrahim A., (2000).“Groundwater prediction potential zone in Langat basin using the integration of RS and GIS”, Proceedings ACRS 2000.

Kiran, P.S.R., Kumar, R.S., Stalin, K., Archana, P., Sridevi, L., Radha, A.S., (2008).“GIS Techniques for groundwater contamination risk mapping”, Proceedings Map India 2008.

Nkwunonwo U.C. (2009). “Digital Soil Map and Soil database of Nigeria”. Department of Geoinformatics & Surveying, University of Nigeria, Enugu Campus.

Ofomata, G.E. K. (2002).*A Survey of Igbo Nations,* Africana first publishers Ltd 75pp.

O'Leary D, Friedman D, Poh H. (1976). “Lineaments, linear, lineations: some standards for oldTerms”, Geol Soc Am Bull 1976; 87: 1463-69.

Saaty T. L. (1994). How to make a decision: the analytic hierarchyprocess. Interfaces 24(6):19–43.

MANAGEMENT PRACTICE MAPPING OF SELECTED CATCHMENT AREA IN DELTA STATE

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Abstract
The ravaging effects of erosion and flood prone sites in Nigeria especially within the South East zone, has recorded an overwhelming effects on the socio-economic activities of the people within those localities.These effects are responsible for the degradation of communication, depreciation of transportation and infrastructure, migration of communities and hazards. Several measures have been taken by individuals, communities and government to curtail or contain its impact to the people and environment.Geographic information techniques is today being extensively used in decision-making processes because it has become a fundamental element to provide better understanding about one's surroundings and management.This study therefore iterates the importance and techniques of geoinformatics in flood management. The primary data sources include Quickbird^{TM} imageries, LandSat imagery andAsterDEM.Various thematic layers were prepared, analyzed and integrated to produce management project maps of the sites. The result showed the relevance of geoinformatics and the management practice map of various erosion catchment areas in the study area.

Keyword: *Erosion, GIS, Management, Satellite imagery, AsterDEM*.

INTRODUCTION
Gully erosion is a highly visible form of soil erosion that affects soil productivity, restricts land use and can threaten roads, fences, buildings and even a whole community.
In Nigeria, the management and prevention of erosion and flood especially in rural areas have randomly used sandbags and etc to reduce the erosive effect of runoff. There is however absence of standardmanagement practices both in urban and rural settlements in controlling the effects of erosion and flood hazards.

Thereare various conservation techniques or measuresthat can be described under the headings of agronomic measures, soil management and mechanical methods.Agronomic measures utilize the role of vegetation to protect the soil against erosion. Soil managementis concerned with ways of preparing the soil to promote plant growth and improve its structure so that it is more resistant to erosion. Mechanical or physical methods, often involving engineering structures, depend on manipulating the surface topography – for example, installingterraces or windbreaks –to control the flow of water and air.Agronomic measures combined with good soil management can influence both the detachment and transport phases of erosion, whereas mechanical methods are effective in controlling the transport phase but do little to prevent soil detachment. Morgan *et al* (1985).

The optimal application of geoinformatics becomes imperative to effectively provide results that will aid good decision-making for management practices for controlling erosion and flood. The objective of the study was therefore to produce management practice map using GIS techniques based on different erosion practice measures from prescribed literatures.

MATERIALS AND METHOD

Study Area

This study was carried out in Delta State Nigeria which has her administrative seat in Asaba, a city located in the northern-eastern part of the state. There are twenty-five (25) Local Government Areas in Delta State (See figure 1). It lies within Latitudes 6° 29' 38.563"N and 5° 0' 33.342"N and Longitude 4° 59' 10.59"E and 6° 46' 6.569"E. The state occupies the area on the lower River Niger in the South-South geopolitical zone of Nigeria; and is bounded on the West by the Atlantic Ocean and Ondo State, on the North by the Edo State; and on the East by Anambra State, Imo State and Rivers State, while Bayelsa State bounds it on the south. Delta state covers an area of about 16,842 sq. km; and returned a population figure of about 4,098,291 people with 2,674,306 males and 2,024,085 females during the 2006 Census exercise. (NPC 2007).

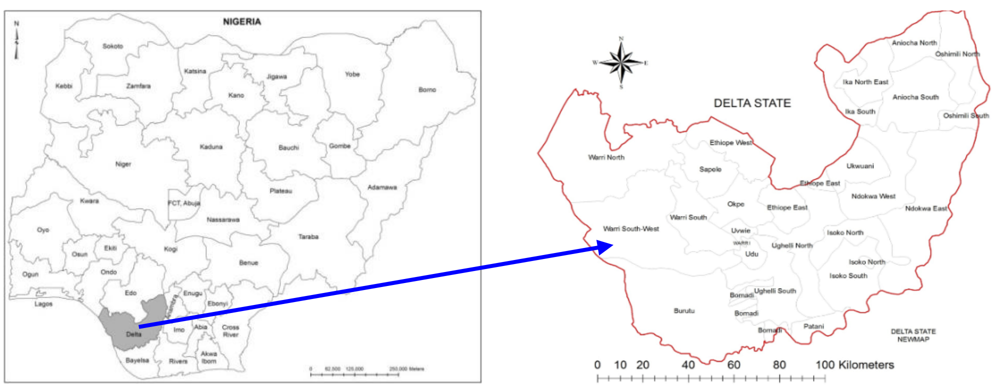

Figure 1: Map showing location of Delta State

There are five selected catchment areas to be covered in Delta State for this project:

(i) Midoma/ Ewerebor Erosion Site is located at Boji-Boji Owa, Ika North East LGA, Delta State with coordinates of Latitude N 6º 14’ 26.4’’ and Longitude E 6º 11’ 34.9’’ with estimated length and depth of 2800m and 25m respectively.

(ii) Obomkpa Erosion Site is located at Obomkpa in Aniocha North LGA, Delta State with coordinates of Latitude N 6º 23’ 6.6’’ and Longitude E 6º 28’ 58’’ with estimated length and depth of 2500m and 6m respectively.

(iii) Ogbe-Okwe Erosion Site is located at Ukwu-Nzu, Aniocha North LGA with coordinates of Latitude N 6º 23’ 10.6’’ and Longitude E 6º 28’ 52.7’’ with estimated length and depth of 600m and 11m respectively.

(iv) Onicha Road Erosion Site is located at Ubulu-Uku, Aniocha South, LGA with coordinates of Latitude N 6º 14’ 30’’ and Longitude E 6º 26’ 44.5’’ with estimated length and depth of 700m and 3m respectively.

(v) Jesse Erosion and Flood Site is located in Jesse, Ethiope West LGA with coordinates of Latitude N 5º 51’ 45.5’’ and Longitude E 5º 43’ 4.8”

Land Use / Land Cover Layer

For the purpose of land use / land cover mapping, row 56 of paths 189 and 190 seams of the Landsat 8 data was obtained from the Global Land Cover Facility(See figure 2).

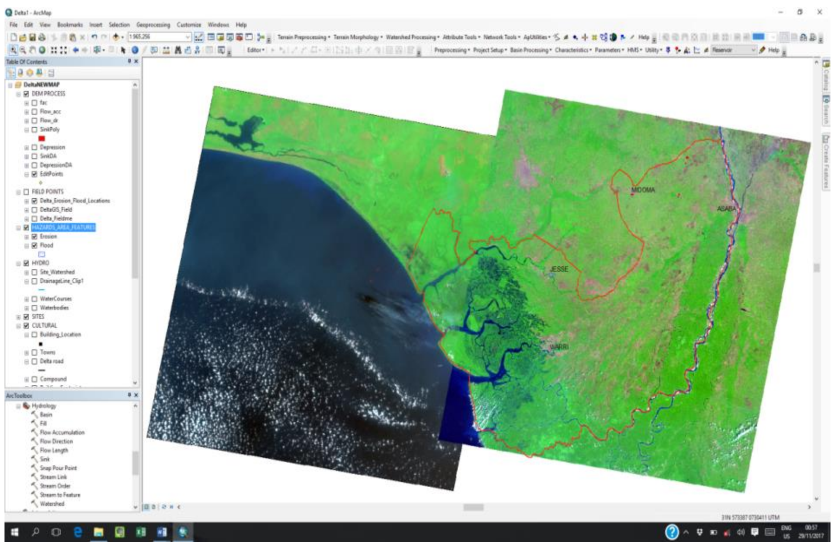

Figure 2: Landsat Images covering Delta State

The land use / land cover map of Delta State was generated from a supervised classification of the band 8 pan-sharpened RGB composite which consists of images of bands 4, 3, and 2 captured by the OLI (Operational Land Imager) sensor aboard Landsat 8. The supervised classification of the Landsat image was executed using the Multivariate toolset of the Spatial Analyst extension in ArcGIS.The procedure for the image classification is as represented in the flowchart in figure 3.Training samples were acquired and its data followed the Gaussian distribution.

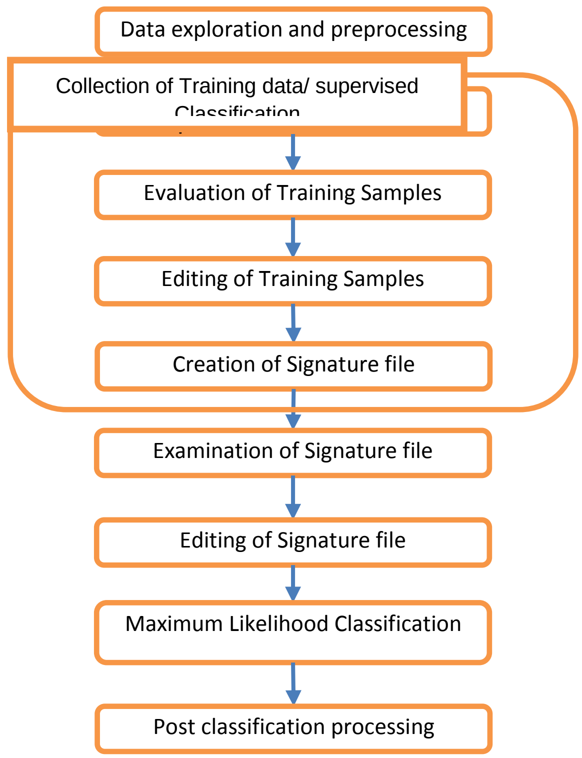

Figure 3: Flowchart for Landuse / Landcover classification

The maximum likelihood classification method is based on the Bayesian theorem of decision making was applied and equal à priori probability weighting was specified for all the land cover classes. See figure 4.

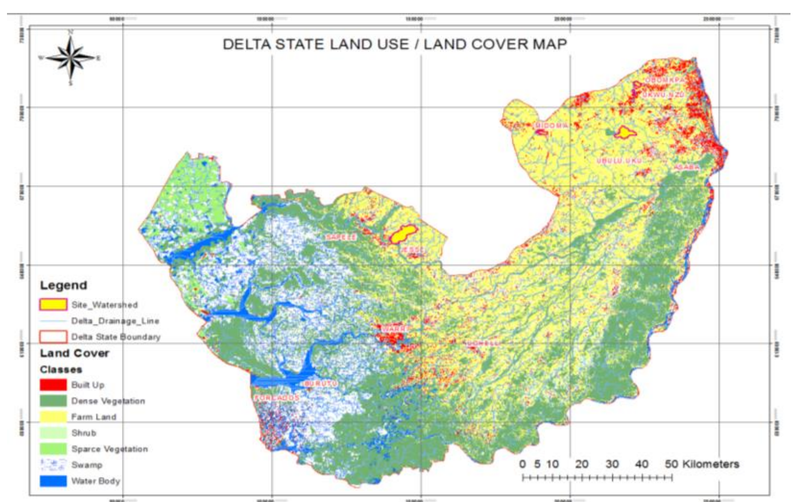

Figure 4: Delta State Landuse / Landcover Classification

Land Cover Composition Sites Catchment

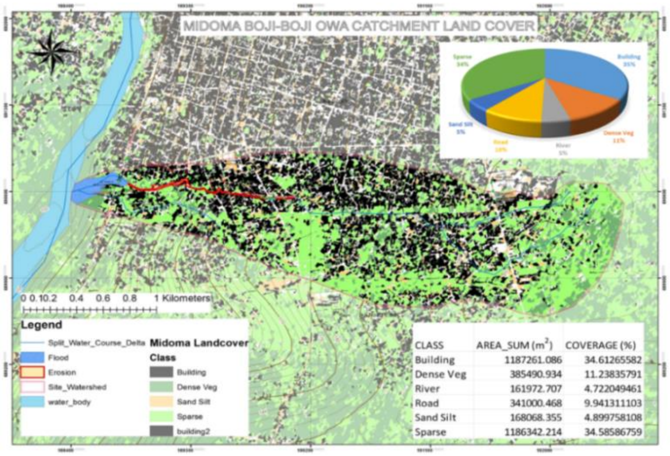

Figure 5: Ndoma Site Land Cover analysis

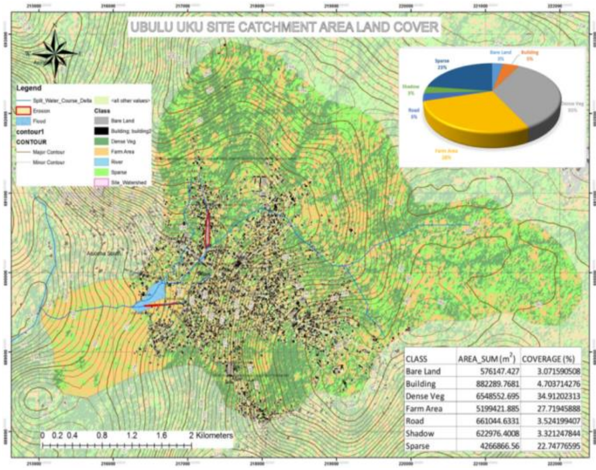

Figure 6: Ubulu Uku Site Land Cover analysis

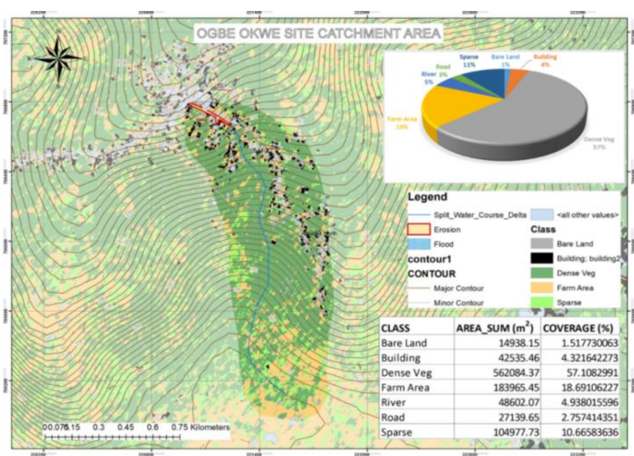

Figure 7: Ogbe-Okwe Site LandCover analysis

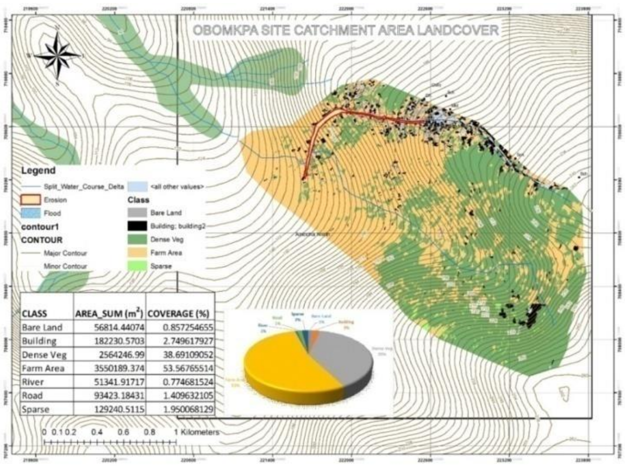

Figure 8: Obomkpa Site Watershed LandCover Analysis

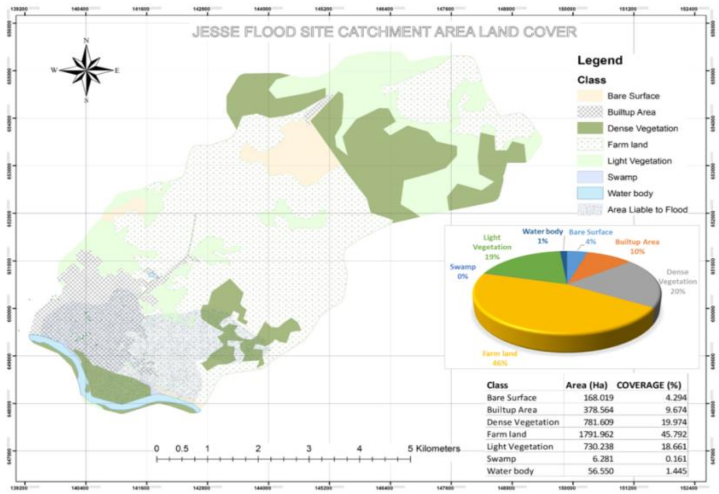

Figure 9: Jesse Flood Site Watershed Land Cover Analysis

The DEM Processing

Aster DEM which is a remotely sensed data was used and preprocessing wasdone.The preprocessing was carried out using ArcHydro Tools which plugs in seamlessly to ArcMap.

The elevation value of the DEM before treatment begins from -16 which are inconsistent with the a-priori knowledge of the area of study whereas the least value of cell elevation for treated DEM grid data is 10. See figure 10.

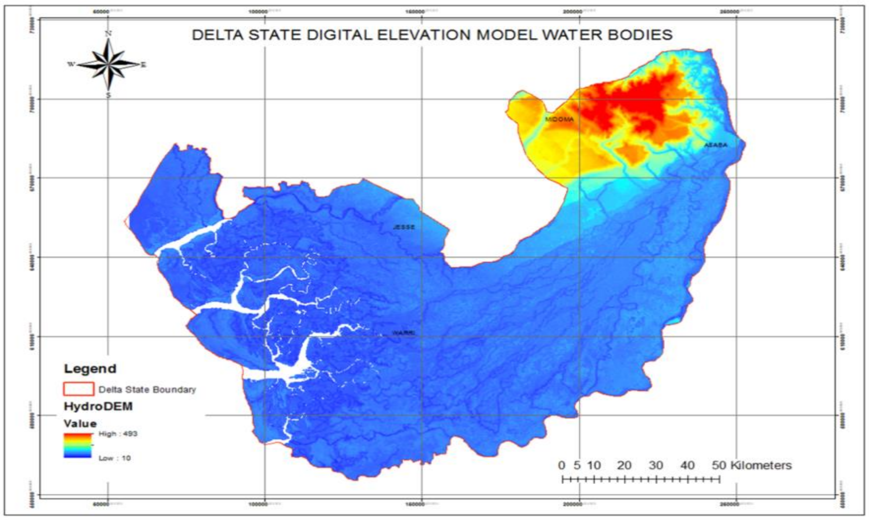

Figure 10: Digital Elevation Model of Delta State

Slope Analysis

Slope analysis was carried out on the Digital Elevation Model and categories were created for perception of clustered values. A Majority Zonal Statistics was carried out to investigate the relationship between terrain slope and the hazards of flood and erosion. Results show that 2° to 6.3°slope rise was found to hold for most erosion sites. The flood sites are found to fall within zones where the slope makes a 0.5° to1.5° inclination with the horizontal. See figure11.

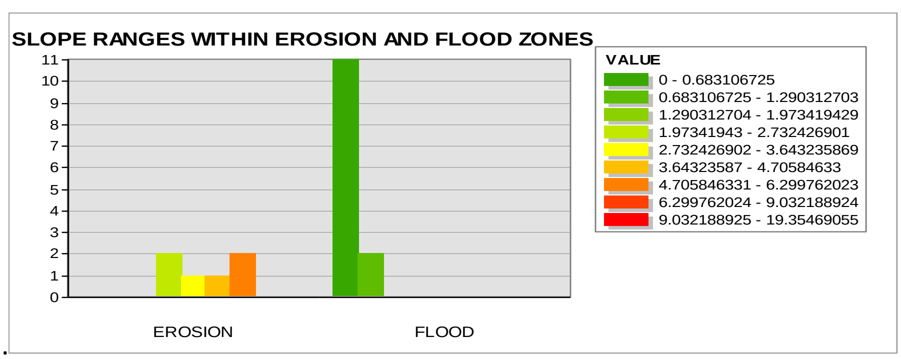

Figure 11: Histogram of Hazard Sites with respect to Slope

Furthermore, analysis to locate areas hit by erosion and flood geo-hazards was performed.The overlay capabilities of the GIS to extract the values of the slopes from the Slope raster into the Attributes table of the Erosion_and_Flood layer and subsequently queried for geo-hazard site that have intersecting locations as slope grid cells with threshold value of 10° inclination with the horizontal.This result was concordant with the observations made during field ground truthing see figures 12 & 13.

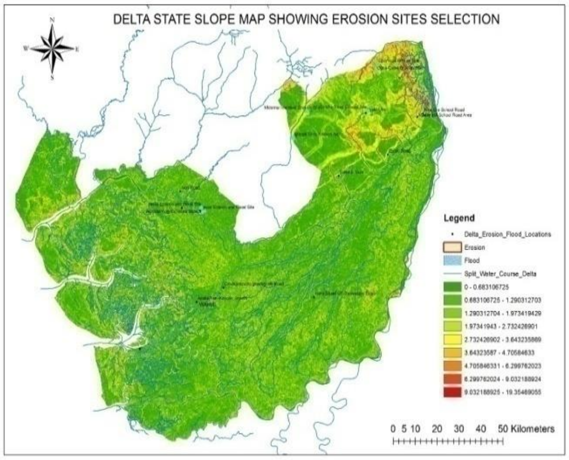

Figure 12: Slope Layer Erosion sites overlay

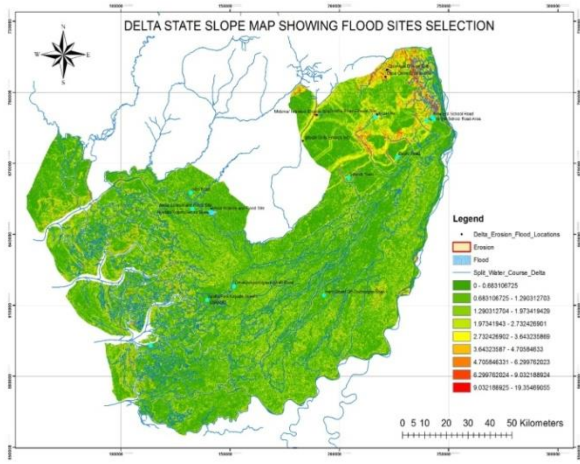

Figure 13: Slope Layer Flood sites overlay

Management Practices for Erosion and Flood Control

Preventing and Managing Erosion

The 3 main principles applicable in the control of erosion are:

i. Land Capability

Soil erosion can be avoided by using land within its capability.The land's position, soil type and slope determine how vulnerable it will be to erosion. It may not be suitable for agriculture, or suitable only for an activity which limits erosion.Using land according to its capability will require that the steeper slopes and shallower soils should be allocated for growing pastures, while the lower slopes and deeper soils should be used for growing crops.Morgan et al (1985)

ii. Surface Cover and Runoff

Surface cover is a major factor to control erosion because it reduces the impact of raindrops falling on bare soils and wind removing soil particles. It also reduces the speed of water flowing over the land.Erosion risk is significantly reduced when there is more than 30% soil cover. Total cover is achievable for many grazing and cropping systems.Morgan *et al* (1985)

iii. Useof Trees to Control Erosion

Trees are often considered to be the universal answer to control soil erosion. Tree roots help prevent landslides on steep slopes and stream bank erosion but they don't stop erosion on moderately sloping hillslopes.Asiabaka *et al* (1988)

Other practices of Erosion control in cropping lands also includeTillage, Contour banks/strip cropping and green cane.Morgan et al (1985)

Management Practice Map

For this study, the slope map, elevation, landuse landcover, ground truthing field observation and different management practice measures were usedto produce the management practice maps of various erosion sites in Delta State based on literatures. Figure 14 below shows the Management practice map for Jesse catchment, while Figures 15, 16 and 17 shows the Management practice map forMidoma catchment, Ubulu Uku catchment and Ukwu Nzu catchment respectively.

RESULTS AND DISCUSSION

The result shows that the runoff concentration is managed by structural measures such as contour banks in upland areas in Ubulu Uku and Ogbe Okwe, andstrip cropping on flood plains in Jesse in order to spread flood flowssee figures 14-17. Lower watersheds of Midoma Ewerebor, Flow between properties and across roads as seen in the upper watershed of Midoma and Uku Nzu must be coordinated and suit those affected by the changes.

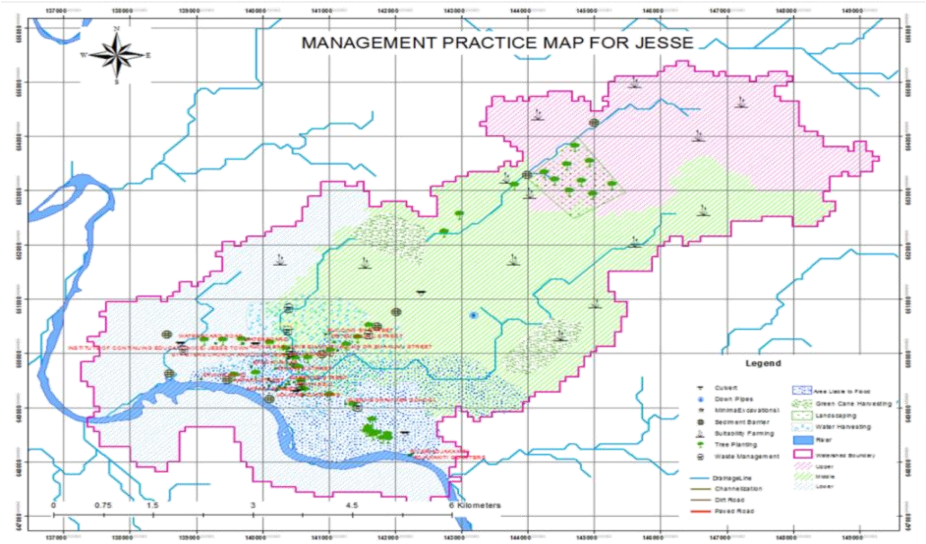

Figure 14: Management practice map for Jesse Catchment

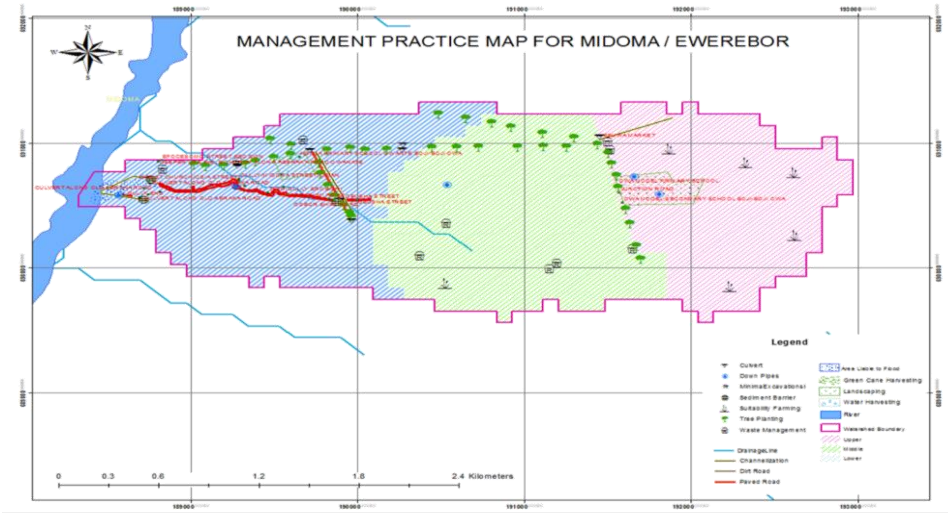

Figure 15: Management Practice Map for Midoma Catchment

The green cane harvesting and trees planting practice measures in figures 15, 16, 17& 18 were used to protect the soil from erosion by raindrop impact to maintain soil cover.

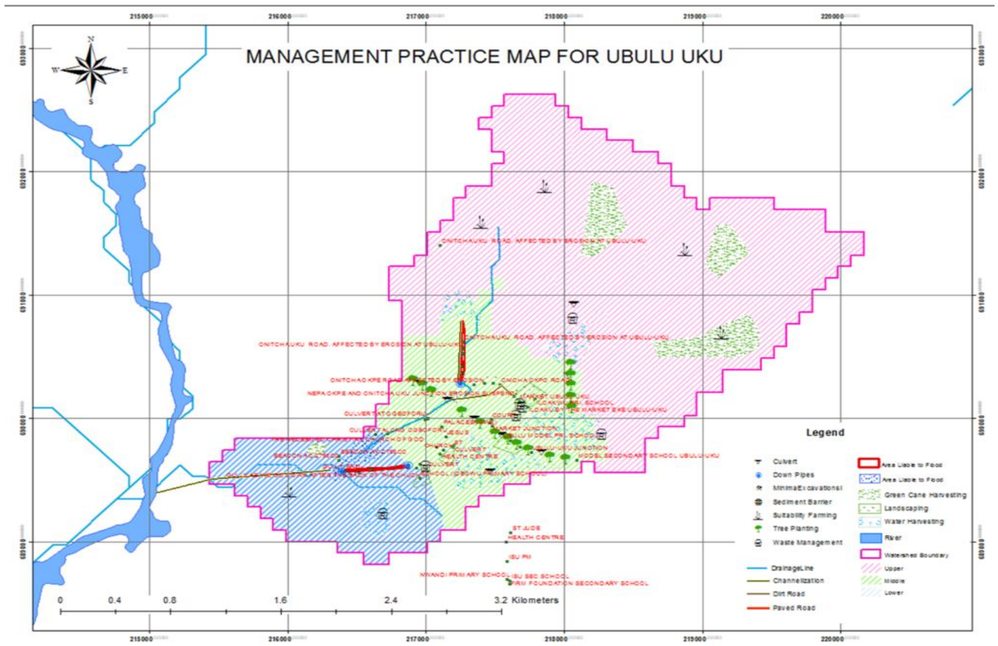

Figure 16: Management Practice Map for Ubulu Uku Catchment

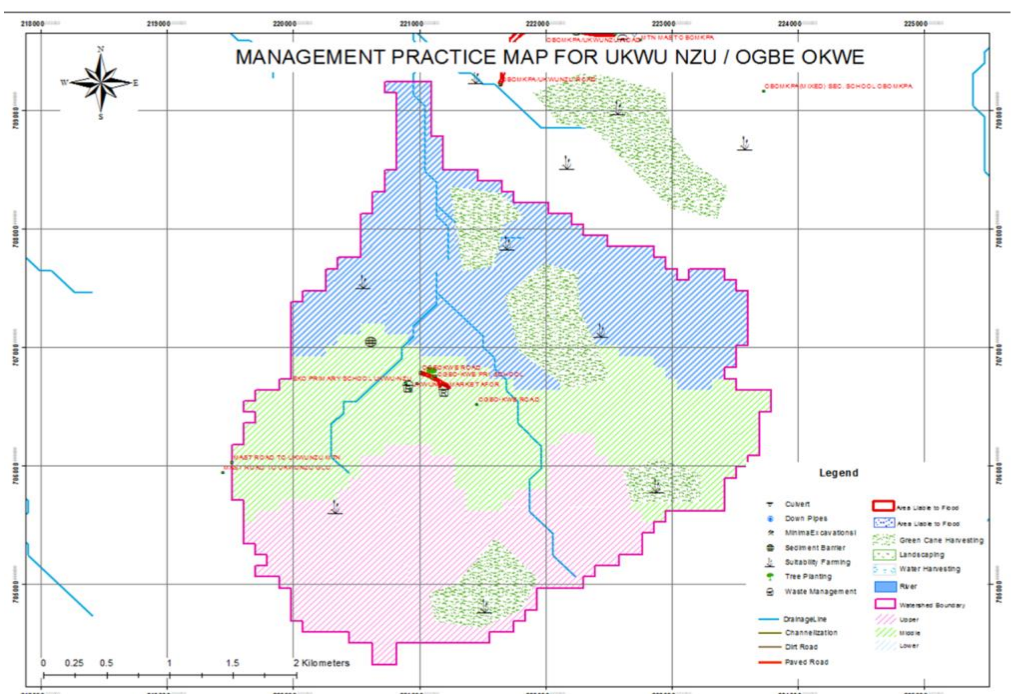

Figure 17: Management Practice Map for Ukwu Nzu Catchment

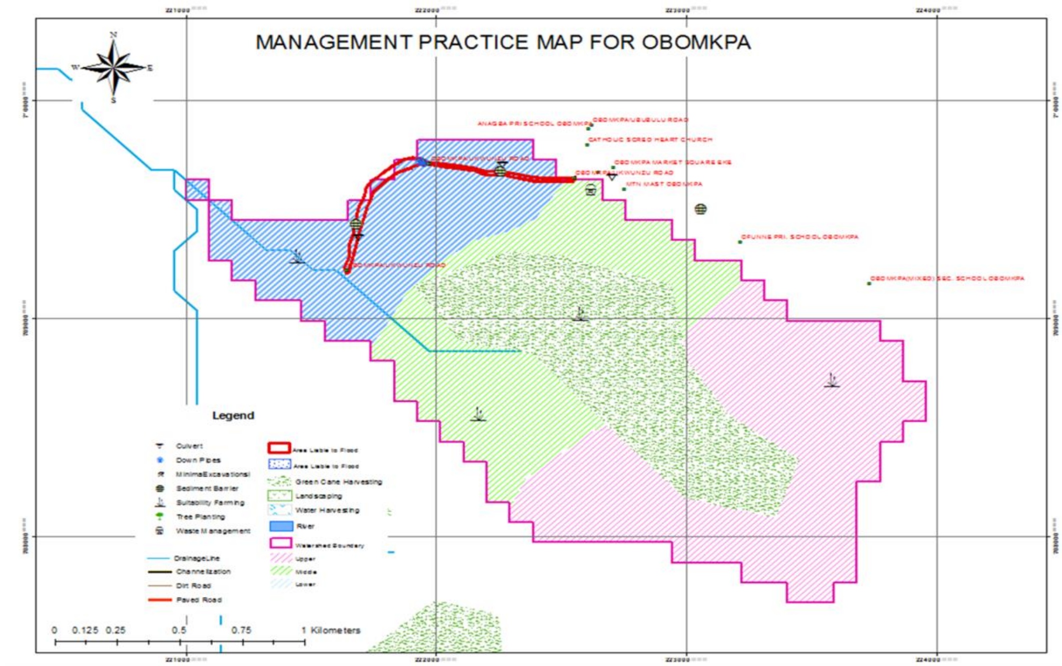

Figure 18: Management Practice Map for ObomkpaCatchment

Ubulu Uku also shows drainage extension practice due to the lowland nature of the area connecting the Onitchao Kpe road to take care of the gully formation due to wrongly terminated drain and also the installation of down pipes to properly channel the drainage line against damaging the Onitcho Epe road seeFig 16.

Measures taken in urbanareas when excavating, where possible, divert upslope stormwater around the work site and other disturbed areas, install sediment barriers (e.g. sediment fences or turf buffer strips) downslope of the construction site to filter coarse sediments and restrict vehicle access to one entry point where possible.

CONCLUSION AND RECOMMENDATIONS

Sustainable development relies on the control of the consequences of public decisions regarding natural resources, the people and the involved interrelationships.The result also demonstrates the relevance and capabilities of Geographic Information System in processing, decision-making in environmental erosion and hazard management.

Recommendations

Based on the results and analysis obtained, the government agency like Delta State Nigerian Erosion and Watershed Management (DTS-NEWMAP) saddled with the mandate of controlling, monitoring and measurement of erosion/flood hazard should engage the services of geoinformaticans for monitoringand effective management of such projects for the safety of lives, properties and the environment.

REFERENCES

Asiabaka C. C., Boers M. (1988). An analysis of the existing traditional methods of farming and erosion control among farmers in South East Nigeria. Report of the Erosion Research Centre, FUT. Owerri, Nigeria.

Igbokwe, J. I., Akinyede, J. O., Dang, B., Alagac, T., Onoa, M. N., Nnodu, V. C., Anike, L.O. (2008). ‘Mapping and monitoring of the impact of gully erosion in Southeastern Nigeria with satellite remote sensing and Geographic Information System’. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 37*, B8. Beijing.

Morgan, R.P.C. (1985a). Assessment of soil erosion risk in England and Wales. *Soil Use and Management* 1:127–31.

Morgan, R.P.C. and Rickson, R.J. (eds), *Slope stabilization and erosion control: a bioengineering approach*.E. and F.N. Spon, London: 95–131.

Morgan, R.P.C., (1985).Soil Erosion and Conservationby Blackwell Science Ltda Blackwell Publishing company2005, Third edition.

UTILIZATION OF CLIMATE ADAPTATION STRATEGIES AMONG ARABLE CROP FARMERS IN SOUTHWESTERN NIGERIA

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Abstract

Extreme climatic condition has posed a major threat to hunger reduction, food security and nutrition through it impact on agriculture. Adaptation remains the key solution to shape the future severity of climate change impacts on food production. In this study, the factors influencing utilization of adaptation strategies among arable crop farmers were examined. Primary data was collected with the aid of questionnaire and data were analysed using Descriptive statistics, Polychoric Principal Component analysis (PPCA) and Ordinary Least Square regression. The result showed that majority of the farmers were male (59%), married (82%) with an average age of 47.47± 14.91years. The strategy used by most of the farmers was the use different planting dates while the least used strategy was shifting cultivation. On the average, a farmer has an adaptation score of 5 and over 60% of the farmers used 5 or more adaptation strategies to minimize the effect of climate change. The factors influencing utilization of adaptation strategies among arable crop farmers in the area were age of the farmer, sex of the farmer, marital status, farm size, access to extension, access to climatic information and farming experience. It is thus recommended that government should strengthened initiatives that encourage youth and women in agriculture.

Keywords: *Adaptation, Arable Crops, Climate Change, Farmers.*

INTRODUCTION

Agriculture remains one of the major drivers of economy growth in Nigeria (Sertoglu *et al.,* 2017).The sector is largely affected by climate conditions limiting its production capacities since agriculture in Nigeria depend solely on rain-fedsystem (Agbola and Fayiga, 2016).Fatuase (2017) opined that extreme climatic condition has posed a major threat to hunger reduction, food security and nutrition through its impact on agriculture. The noticeable effect of climate change includefrequent drought, increased crop infestation by pests and diseases, decline in soil condition (soil water and nutrient), depletion of farm assets through flood, decline in forest products, increased rural–urban migration, increased health risk,spread of infectious diseases among others (Goyol and Pathirage, 2018; US-EPA, 2017).

Apata *et al.* (2009) reported that food crop farmers in Southwestern Nigeria are important pillar of the Nigerian economy as they provide the bulk of arable crops that are consumed locally and also supply major food crop to other regions in the country. However, these farmers are not left out in the crisis of adverse weather condition because climate change has strong negative impact on agricultural productivity (Anand and Khetarpal, 2015). Smith and Skinner (2002) in their own research opined that vulnerability to climate change can largely be reduced with adaptation to climate change because the vulnerability of farmers to climate change will continue to increase with climate variability and change without adaptation. Falaki *et al.* (2012) defined adaptation to climate change as a set of strategies put in place to reduce climate change effects with respect to agricultural and economic systems.

Adaptation remains the key factor that will provide solution to the future severity of climate change impacts on food security as well as agriculture in general thus enable farmers to achieve their food, income and economic objectives in the face of changing climatic environment (Ziervogel and Ericksen, 2010) . Studies have affirmed that smallholder farmers in rural areas have some knowledge, ideas and information on how to cope and adopt strategies to mitigate the climatic change impacts (Falola and Achem, 2017; Obayelu *et al.*, 2014; Fatusi, 2014) but it is still unclear whether the responses of the farmers to climate change are adequate to ensure food security and sustainable agriculture in the region and the country in general. Therefore, the objective of this study is to examine the utilization of adaptation strategies among arable crop farmers in Southwestern, Nigeria with the aim of identifying the adaptation strategies used and the factors that influenced farmer's utilization of adaptation strategies.

MATERIALS AND METHODS

Study Area

The study was carried out in southwestern Nigeria. The region is one of the six geo-political zones in Nigeria. It is made up of six States namely Oyo, Ogun, Osun, Lagos, Ondo and Ekiti States. The region is classified as warm humid climate with two distinct seasons namely; the rainy and dry seasons. The region is located on longitude and latitude of 8.6753^0 and 9.082^0 respectively with land area of $77{,}818km^2$. The temperature of the area ranges between 21^0C and 34^0C with an annual rainfall that ranges between150mm and 3000mm. The arable crops produced in the area include are; maize, cowpea, cassava etc.

Source and type of Data

Primary data were collected and was used for this study. Data were collected with aid of a well-structured questionnaire. Data were collected on socio-economic characteristics of the farmers, farm enterprise information and adaptation strategies used by the farmers.

Sampling Technique and Sample Size

Multistage sampling technique was used to select respondents for the study. The population of the study was arable crop farmers that utilized atleast one adaptation strategy. In the first stage, two out of six States in the southwest zone were randomly selected. The States selected were Oyo and Ekiti States. In the second stage, four Local Governments Areas (LGAs) were selectedin each State. The third stage of the sampling was a random selection of five villages from each of the selected LGAs based on predominant of arable crop farmers. Finally, ten arable crop farmers that adapt to climate change were selected for this study. A sample size of 400 respondents was used butinformation of 355 respondents was used for analysis due to inconsistencies in the responses and/or non response of some arable crop farmers.

Data Analysis

Descriptive statistics such as mean, standard deviation, minimum and maximum values were used to describe the socio-economic characteristics of the respondents, farm enterprise variables as well as the summary statistics of the adaptation strategies used by the farmers.Polychoric principal component analysis was used to aggregate the adaptation strategies used by the arable crop farmers. The methodology was used to generate the adaptation index that was used as the dependent variable in the regression analysis. The indicators used to generate the adaptation index are presented in the Table 1.

Table1 : Indicators used to generate adaptation index

S/N	Climate Adaptation Variables	Modalities
1	Crop Rotation	Yes, No
2	Mixed Farming	Yes, No
3	Mixed Cropping	Yes, No
4	Shifting Cultivation	Yes, No
5	Use of different Planting Dates	Yes, No
6	Reduction of Farm Inputs	Yes, No
7	Mulching	Yes, No
8	Irrigation	Yes, No
9	Use of Improved Varieties	Yes, No

Source: Field Survey, 2017.

Ordinary least square regression was used to identify the factors that influence adaptation to climate change among arable crop farmers. The OLS model used in this study is specified as:

$$Adaptation\ index_i = \beta_0 + x_i\beta_i + v_i\ , \quad \ldots\ldots\ldots \quad (1)$$

Where x are independent variables

$Adaptation\ index_i$ is the dependent variable

The explanatory variables x are specified as:

x_1=Sex of farmer (1 if male, 0 otherwise); x_2 = Age of farmers (years); x_3= Marital status (1 if married, 0 otherwise); x_4= Farmer engage in non-farm activities (1 if yes, 0 otherwise)

x_5= Access to credit (1 if yes, 0 otherwise); x_6= Access to extension (1 if yes, 0 otherwise)

x_7= Household size (persons); x_8= Farming experience (years); x_9 = Farm size (acres)

x_{10}= Access to climatic information (1 if yes, 0 otherwise); x_{11}= Farm income (₦)

RESULTS AND DISCUSSION

Descriptive Statistics of Selected Characteristics of Respondents

Table 2 shows the descriptive statistics of selected characteristics of respondents. The average age of arable crop farmers in the study was 47.47± 14.91years and about 59% were male. This implies that majority of the farmers were male in their late forties which is consistence with the findings of Awotide *et al.*, (2015). More than 80% of the farmers were married with a mean household size of 6 persons. The large family size among arable crop farmers has been previously reported by Ibrahim *et al.*, (2015). It was also revealed that majority of the farmers (52%) had no formal education while about 8% had tertiary education. Almost 60% of the farmers engaged in non-farm activities. Only 32% of farmers have access to extension agents while over 70% of farmers have access to credit. The average farm size of the farmers was 6.19±10.07acres and only 16% of the farmers own land. Arable crop farmers in the area have average farming experience of 15.13±10.07years with average income of ₦178,823.5 per annum from farming activities.

Table 2: Summary Statistics of Selected Variables

Variable	No of Obs	Mean	Std. Dev.	Min	Max	
Age of Farmer	355	47.4732	14.9052	20	80	Age of farmer in completed years
Sex of Farmer	355	0.5859	0.4933	0	1	1 if farmer is male, 0 otherwise
Marital Status	355	0.8225	0.3826	0	1	1 if farmer is married, 0 otherwise
Household size	355	5.9492	3.0314	1	27	Number of household members
No formal education	355	0.5239	0.5001	0	1	Dummy for education if obtain no formal education
Primary	355	0.2901	0.4545	0	1	Dummy for education if obtain primary education
Secondary	355	0.1098	0.3132	0	1	Dummy for education if obtain secondary education
Post –Secondary	355	0.0761	0.2655	0	1	Dummy for education if obtain tertiary
Engage in non-farm	355	0.5887	0.4927	0	1	1 if farmer engage in non-farm activities
Extension Reach	355	0.3183	0.4665	0	1	1= farmer reached by extension services
Credit Access	355	0.7352	0.4418	0	1	1=farmer have access to credit
Farm Size	355	6.1951	10.0716	0.5	10	Farm size in acres
Farming Experience	355	15.1296	12.9401	1	50	Farmers experience in years
Landownership	355	0.1606	0.3676	0	1	1 if farmer owns land
Access to Climatic information	355	0.4028	0.4911	0	1	1 if farmers have access to climatic information
Farm income	355	178823.5	201122.4	25250	2000000	Farm income in (₦)
Adaptation score	355	5.2732	2.5202	1	9	Number of adaption strategies used

Source: Data Analysis, 2018

Adaptation Strategies used by Arable Crop Farmers

Adaptation strategies used by farmers was reported in Table 3. Majority of the arable farmers of over 50% of the farmers used different planting dates, mixed cropping, crop rotation, use of improved varieties, mulching and mixed farming as adaptation strategies to cope with changes that occurs. Further, less than 50% of farmers utilized shifting cultivation, reduction of farm inputs and irrigation as well. The strategy used by most of the farmers wasdifferent planting dates while the least used strategy was shifting cultivation. This result is not surprising as climatic change has made it difficult for farmers to predict timing of rain and other climatic variables so planting on different dates will reduce the risk of losing the crops on the entire farmland if there is delay in rainfall or adverse effect of other climatic variables (Liwenga, 2003). The use of shifting cultivation may be difficult for farmers to adopt due to land inaccessibility by farmers

Table 3: Summary statistics for Adaptation Strategies used by Arable Crop Farmers

Variable	Observation	Mean	Std.Dev.	Min	Max
Crop Rotation	355	0.7042	0.4570	0	1
Mixed Farming	355	0.5577	0.4974	0	1
Mixed Cropping	355	0.7211	0.4491	0	1
Shifting Cultivation	355	0.3408	0.4747	0	1
Use of different Planting Dates	355	0.7268	0.4463	0	1
Reduction of farm inputs	355	0.4592	0.4990	0	1
Mulching	355	0.6676	0.4717	0	1
Irrigation	355	0.4423	0.4974	0	1
Use of Improved Varieties	355	0.6704	0.4707	0	1

Source: Data Analysis, 2018

Arable Crop Framers' Adaptation Score

The average adaptation score of farmers was 5.27 (Table 4). This implies that a farmer used five adaptation strategies on the average. This means farmers used multiple strategies to reduce the adverse effect of climate change on their crop. About 34% of the farmers had adaptation score of less than 5 while 66% had adaptation score that is greater or equal to 5. This implies that majority of arable crop farmers used five or more adaptation strategies. The use of multiple strategies among arable crop farmers has been previously reported in the study of Ibrahim *et al.,* (2011).

Table 4: Distribution of Farmer's Adaptation Score

Adaptation Score	Frequency	Percentage (%)
1	52	14.65
2	9	2.54
3	33	9.30
4	27	7.61
5	44	12.39
6	70	19.72
7	44	12.39
8	37	10.42
9	39	10.99

Source: Data Analysis, 2018

Determinants of Farmer's Utilization of Adaptation Strategies

Table 5 below shows the factors that influence arable crop farmer's utilization of adaptation strategies. The predicators of utilization of adaptation strategies in the model were sex of the farmer, age of the farmer, marital status, access to credit, access to extension, farming experience, farm size and access to climatic information. The coefficient of sex is negative and significant. This implies that female farmers adapt with about 29.6% more than male farmers therefore women farmers adapt more than male farmers. Kgosikoma*et al.*(2018) in their research opined that women adapt more to climate change than men due to their willingness to change their livelihood strategies in order to support their family. The result of this study further revealed that a year increase in the age of farmer reduces adaptation by 3.2%. This implies that younger farmers adapt more than older farmers. This is not surprising because younger farmers always have the zeal to adopt and try new innovations or practices that can improve their farm production while older farmers are more risk-averse and conservative (Gbetibouo, 2009). Farmers that are married adapt 57.52% more than farmers that are not married. This may be due to household responsibilities of married farmers. This finding corroborated with the findings of Fatusi (2014). Farmers that have access to credit and extension adapt 60% and 23% respectively more than their counterparts that do have access to credit and extension services. Farmers that have access to extension can get information on the risks of climate change and various adaptation options. Farmers that have access to credit can meet the cost of adaptation and also make beneficial use of available information on climate change. The positive significant relationships of climate adaptation with access to credit and extension have been previously reported by Ojo and Baiyegunhi, (2018). As regards farmer's experience, a one year increase in farmer's experience increase adaptation by 5.3% while a one acre increase in farm size increase adaptation by 2%. Hassan and Nhemachena, (2008) reported that farmers with more farming experience are likely to have more awareness of climate risks while Maddison, (2006) found that farm size is a major determinants of adoption in Africa. Farmers that have access to climatic information adapt 63% more than farmers that do not have access to climatic information.Access to climatic information enables farmers to adjust to changes in the climatic variables; this finding is similar to the findings of Khanal *et al.* (2018).

Table 5: Factors Influencing Arable Crop Farmers Utilization of Adaptation Strategies

Variable	Coefficient	Standard Deviation
Sex of farmer	-0.2962**	0.1322
Age of farmer	-0.0316***	0.0055
Marital status	0.5752***	0.1668
Engage in non-farm	0.1606	0.1307
Credit access	0.5979***	0.1444
Access to extension	0.2264*	0.1375
Household size	0.0100	0.0241
Farming Experience	0.0529***	0.0062
Farm size	0.0193***	0.0067
Access climatic information	0.6341***	0.1299
Ln Farm income	-0.0299	0.1668
Constant	0.7248	0.8536
Observations	355	
R-square	0.3733	
F(11, 355)	18.52	
Prob > F	0.000	

***, **, * Significant at 1%,5% and 10%
Source: Data Analysis, 2018

CONCLUSION AND RECOMMENDATIONS

The determinant of adaptation strategies among arable crop farmers was examined in this study. Generally, majority of arable crop farmers use five or more adaptation strategies. Use of different planting dates was the most used strategy while shifting cultivation was the least used strategies. The major determinants of adaptation in the study area were sex of the farmer, marital status, age of the farmer, access to extension, access to credit, farm size, farming experience and access to climatic information.It is thus recommended that programs/ initiatives that encourage youth and women to participate in agriculture should be strengthened. Gender responsive adaptation strategies/technologies should be developed. Policy options to facilitate availability of credits, land access as well as extension access should also be implemented. Programmes that will increase access to information on climate change and use of various adaptation strategies should be put in place by government.

REFERENCES

Agbola, P. and A.O Fayiga (2016). Effect of Climate Change on Agricultural Production and Rural Livelihood in Nigeria. *Journal of Agricultural Research and Development* 15(1).

Anand, A. and S. Khetarpal (2015). Impact of Climate Change on Agricultural productivity. In Bahadur B., Venkat Rajam M., Sahijram L. and K. Krishnamurthy (eds) *Plant Biology and Biotechnology*. Springer, New Delhi.

Apata, T.G., Samuel, K. D. and A.O. Adeola (2009). Analysis of Climate Change Perception and Adaptation among Arable Food Crop Farmers in South Western Nigeria. Paper presented at the International Association of Agricultural Economists' Conference held in August, 16-22. Beijing, China.

Awotide, D. O., Ikudaisi, O. J., Ajala, S. O. and J. H. Kaltungo (2015). Input Use and Profitability of Arable Crops Production in Nigeria. Journal of Sustainable Development 8(3): 139-146.

Falaki, A.A., Akangbe, J., Ayinde, O., Oje T. and A. Ajayeoba (2012). Climate Change Adaptation in the Context of Development: Middle-belt, Nigeria experience. A contribution to Conference on Climate Change and Development Policy, organized by the World Institute for Development Economics Research of the United Nations University (UNU-WIDER) in Helsinki

Falola, A. and B. A. Achem (2017). Perception on Climate Change and Adaptation Strategies among Sweet Potato Farming Households in Kwara State North-central, Nigeria. *Ceylon Journal of Science*. 46(3): 55-63.

Fatuase A. I. (2017). Climate Change Adaptation: A Panacea for Food Security in Ondo State, Nigeria.*Theor. Appl. Climatol*. 129: 939–947.

Fatusi, F. M. (2014). The Perception and Adaptation to Climate Change among Cocoa Farming Households in Ondo State Nigeria. *Academic Journal of Interdisciplinary Studies*3(1): 147-156.

Gbetibouo, G.A (2009). Understanding Farmer's Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa. IFPRI Discussion Paper No. 00849.

Goyol, S. and C. Pathirage (2018). Farmer's Perceptions of Climate Change Related Events in Shendam and Riyom, Nigeria. *Economies* 6(4):70

Hassan, R. and C. Nhemachena (2008). Determinants of African Farmers Strategies for Adapting to Climate Change: Multinomial Choice Analysis. *African Journal of Agricultural and Resource Economics*. 2(1):83-104.

Ibrahim, S. B., Afolami C. A., Ayinde, I. A. and C. O. Adeofun (2011). Modelling Arable Crop Farmer's Decisions on Climate Change and Adaptation Strategies: A Multinomial Logit Analysis of Ogun State. Proceeding of the Environmental Management Conference held at the Federal University of Agriculture, Abeokuta.

Ibrahim, S., Ayinde, I. and A. Arowolo (2015). Analysis of Arable Crop Farmer's Awareness to Causes and Effects of Climate Change in Southwestern Nigeria. *InternationalJournal of Social Economics* 42(7): 614-628

Kgosikoma, K. R., Lekota P.C. and O. E. Kgosikoma (2018). Agro-pastoralist's Determinants of Adaptation to Climate Change. Retrieved online at www.emeraldinsight.com. on 15th February, 2019.

Khanal, U., Wilson, C., Hoang, V. and B. Lee (2018). Farmer's Adaptation to Climate Change, Its Determinants and Impact on Rice Yield in Nepal. *Ecological Economics*. 144: 139-147.

Liwenga, E.T. (2003). Food Insecurity and Coping Strategies in Semi-Arid Areas: The Case Mvumi in Central Tanzania. Ph. D Dissertation No 11. Stockholm Studies in Human Geography, Stockholm University Stockholm, Sweden.

Maddisson, D. (2006). The Perception and adaptation to Climate Change in Africa. Centre for Environmental Economics and Policy in Africa University of Pretoria, South Africa. CEEPA Discussion Paper No 10.

Obayelu, O. A., Adepoju, A. O. and T. Idowu (2014). Factors Influencing Farmer's Choices of Adaptation to Climate Change in Ekiti State, Nigeria. *Journal of Agriculture and Environment for International Development.* 108(1): 3-16.

Ojo, T. and L. Baiyegunhi (2018). Determinants of Adaptation Strategies to Climate Change among Rice Farmers in Southwestern Nigeria: A Multivariate Probit Approach. Paper presented at the 30th International Conference of Agricultural Economist between July 28th – August 2nd 2018 at Vancouver, Canada.

Sertoglu, K., Ugural S. and F. S Bekun (2017). The Contribution of Agricultural Sector on Economic Growth in Nigeria. *International Journal of Economics and Financial Issues* 7(1): 547-552.

Smith, B. and M. Skinner (2002). Adaptation options in Agriculture to Climate Change: A Typology, Mitigation and Adaptation Strategies for Global Change. 7: 85-114.

United States Environmental Protection Agency (2017). Climate Impact on Human Health. Retrieved online at www.epa.gov on 7th March, 2019.

Ziervogel, G. and P. J. Ericksen (2010). Adapting to Climate Change to Sustain Food Security. Advanced Review 1: 525-540.

SOCIOECONOMIC POTENTIALS OF WOMEN IN HOUSEHOLD WATER MANAGEMENT PRACTICES IN ONDO STATE NIGERIA

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Abstract

This study examined the socioeconomic potentials of women in household water management.Socio-economic characteristics of respondents were examined, determine the role of women in the use of water resources, identify the basic water resources management in the study area, examine the activities of extension available to women on water resources management, examine factors militating against sustainable water resources management by the respondents in the study area.Data collection which involved the use of structured questionnaire from randomly selected 80 respondents. The data obtained were analysed using frequency, percentage, mean statistics, Chi-square and PPMC. The result revealed that the mean age of the respondents was 35 years and had an average household size of 5 members. Most of the respondents were literate and their major occupation was trading. The average income was ₦78,125 per annum and 85% were Christian.The study revealed that the women were the main collectors, users and managers of water in the household. The major water facilities used by the respondents is borehole and this constitute their major source of drinking water. The major water management practices employed by the women to ensure the health of their families include storing/pre-settlement (72.5%), addition of alum (46.3%), boil and filter (35%) and so on. The findings revealed that there was no significant relationship between the socioeconomic characteristics of the respondents (age, marital status, educational level, household size, income, members of social organization) and water management practices. However, there was a positive correlation between (age, income) and water management practices. While the correlation between household size and water management practices is negative.

***Keywords**: Water, Management, Women, Household, Usage*.

INTRODUCTION

Water is essential for all forms of life and crucial for human development. Water systems, coastal zones, surface waters and aquifers provide a vast majority of environmental goods and services, including drinking water, transport and food. As the world population has tripled over the last century the use of renewable water resources has grown six fold. Water sustaining role in the ecosystems remains undervalued despite the fact that minimum flows in water bodies are needed to support environmental health and increasing human demands. Faced with shortages and a grim future if current trends persist, there is a growing understanding that sustainable water management becomes inevitable. Thus water deprivation becomes a major concern in both the quality and quantity (Nuratu, 2014). According to the United Nation's FAO, over 230 million people live in 26 countries classified as water deficient, of which 11are in Africa. Water scarcity hits the poor and the most vulnerable first and hardest who are mostly women and children. The role of women in management therefore cannot be over emphasized.

Water is essential to human life. Human survival and well-being in space and time is partly dependent on the access to and the utilization of potable water. Water is required in homes for different purposes including bathing, drinking, cooking, laundry and cleaning, among others. Women and men experience unequal water roles and responsibilities. Women struggle hours every day to collect water for the household, whilst men occupy the decision making positions regarding the water supply management and development, locally and nationally. Women have the potential powers to play an important role in the provision, management and safeguarding of the water resources. In most rural areas, women are the main providers and users of water at the household and community levels. They are responsible for collecting, transporting, storing and managing water to meet their basic needs such as cooking, cleaning, washing, and personal hygiene (Aureli and Brelet, 2004). Women and water are linked in several ways; an important linkage being their role in the management of water (Aureli and Brelet, 2004). Traditionally, and almost universally, women in rural areas are predominantly regarded as domestic water managers. However, their roles are neither limited nor static. It is known that women also play a substantial role in food production, although it varies regionally and from country to country. In Africa, women produce about 70% of the food, while in Asia, the figure stands at 60% (Aureli and Brelet, 2004). This makes women the primary water users and managers in the agricultural sector (Singh, 2006).

Water is critical to the livelihoods and well-being of the world's population but millions suffer from lack of access to clean water, inadequate water for food production and the effects of pollution and environmental change. Increasingly, improved water supply management is seen as centrally important to poverty alleviation and to ensuring a sustainable future for millions of people with vulnerable livelihoods in marginal environments. The impact of inequitable access and poor management is huge.

Management of water is becoming especially important as regions of the globe become warmer and drier under the influence of global warming. As water becomes scarcer, the importance of how it is managed grows vastly. Finding a balance between what is needed by humans and what is needed in the environment is an important step in the sustainability of water resources. The decline in quantity and quality of water leads to overexploitation of surface and groundwater resources and magnifies problems related to desertification.Many rural dwellers lack indoor plumbing or nearby outdoor piped water from a safe supply (from wells, boreholes, protected or upland surface water sources, etc.). Often they have to travel considerable distances to reach any water source, regardless of quality, for collection and household use. The water collected for domestic use often becomes contaminated by unsafe consumer storage and handling practices at the household level. Many continue to obtain their water on a daily or other frequent basis from any available source and either carry it or otherwise have it delivered to the home for personal use. Typically, this water is gathered and stored in vessels of various designs and materials. Often, the water is not treated or otherwise protected from subsequent contamination during use. Key factors in the provision of safe household water include the conditions and practices of water collection and storage and the choice of water collection and storage containers or vessels.Water management means dealing with water in the best possible way. This can be done by local authorities (municipal water management) or it can be done by individuals at home (when we manage how we use our own water supplies).

Women play an important role in water management. They are most often the collectors, users and managers of water in the household as well as farmers of irrigated and rain fed crops. Because of these roles, women have considerable knowledge about water resources including quality and reliability, restrictions and acceptable storage methods and keys to the success of water resources development and irrigation policies and programs.Women make multiple and maximum use of water sources and attempt to assure that these sources do not become polluted. Given their multiple and often competing needs such as water for livestock and human consumption as well as time and resource constraints, women often cannot avoid contaminating water supplies.

Due to an increasingly growing population currently reaching over 6 billion people, the pressure on the earth's water resource has grown (UNESCO-WWAP, 2003). Great parts of the world suffer from water scarcities as a result of an imbalance between water use and available water resources. Although many communities are considered to have rich water resources, the production, distribution and use of water is not efficient, sufficient, or sustainable. Since women are active agents of conservation and restoration of water resource, their caregiving responsibilities and livelihood activities are often highly dependent on it.

Women's direct contact with water resource has produced their deep-knowledge about its management, thus, women served as water managers. Water-resource planners, representing both national governments and donors, have focused their attention on women's reproductive and primarily domestic responsibilities. This has been a fundamental error because women's strategic interest in water is closely associated with their productive roles (which, in turn, are often synchronous with their reproductive tasks). In overlooking this reality, planners have seriously undermined the capacity of women to make a substantial contribution to national-development processes, and this has led to significant losses of water resources in Africa (Rathgeber, 1997). Although the economic contribution of women's work can be of significant importance to the household, women's access to water resources is often strictly controlled both directly by their husbands and indirectly by existing cultural norms and practices. A major question under consideration is whether the socioeconomic potentials of these women has influence on management of water resources at their disposal.In view of this, this study was broadly designed to examine the socio-economic potentials of women in household Water Management practices, with Ondo State, Nigeria as a case study.The specific objectives of the study were to; (1) examine the socio-economic characteristics of respondents (2) identify the sources of water available to the respondents for household usage (3) examine the factors considered by the respondents when sourcing for water and;(4) identify the basic water management practices undertaken by the women.in the study area.The null hypothesis tested;

H_o: There is no significant relationship between socio-economic characteristics of the respondents and water management practices.

MATERIALS AND METHODS

Ondo State is located between latitude 6.8959^{o}N and longitude 4.8936^{o}E. The State contains eighteen Local Government Areas, the major ones being Akoko, Akure, Okitipupa, Ondo, Ilaje and Owo. It occupies about 15,500 km^2 (6,000sq.ml) with a population of 3.4million people at 2006 census. Ondo State shares its borders with Ogun and Osun States to the west, to the east with Edo and Delta States, Ekiti and Kogi States lies on its northern side while the Bight of Benin and the Atlantic Ocean completes its southern borders.

Ilaje is one of Ondo State Local Government with headquarter at Igbokoda. Ilaje Local Government was created out of the defunct Ilaje/Ese-Odo Local Government Area on October 1, 1996 by the federal government. The Ilajes are a distinguished, distinct linguistic group of Yoruba peoples made up of four geo-graphical entities namely Ugbo, Mahin, Etikan and Aheri. It consists of over four hundred towns and villages, covering an area of 3,000 square kilometers and population of 290,615 at the 2006 census. The Ilajes are one of the most dynamic and enterprising people in Nigeria. Their aquatic skill, coupled with their ability to adapt enabled them to conquer their harsh geographical environment and turn it to their advantage.Ilaje Local Government is the largest local Government in Ondo State in terms of its landmass. It has a shoreline covering about 180 km thereby making Ondo State, a state with the longest coastline in Nigeria, Crude oil, which is the mainstay of the Nigerian economy. Agricultural products produce in Ilaje include fish, poultry, piggery, maize, palm oil, vegetables, timber, okro, cocoyam, banana and cassava. The natural environment of Ilaje land is particularly suitable for the development of large scale rice plantation and salt industry. The occupation activities of the Ilajes include fishing, canoe making, and lumbering, net making, mat making, launch making, farming and trading.

Okitipupa is one of the local government in Ondo State. Most of the inhabitants of Okitipupa local government are interested mostly in farming and are involved with the cultivation of a lot of cash crops and food crops. The various crops cultivated and produced in Okitipupa include yam, maize, cassava, pineapple, plantain, cashew, oil palm, kolanut, cocoa, pepper and vegetables.

Sample Size and Sampling Procedure

Ilaje and Okitipupa Local Government areasconstituted the population of the study. Two (2) communities were randomly selected from each local Government making a total of 4 communities namely Okitipupa, Ilutitun, Igbokoda and Ugbo. Twenty (20) women respondents were randomly selected from each community making a total of eighty (80) questionnaire administered to the sampled resspondents.

Data Analysis

Data were analyzed using descriptive and inferential statistics. The descriptive statistic was used for the analysis of the socio-economic characteristics of the sampled respondents. Chi-square and Pearson Product Moment Correlation (PPMC) were used to test the hypothesis at $p<0.05$ level of significance.

RESULTS AND DISCUSSION

The respondents were women who are the main providers and users of water at the household and community levels. The majorities (47.5%) of the respondents were between the age bracket of 30 and 39 years, 25% were between the age bracket of 20 and 29 years, 22.5% were between 40-49 years while 5% are above 50 years and the mean age of the respondents was 35. The study revealed that majority (86.3%) of the respondent were married, 8.8% were single, 3.8% were separated and 1.3% were divorced. 85% of the respondents practices Christianity and 15% practices Islam. The educational level of the respondents on table1 revealed that 98.9% had formal education and 1.3% had no formal education which indicates that majority of the respondents were literate and should have good knowledge of water management. The mean of the household size was 5. The results showed that 2-5 members constitute 70%, 6-9 members constitute 28.8% and 1.3% had 10-13 members within the household. Majority (93.8%) of the respondents had their husbands as the head of the house and 6.3% of the respondents were the head of their household. Table 1 shows the primary occupation of the respondents in the study area with 37.3%being traders, 31.3% farmers and 31.3% civil servant showing majority being literate. The average income of the respondents was ₦78.12 per annum. Results in table 1 show that majority (86.3%) earn less than ₦100,000 in a year, 12.5% earn between ₦100,000 and₦500,000 and, 1.3% earn above ₦500,000 in a year.Eighty percent of the respondents did not belong to any social organization while 20% (16 members) of the respondents is a member of one organization or the other. Out of the 16 members that belong to social organization, 25% held the post of secretary, 18.8% held the post of treasurer and 56.3% are members. Majority (62.5%) of the respondents out of the 16 members join the social organization for financial benefits and 37.5% join for sense of belonging.

Table 1: Distribution of Respondents According to their Socio-economic Characteristics

Characteristics	Category	Frequency	Percentage
Sex	Female	80	100
Age (in years)	20-29	20	25
	30-39	38	47.5
	40-49	18	22.5
	50-59	4	5
Total		80	100
Marital status	Single	7	8.8
	Married	69	86.1
	Divorced	1	1.3
	Separated	3	3.8
Total		100	100
Religion	Christianity	68	85
	Islam	12	15
Total		100	100
Educational level	No formal education	1	1.3
	Adult education	4	5.0
	Attempted primary school	2	2.5
	Completed primary school	4	5.0
	Attempted secondary school	5	6.3
	Completed secondary school	23	28.6
	Attempted tertiary school	9	11.3
	Completed tertiary school	32	40
Total		80	100
Household size	2-5	56	70.0
	6-9	23	28.8
	10-13	1	1.2
Total		80	100
Household head	Husband	75	93.8
	Wife	5	6.2
Total		80	100
Occupation	Farming	25	31.3
	Trading	30	37.4
	Civil service	25	31.3
Total		80	100

Annual income	<100000	69	86.3
	100000-500000	10	12.5
	>500000	1	1.2
Total		80	100
Membership of organization	No	64	80.0
	Yes	16	20.0
Total		80	100
Benefit of joining organization	Financial benefit	10	62.5
	Sense of belonging	6	37.5
Total		16	100
Holding a post	Yes	7	43.7
	No	9	56.3
Total		16	100
Post held	Secretary	4	25.0
	Treasurer	3	18.7
	Members	9	56.3

Source:Field Survey, 2018.

Sources of water available to the respondents for household water usage

Table 2 show the water facilities used by the respondents in which majority (31.3%) sourced their water from borehole, 30% well, 13.8% tap, 23.8% stream and 1.3% rain water. The main uses of water in the households in both areas are drinking, cooking, and washing clothes, cleaning including personal hygiene and other activities like watering plants. Koskei *et al* (2013) established the type of water source used by household is significantly influenced by the occupation of the household head. Majority (43.8%) of the respondents have their own personal source of water in which they collect their water from, 31.3% make use of the communal source provide by the government and 25% make use of the neighbour source.

The study revealed that the women (57.5%) and their children (23.8%) were the main water collectors, though the husband sometimes helps their wives in collecting water (18.8%). Ademun (2009) reported that the issue of water fetching was a general problem for both the urban and the rural population and that women and children bear the greatest burden because of their social gender roles.Majority of the respondents (72.5%) did not have to collect water from far distance while 27.5% walked a long distance before collecting water. Majority (70%) of the respondents did not spend money on sourcing for water while 30% of the respondents did spend money on water.Large percentage (53.8%) of the women respondents claimed to be the decision maker on water usage within the household while 46.3% of the respondent's husband were the decision maker. This implies that women are primary user of water and they should be the one to decide on how the water is used. This report is in line with the study carried out by Ifabiyi *et al.* (2010) who asserts that women possess the power to allocate and determine how and who uses water in households.

Table 2: Distribution according to water sources for household usage

		Frequency	Percentage
Water Source (a)	Borehole	25	31.3
	Well	24	30.0
	Stream	19	23.8
	Tap	11	13.8
	Rain	1	1.3
(b)	Personal source	35	43.8
	Communal source	25	31.3
	Neighbour source	20	25.0
Water collector	Wife	46	57.5
	Children	19	23.8
	Husband	15	18.8
Distance	Close	58	72.5
	Far	22	27.5
Spend money	No	56	70.0
	Yes	24	30.0
Decision maker	Wife	43	53.8
	Husband	37	46.3

Source: Field Survey, 2018

Basic Water Management Practices

Majority (87.5%) of the water used by the respondents are clean, 11.3% were considered dirty by the respondents and 1.3% were said to be salty. Basic water management practices identified by the respondents included,storing/pre-settlement (72.5%), addition of alum (46.3%), boiling and filtering (35%),boiling only (33.8%), chlorination (27.5%) and 15% of the respondents strain the water through cloth (Table 3).

Table 3: Water Management Practices used by the Respondents

	Frequency	Percentage
Quality of water		
Clean	70	87.5
Dirty	9	11.3
Salty	1	1.3
Water management		
Storing/pre-settlement	58	72.5
Addition of alum	37	46.3
Boil and filter	28	35.0
Boil only	27	33.8
Chlorination	22	27.5
Strain through a cloth	12	15.0
Total	184**	

Source: Field Survey, 2018 **Multiple Responses

Factors considered when sourcing for water

Studyrevealed the various mean score based on the consideration of respondents when collecting water. The only less significant is cost (1.46), this implies that the respondents does not consider cost before deciding where to collect water. The consideration that are significant to the respondents when deciding where to get water include usage of water (2.70), easy access (2.61), good water quality (2.43) and proper management (2.26). This implies that the respondents consider what the water is to be used (i.e the purpose) for whether for drinking, cooking or bathing and how close the water source is before collecting the water (Table 4).

Table 4: Consideration of respondents when collecting water

Characteristics	Always	Sometimes	Rarely	Never	Mean
	Freq(%)	Freq(%)	Freq(%)	Freq(%)	
Usage of water	58(72.5)	20(25.0)	2(2.5)	_	2.70
Easy access	57(71.3)	18(22.5)	2(2.5)	3(3.8)	2.61
Good water quality	43(53.8)	30(37.5)	5(6.3)	2(2.5)	2.43
Proper management	34(42.5)	34(42.5)	11(13.8)	1(1.3)	2.26
Cost	20(25.0)	17(21.3)	23(28.8)	20(25.0)	1.46
Grand mean=1.5					

Source: Field Survey, 2018.

Hypothesis:

H_o1: There is no significant relationship between socio-economic characteristics of the respondents and water management practices.

Result of variables revealed that age (R= 0.05, P=0.967), household size (R=-0.019, P=0.870) and income (R=0.064, P=0.571) had a relationship with water management practices but the relationship is not significant, to have influenced their participation in water management practices (Table 5). The correlation between age and water management practices is positive that is, the R value is positive. This implies that, as women increase in age, they have more knowledge and potential in how to manage water, this could be as a result of frequent usage and experience gained from different activities and roles they are involved in, such as productive, reproductive, caregiver and so on.

The type of correlation that exist between household size and the water management practices is negative that is, inverse relationship. This implies that as household size increase, the women's level of involvement in water management practices decrease. The number of people in a household determines whether this household obtains its water from an improved source or not and whether they will treat the water or not (Totoum 2013). Although it is expected that as household size increases, the amount of water usage increases, but the responsibility involving the decision and involvement in water management may be shared among the household members thereby reducing the role play by the women.Income has a positive relationship with water management practices. This implies that increase in income brings about more involvement in water management practices, more money for improved water source (well, borehole), water accessibility and water sanitation activities. Income of a household is a key determinant of the kind of life in which members of the household will live. Smith and Hanson (2013) established that household income is one of the main determinants of access to water and sanitation facilities, household with lower income have limited opportunities to improve their water and sanitation conditions. Marital status (X^2=3.395, P=0.335), Educational level (X^2= 12.129, P=0.96) and Membership in social organization (X^2=0.833, P=3.61) do not had a significant influence on the water management practices (Table 6). This implies that whether the women are married, educated or belonged to any social organization or not, does not determine how they manage water.

Table 5: PPMC Result of Socioeconomic Characteristics and Water Management Practices

Socioeconomic variables	R	P-value	Decision
Age	0.05	0.967	NS
Household size	-0.019	0.870	NS
Income	0.064	0.571	NS

At 5% level of significance NS= Not significant

Source: Field Survey, 2018

Table 6: Chi Square Analysis of Socioeconomic Characteristics and Water Management Practices

Socioeconomic variables	Calculated X^2	Df	P-value	Decision
Marital status	3.395	3	0.335	NS
Educational status	12.129	7	0.096	NS
Membership	0.833	1	0.361	NS

Source: Field Survey, 2018

CONCLUSION AND RECOMMENDATIONS

Women are the main collectors, users and managers of water in the household. They are saddle with the responsibility of making water available for use and the decision on how the water is being used. The study concluded that the potentials of women in managing water is not significantly influenced by age, education, household size, religion, marital status and income. However, there was a positive relationship between age, income and water management practices which implies that as women increase in age, they have more knowledge and potential on how to manage water, and decrease in their income also bring about their less involvement in water management practices. As household size increases, women's level of involvement in water management practices decrease, it is expected that roles including decision on water management will be shared by members of the household. It wasrecommended thatwomen should be encourage both at home and in the community to participate in water management project and decision making, their roles and interest should be seen beyond domestic, this will give them a sense of responsibility and ownership for the water sources in which their livelihood depend on.

REFERENCES

Ademun, S.R. (2009).Domestic Water Supply: An Evaluation of the Impacts, Challenges and Prospects on Women in Rural Households in Uganda, Unpublished MSc thesis, University of Lund.

Aureli, A., & Brelet, C. (2004). Women and Water. An ethical issue Series *on Women and Ethics, Essay 4.* Paris, France: UNESCO.

Ifabiyi I. P., Usman B. A., Orire I.O., and Aledare A. (2010). Productive Time of Women and Water Supply in Ijumu, Local Government Area, Kogi State, Nigeria. *Global Journal of Human Social Sciences*. 10(5):45-52.

Koskei, E.C., Koskei, R.C., Koske, M.C. and Koech, H.K. (2013). Effect of Socio-economic Factors on Access to Improved Water Sources and Basic Sanitation in Bomet Municipality, Kenya *Research Journal of Environmental and Earth Sciences* 5(12): 714-719.

Nuratu, M. (2014). Management of Domestic water by Women in Parts of Kano State, Nigeria. *Journal of Academic Research International*. Vol. 5(4).

Rathgeber, E. (1997). Gender analysis: What are we looking for? In: Management of Water Demand in Africa and the Middle East – Current Practices and Future Needs. Brooks, D.2010-11-02. Available online at: <http://www.idrc.ca/en/ev-9316-201-1- DO_TOPIC.html>

Singh, N (2006). The changing role of women in water management: Myths and realities. In:*Wagudu:A Journal of transistional women's and gender studies* Vol spring p 94-113.

Smith, L. and Hanson S. (2013). Access to Water for the Urban Poor in Cape Town: Where Equity Meets Cost Recovery, *Journal of Urban Studies* 40, 1517–1548.

Totouom F. L A. (2013). Awareness and the Demand for Improved Drinking Water Source in Cameroon. *International Journal of Economic Practices and Theories,* 3(1). UNESCO-WWAP. (2003). Water for People, Water for Life - *UN World Water Development Report (WWDR)*. Executive Summary. UNESCO Publishing, Paris. Co-published with Berghahn Books, UK.

EFFECTS OF GAS FLARING ON SOIL, AIR AND WATER QUALITY, VEGETATION PATTERNS AND ECOSYSTEM HEALTH IN THE NIGER DELTA ZONE OF NIGERIA

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Abstract

Nigeria is an oil and gas producing nation and gas flaring started since the discovery of crude oil in the late 1950s and has been ongoing till date. About 10 – 40% of associated gas with crude oil production is underutilized and is flared into the environment. The Niger Delta is the Nigerian oil and gas province, gas flaring activities takes place. The World Bank (2016) reported that the volume of gas flared (15.1BCM) in Nigeria was equivalent to one-sixth of total gas flared in the world.The increasing menace of unsustainable practices in the oil and gas sector (exploitation and exploration) in particular, gas flaring and oil spillage, has strongly impacted ecosystem components and health (soil, water and air pollution and temperature elevation, vegetation /floral diversity, structure, composition and abundance of flora specie) in the Niger Delta of Nigeria. This trend has implications for productivity of agriculture, human and ecosystem health (land, soil, air, water bodies, flora and fauna species diversity) and function. Gas flaring is known to cause physical damage to soil, air, water bodies, houses and plant close to the flare stack which could lead to other downstream impacts.Gas flaring is reported to produce significant transformations in soil properties, physical, chemical and biological activities possibly due to exposure to elevated temperatures (warming) and pollutant effects.Large negative environmental impact results from gas flaring stations, soil and air pollution and elevated temperatures varied with distance from the gas flaring station. Result shows the thermal effects of gas flaring varied at distances away from the flare station to a distance of about at 1800m from the station and that soil and air temperatures were above the acceptable thresholds for plants and animals. Soil and air temperature tends to normalized at about 29^0C at about 2000m away from the flare point.This increase in temperature also has other negative effects on the health of other components of the ecosystem.The burning and "die-back" effect of gas flare and hydrocarbon, which are often visible in leaf/canopy of plants around flaring facilities. Gas flaring is a major cause of acid rain, elevated thermal events (high temperatures) and pollution of soil, air, water bodies and depletion of vegetation diversity and cover in the Niger Delta region of Nigeria.This review contribute to body of evidence to what is at presently gaps in knowledge of the effects of gas flaring on tropical ecosystem (soil, water, air, forests and cultivated crops) and underlines the need for more research efforts to be diverted to provide information and enhance understanding of the full menace and impact of gas flaring on the components and quality of the ecosystem. Reductions in volume of gas flare can be achieved by utilizing micro-gas turbines, re-injection and pursued as part of a new agenda for responsible governance in Nigeria. Research findings have contributed to the environmental monitoring of gas flaring effects on tropical forest species, soil and water resources.

Keywords: *Floral, Gas flaring, Soil, Tropical ecosystem, Water*

INTRODUCTION

Crude oil and natural gas account for about 50% of global energy resources (NNPC-CPDD Report, 2014). In Nigeria, crude oil and natural gas are domicile in the Niger Delta region of Ondo, Edo, Delta, Bayelsa, Rivers,Abia, Imo, AkwaIbom and Cross Rivers States. The crude oil and natural gas is located in both offshore and onshore in the region. Two major products are produced include the exploration and exploitation of crude oil and natural gas had produced adverse effect on the environments (Ede and Edokpa, 2015, Idah *et al.,* 2017).

Flaring is a common method of disposing gaseous and liquid hydrocarbons through combustion at oil and gas production and processing facilities and sites (Emam, 2015). The prevalence of gas flaring may be connected with poor policy framework, technological and infrastructure (pipelines and other gas transportation) development and in part for consideration for protection against the dangers of over-pressurizing industrial plant equipment (Obanijesu *et al.*, 2009, Fawole *et al.,* 2016).

Gas flaring leads to release of three major components including noxious gases, heat and noise. Gas flaring is common in the Niger Delta region of Nigeria, during flaring, several pollutants gases are released into the environment including nitrogen dioxides, sulphur dioxide, volatile organic compounds like benzene, toluene, xylene, polyaromatic hydrocarbons, hydrogen sulfide, benzapyrene and dioxins and particulate matter (Ana *et al*., 2012, Edwards*et al.,* 2013). However,the demand for gas increase as a result of new opportunities for gas micro power, combined cycle turbines, independent power plant, gas to liquids and expansion in liquefied natural gas trade also contributed to the utilization (NNPC-CPDD Report, 2014).

According to estimates from satellite data, globally, the total volume of flared gas was estimated at 143 billion cubic meters (BCM) in 2012, accounting for 3.5% of overall global gas production. Annual economic losses related to gas flaring are estimated to be more than 5 and 11 billion dollars for Russiaand Nigeriawhich are the top andbiggest contributors to gas flaring volumes in the world (Fawole *et al.*, 2016).

The petroleum and other liquid fuel production from OPEC and non-OPEC sources are predicted to increase continuously by 23 million barrels per day from 76 million in 2012 to 100 million b/d in 2040 (NNPC-CPDD, 2004, 2010). Although the ‘Zero Routine Flaring by 2030’ initiative launched by the World Bank in 2015 attracted nine countries, some major flaring countries still have not participated, claiming that this target is hard to achieve.

Nigeria is an oil and gas producing nation andgas flaring started since the discovery of crude oil in the late 1950s and has been ongoing till date.About 10 – 40% of associated gas with crude oil production is underutilized and is flared into the environment. The Niger Delta is the Nigerian oil and gas province, gas flaring activities takes place, a region endowed with mangrove swamp with a total of 131 gas flaring sites (Dung et al., 2008, Edino *et al.,* 2010)(Figure 1).

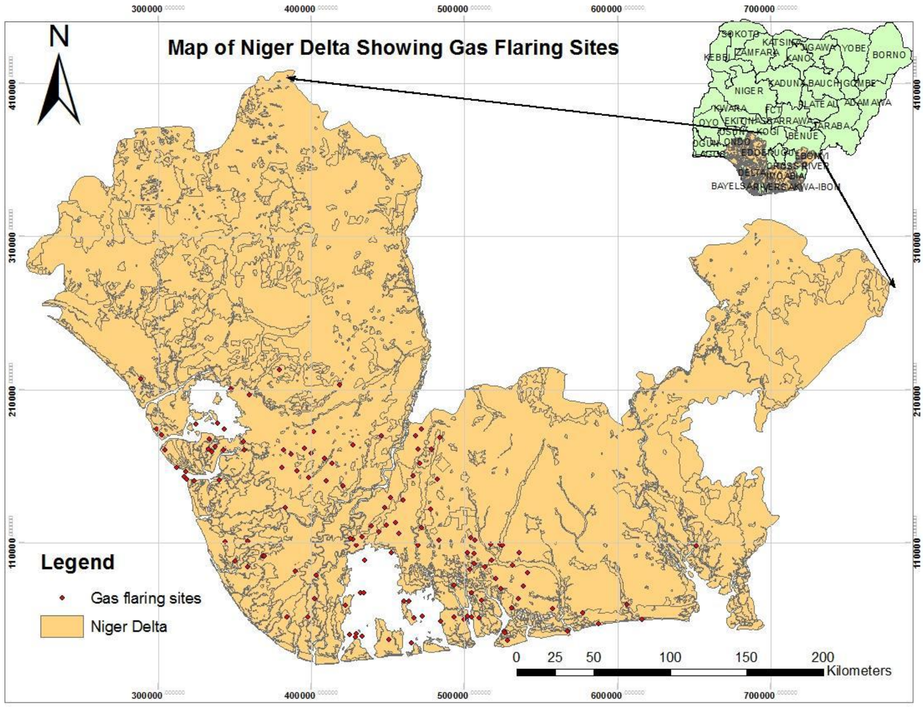

Figure 1. Summary of Flare Gas Compositions of the Measured Flares by Chemical Group with Key

It is reported that the volume of gas flared in Nigeria was equivalent to one-sixth of total gas flared in the world at estimated amount of gas flared in Nigeria is about 15 billion cubic meters (BCM) (Obanijesu *et al.*, 2009, Fawole *et al.*, 2016). It is reported that approximately 8 BCM of gas is flared every year at different oil production sites in Nigeria which equates about 2.5 BCM (NOAA/GGFR satellite data). This trend provides estimates of the quantity of energy that ought to be saved and has been attributed to the avoidable extreme weather conditions that prevail in Nigeria. Therefore, gas flaring violates the tenets of sustainable development and seriously contributes to global warming.

Alterations of land cover dynamics is currently regarded as the single most important variable of global change affecting ecological systems (Agele *et al.*, 2017). Like wildfires, gas flaring is considered as one of the most widespread ecological disturbances of natural ecosystems that dramatically affect land cover dynamics at a variety of spatial and temporal scales as a result of the complete or partial removal of vegetation cover. In this context, knowledge of the spatio-temporal distribution of impacts of gas faring on ecosystems components and health is of key importance. Such information plays a significant role in various aspects of policy and decision-making as well as in the dynamics and structures of soil, water, air quality, plant and animal communities within the affected ecosystems.



Flare Gas Properties Relevant to BC Emissions from Turbulent Diffusion Flames

Based on reports from scientific literature, air pollution emanating from gas flaring and its associated effects on ecosystem health in the Niger Delta is a cause for concern (Ana et al., 2012, Huang and Fu, 2016). There are clear connections between gas flaring, soil, water and air pollution and ecosystem health andbiodiverty (Sonibare *et al.*, 2010, Ede and Edokpa, 2015). Studies have clearly indicated that air pollutants (particulate matter, ozone, nitrogen oxides and sulphur dioxide) emitted form gas flaring facilities negatively impacted ecosystem health (Lichtenthaler, 1996, Nwankwo and Ogagarue, 2011) (Table 1 and 2).

In addition, air pollutants from gas flaring can negatively affect natural vegetation thereby reducing biodiversity, the wet and dry deposition of acids and acidic particles also affect the ecosystem, especially aquatic and soil systems, and damaged physical infrastructure (Ezenwaji *et al.*, 2013, Ezenwaji *et al.*, 2013). The emission of CO_2 and CH_4 from gas flares contribute to global warming (Obi and Osang, 2015) which can lead to significant transformation of the structure of terrestrial ecosystems and changes in the mode of functioning of its components.

Table 1. Composition of Nigerian natural gas.

Component	HP (Mol%)	LP (Mol%)	SV (mol%)
N_2	0.12	0.10	0.14
CO_2	0.58	0.95	1.06
H_2S	0.00	0.00	0.00
C1	87.80	87.45	71.94
C2	5.74	4.90	10.24
C3	3.04	2.54	7.40
iC4	0.79	0.94	2.38
nC4	0.90	1.27	3.02
iC5	0.30	0.55	1.15
nC5	0.21	0.40	0.82
C6	0.25	0.50	1.01
C7	0.16	0.30	0.52
C8	0.08	0.07	0.23
C9	0.02	0.03	0.07
C10	0.00	0.00	0.00
C11	0.00	0.00	0.00
Total	**99.99**	**100**	**99.98**

Adapted from NNPC-CPDD(2006-2014).

Table 2.Flared gas composition and specific energies at 298.15degrees K.

a	b (vol/mol%)	c (RMM)	d (bc/100)	e(d/19.78) %	f	g
C1	87.45	16	13.99	70.72	55 545	50 000
C2	4.90	30	1.47	7.43	51 920	47 525
C3	2.54	44	1.12	5.66	50 385	46 390
iC4	0.94	58	0.54	2.73	49 565	45 775
nC4	1.27	58	0.73	3.69	49 445	45 660
iC5	0.55	72	0.38	1.92	49 060	45 430
nC5	0.40	72	0.28	1.41	48 970	45 305
C6	0.50	86	0.43	2.17	49 710	46 130
C7	0.30	100	0.30	1.51	55 010	50 967
C8	0.07	114	0.07	0.35	57 330	52 903
C9	0.03	128	0.03	0.15	60 103	53 290
C10	0.00					
N_2	0.10	28	0.02	0.10		
CO_2	0.95	44	0.42	2.12		
H_2S	0.00					
Total	**100**		**19.78**			

Source: Nwanya (2011).

More comprehensive research studies are needed for enhanced insights on the impact of air pollution from gas flaring on ecosystem components and quality as well as local and regional climate feedbacks. Gas flaring affect the components and health of the ecosystem (soil, water and air pollution, temperature elevation, vegetation /floral diversity, structure, composition and abundance of flora specie) in the Niger Delta of Nigeria (Ezenwaji *et al.*, 2013, Ubani and Oyejelure, 2013, Obi and Osang, 2015, Fawole *et al.*, 2016).

The menace of unsustainable practices, non-compliance with global best practice and non- consideration for the environment in the oil and gas(exploration and exploitation) sector in the Niger Delta region of Nigeria in particular environment effects of oil spillage and gas flaring has been variously described by authors. Edino*et al.,* (2010) said that: the environmental cost of gas flaring is yet to be fully estimated, but anecdotal evidence suggests it is equally colossal. Dung *et al.*,(2008) also asserted that: the environmental costs of gas flaring is yet to be adequately quantified".

Impact of gas flaring on ecosystem and local climate

Studies in different parts of the world have shown that air pollution can have a significant impact on local climate. This implies that changes in emissions of air pollutants can significantly affect local climate (Obi and Osang, 2015). Due to the short residence time of air pollutants in the atmosphere, their spatial distributions are non-homogeneous, with higher concentrations mostly located near emission sources. Gas flaring also cause deforestation and acid rain, thus exploitation of crude oil and associated gas flaring is a major contributor of acid rain in the Niger Delta region of Nigeria (Efe, 2010, Amadi, 2014). The dry or wet deposition of nitrate and sulphate has been identified as a major contaminant of soil, water resources and pollutant effects on forest/vegetation diversity in the Niger Delta.The deposition of acid has also been shown to be responsible for the rapid corrosion of metal sheeting (such as is used for roofs) and the deterioration of paint and stone. This has significantly reduced the durability of buildings, monuments and other physical infrastructure (Ezenwaji *et al.*, 2013, Amadi 2014)

Gas flaring releases metals and other pollutants into the environment which has been shown to cause a variety of environmental problems include wet and dry deposition of acid and acidic particles that lead to corrosion of metal roofs, harm to aquatic species and soil micro-organisms (Ezenwaji *et al.*, 2014).Atmospheric pollutants from gas flaring include CO_2, CO, CH_4, NOx, N_2O, H_2S, hydrocarbons, PM, etc. The flaring of natural gas from different oil production sites is also accompanied by air pollutants such as particulate matter (PM), ozone (O_3), nitrogen oxides (NOx), volatile organic compounds (VOC), sulphur dioxide (SO_2) and metals (Sonibare *et al.*, 2010, Nwankwo and Ogagarue, 2011, Edwards *et al.*, 2013). Of the emitted gaseous species, CH_4 and N_2O are both greenhouse gases with much higher global warming potential than CO_2. In addition, the associated gas containing H_2S (sour gas) can be toxic to ecosystem components (Edwards *et al.*, 2013, Ede and Edokpa, 2015, Fawole *et al.*, 2016). Gas flaring contributes directly to global warming by acting as a source of CO_2 and CH_4 in to the atmosphere which are two major greenhouse gases. These pollutants have been shown to have negative impacts on human and ecosystem health (Dung *et al.*, 2008, Edino *et al.*, 2010.

Other air pollutants emitted from gas flares such as BC, or which are formed in the atmosphere from precursor gases such as NOx, COx, and VOC (ozone), also have a warming effect on the climate system. In particular, gas flaring of associated petroleum gas is a potential emission source of particulate matters (PM). Particulate matter emitted from gas flaring is mainly in the form of soot or black carbon (BC), which is a strong short-lived climate forcer and is thought to be second to carbon dioxide in terms of global warming (Huang and Fu, 2016). Particulate matter (PM) from gas flaring directly warms the atmosphere by absorbing sunlight and also indirectly, reducing surface albedo via deposition on ice and snow covers. In contrast to greenhouse gases with long lifetimes, Black carbon usually stays in the atmosphere for days to weeks, and thus is considered to be a short-lived climate forcer (SLCF). In this light, control of black carbon particles by emission reduction measures would have immediate benefits for air quality and global climate.The emissions of CO_2, CH_4 and of ozone precursor gases such as NOx and VOC from gas flares have also contributed to human-induced changes in climate (Edwards et al., 2013).Gas flaring contributes to climate change by releasing millions of tons of CO_2 and Black Carbon (BC) in to the atmosphere (Hunag and Fu, 2016). The emissions of CO_2, CH_4 and of ozone precursor gases such as NOx and VOC from gas flares have also contributed to human-induced climate change.

Table 3. Crude oil and gas production and utilization in Nigeria between 2006 and 2014 (after Seyaboh and Izah, 2017.

Year	Crude oil and condensate production, barrels total	daily average mmd/pb	Total gas, BSCF	Quantity of gas utilized, BSCF	Quantity flared, BSCF
2014	798,541,589	2.19	2,524.27	2,233.49	289.60
2013	800,488,102	2.19 2,	325.14	1,916.53	409.31
2012	852,776,653	2.27 2,	580.17	1,991.50	588.67
2011	866,245,232	2.37 2,	400.40	1,781.37	619.03
2010	896,043,406	2.45 2,	392.84	1,811.27	581.57
2009	780,347,940	2.14 1,	837.28	1,327.93	509.35
2008	768,745,932	2.10 2,	282.44	1,664.97	617.62
2007	803,000,708	2.20 2	415.65	1,626.10	789.55
2006	869,196,506	2.38 2,	182.43	1,382.43	799.99

***BSCF: Billion standard cubic feet)**

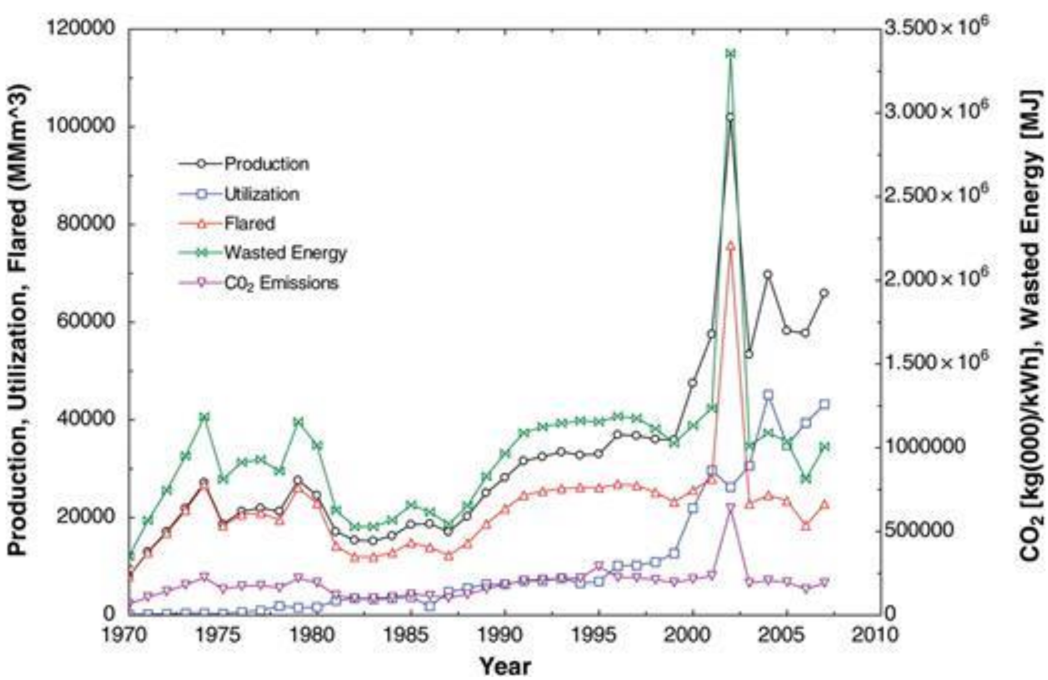

Fig. 2. Global trends in crude oil production, gas flaring, CO_2 evolution and energy losses

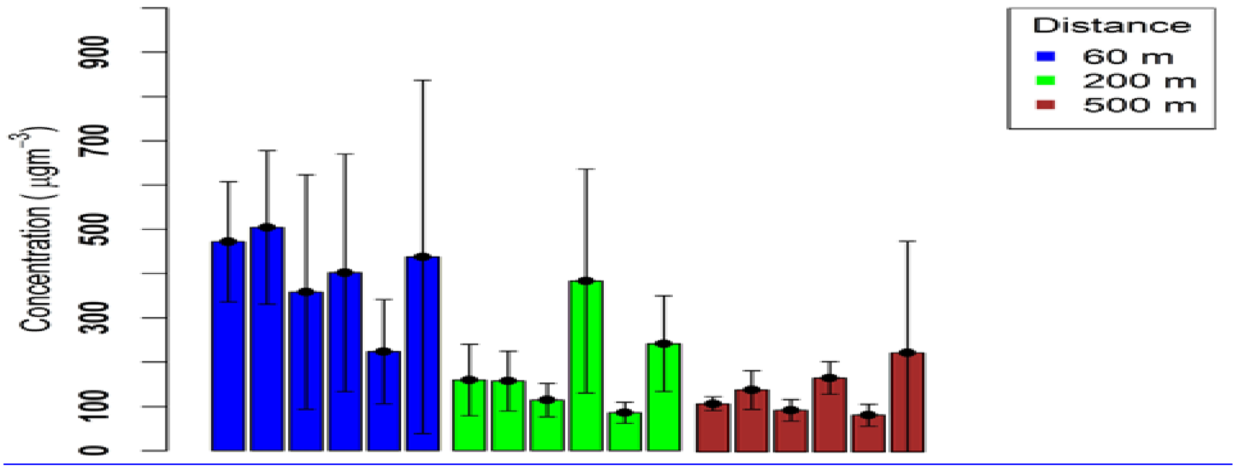

Fig. 3 : **Spatial variation of SO2 concentration downwind of six gas flaring sites (adapted from Obanijesu et al. (2009)**

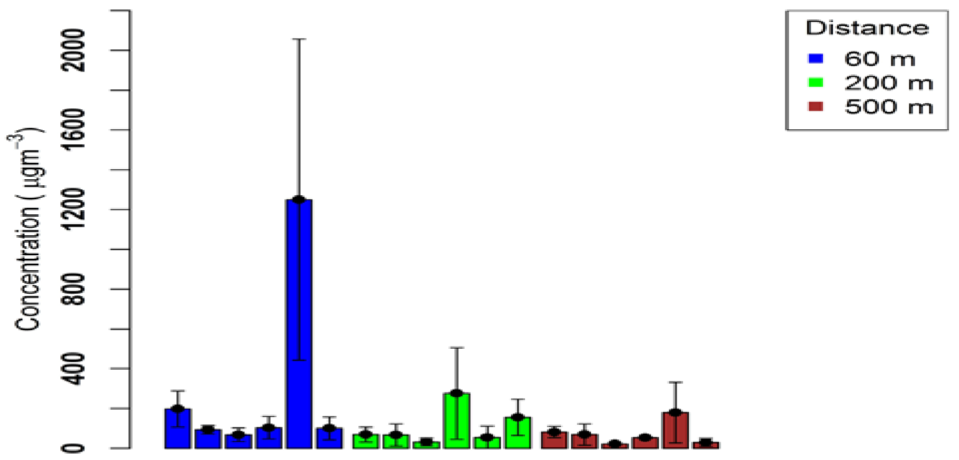

Fig.4.Spatial variation of NO2 concentration downwind of six gas flaring sites (adapted from Sonibare *et al.* (2010))

Table 4. Amount of gas production, gas utilization and Flared gas in Nigeria, 1970–2010

	Production (MMm^3)	Utilization (MMm^3)	Flared (MMm^3)
1970	8030	210	16550
1975	18600	350	1825
1980	25550	1560	23000
1985	18500	3520	13500
1990	27850	6030	20500
1995	30900	6520	25500
2000	45900	20800	20000
2005	60800	45000	23700
2010	65300	42580	22000

Source: Gas production data from Nigeria (CBN Bull. 2010)

Table 5: Pollutant measurements around several oil and gas facilities

474 **BC (ng kg-^{1})**	**O_3 (ppbv)**	**VOC (ppbv)**	**PAH (ng m^{-3})**	**NO (ppbv)**	**NO2 (ppbv)**	**SO2 (ppbv)**	**CO (ppbv)**
-	> 120	100 -350	-	> 3.5	> 7.5	-	> 80
> 40	> 25	-	-	> 1.2	-	> 1.2	> 90
-	-	-	0.34 - 3.3x104	-	-	-	-

Table 6a. Atmospheric temperature with distance from gas flaring facility (after *Obi and Osang, 2015)*

	Temperature (0C)									
Months	200m	400m	600m	800m	1000m	1200m	1400m	1600m	1800m	2000m
October	49	47	45	42	40	38	35	32	29	28
November	50	49	47	44	41	39	38	37	30	28
December	48	47	45	44	42	38	36	34	33	29
January	50	49	48	45	41	37	37	35	32	30
February	50	48	46	43	40	39	37	36	35	29
March	50	49	47	45	43	40	38	37	34	31
April	50	48	47	45	40	38	34	31	30	29
May	49	48	48	48	47	45	44	43	30	28
June	50	49	48	48	47	46	43	43	33	29
July	49	49	49	48	48	47	44	40	35	30
August	48	52	50	49	46	45	44	39	34	29
Sept	48	53	52	49	47	45	45	40	40	31

Table 6b.Soil temperature with distance from flaring site (after *Obi and Osang, 2015)*

	Temperaure (0C)									
Months	200m	400m	600m	800m	1000m	1200m	1400m	1600m	1800m	2000m
October	33	32	31	30	30	30	29	29	28	27
November	32	31	30	29	29	29	29	28	28	28
December	34	33	31	30	30	30	29	29	28	27
January	34	31	30	28	28	28	28	27	27	27
Febrary	35	32	32	30	30	30	29	29	28	27
March	35	34	32	32	32	31	30	30	29	28

	Temperature (0C)									
Months	200m	400m	600m	800m	1000m	1200m	1400m	1600m	1800m	2000m
April	30	30	29	29	29	28	28	28	28	27
May	31	31	31	30	30	29	29	28	28	27
June	32	32	32	31	30	30	29	28	28	28
July	32	31	31	30	30	29	29	28	27	27
August	33	32	32	31	31	30	29	29	28	28
Sept	32	32	32	31	31	31	30	29	29	28

Effects on water and air quality

Water is typically impacted by gas flaring activities. Literature has variously reported that some quality parameters of surface water, ground water and rain water are affected in gas flaring locations in the Niger Delta (Nwankwo and Ogagarue, 2011, Ezenwaji *et al.*, 2013, Madi, 2014). Air pollution from gas flares can significantly affect natural vegetation and hence biodiversity. In addition, the deposition of acid precipitation and acidic particles on different ecosystems has impact on aquatic life and soils micro-organism communities.Studies of the impacts gas flaring and oil spillage on rainwater quality for domestic use have reported that temperature, taste, color, conductivity, total dissolved, salts and alkalinity were altered when compared to the permissible limits specified by National Agency for Food and Drug Administration and Control, United State Environmental Protection Agency and World Health Organization for drinking water. The impacts of gas flaring and oil spillage on groundwater quality for domestic use in some parts of the Niger Delta reports changes in color is majorly impacted and to lesser extent conductivity were affected in some locations due to accumulation of dissolved salts and other organic materials. It is also reported that noticeable effects of gas flaring on surface and groundwater quality in Delta state where water from gas flaring area have high concentrations of metals such as barium, cyanide, selenium, cadmium, chromium, iron, lead, manganese and copper, electrical conductivity, color and taste when compared to non-flaring location (Efe, 2010, Amadi, 2014, Igberua *et al.*, 2017).Other quality parameters affected include elevated temperature, lead, conductivity, total dissolved solid, nitrate, carbonate, sulphate and pH had values which were above World Health Organization permissible limits.The imperativeness of use of sophisticated scientific tool such as space technologies (Geographic Information System ,GIS, remote sensing, drone technology) would be required to fully assess the impacts gas flaring has on the land cover (vegetation), soil and water resources in areas of gas flaring sites over time (Fawole *et al.*, 2016).

Impacts on Vegetation

Acid rain result in the decline in productivity and growth of crops, forest trees and may alter properties (physical, chemical and biological)of soil and water resources. Air pollutants from gas flaring can negatively affect natural vegetation, thereby reducing biodiversity and contribute to global warming by reducing CO_2 uptake by plants (Abua and Ashua, 2015). Acid rain could lead to loss of vegetation and several symptoms in plants that could lead to their death (Lichtenthaler, 1996, Ezenwaji et al., 2013). In addition, the deposition of acid precipitation and acidic particles on different ecosystems has impacted aquatic life and soils micro-organism communities. Some of the notable symptoms of acid rain on plants include chlorosis, abscission and yellowing of leaves, wilting of the leaf tips and accelerated senescence, root and shoot of plants are also destroyed and microbialcommunity that aid in decompositions processes. The impacts of acid rain on vegetation structures and cover is most severe close to gas flaring stack (Abua and Ashua, 2015). Acid rain result in the decline in productivity and growth of some major food crops such as cassava, sweet potatoes, maize, melon, plantain, and cash crop like rubber (Seyabor and Izah, 2017). The impacts of gas flaring on the growth and productivity of cultivated crops and forest vegetation can also implicate impacts on soil fertility. This may lead to loss of vital soil nutrients that encourage thegrowth of plants. Acid rain could lead to loss of vegetation (ref). Several symptoms in plants that could lead to their mortality such as notable symptoms include chlorosis, abscission and yellowing of leaves, wilting of the leaf tips and accelerated senescence, root and shoot of plants are also destroyed. Around the viscinity of gas flaring facilities in the Niger Delta, pronounced loss in forest cover and vegetation diversity decline with a massive loss of 469,731ha, 8% of the vegetation cover of the region had been reported. The variations in percentage decline of green vegetation suggested that other factors like time of commissioning of gas flaring sites and volume of gas flared can determine the magnitude of gas flaring impacts. Ecophysiological stress effects of gas flaring (pollutants and elevated temperatures) is felt on the floral diversity and structure (composition and abundance of flora species/vegetation) of the Niger Delta. The rapid decline in vegetation was coined by UNDP (2010) thus: “there is a strong feeling in the region that the degree and rate of degradation are pushing the delta towards ecological disaster”.

Impacts on vegetation components

Four of the 15 important forest species and families that are representative of the Niger Delta ecoregion are: Melastomataceae, Fabaceae, Rubiaceae and Euphorbiaceae. Family and species-specific responses of biodiversity components to temperature gradients along transects of gas flaring has been reported. Improved understanding of how plant species survive in high-temperature ecosystems may provide insight into strategies adopted to cope with changes in temperature in these and other extreme habitats and how other species may respond to future climate change. An awareness of the interactions between temperature and plant community structure can help plan conservation strategies for the future.

Lowland rainforest

The lowland rainforest is among the complex ecological zones in the Niger Delta with regard to diversity of species. The rainforest zone is characterized by tall trees (1st layer/ stratum which is characterized by thick/dense forest with smooth bark trees of about 40 to 50m tall and often a times, epiphytes and lianas are attached to the back of the tree), big trees with canopy (2nd layer/ stratum which are plants with high branch, 20–35metre tall and can provide shade), lower trees with bare trunks (3rd layer/ stratum which are plant that about 20metre tall) and 4th layer which areas with mosses, small stemmed shrubs, lichens, herbs and ferns) (4th layer/stratum). The vegetation found in rainforest are mainly used for timber, firewood, saw wood, particleboard, pulp/paper, poles and traditional medicine.Some of the commonly found species include *Khayaivorensis*, *Guareathompsonii*, *Entandophragmacylindricum*, *Entandrophragmaangolense*, *Guareacedrata*, *Lovoatrichilioides*, *Gossweilerodendronbalsamiferum*, *Miliciaexcelsa*, *Terminaliaivorensis*, *Triplochitonscleroxylon*and *Terminaliasuperba.*

Mangroves ecosystem (estuarine and marine)

Brackish water is also referred as estuarine (salt and fresh water interphase) and they compromises of part of the Niger Delta mangroves. Typically, the Niger Delta Mangroves is one of the largest in Africa. In estuarine, the salinity level is lower than that of marine water but higher than that of freshwater. The area is dominated by some mangroves plants with narrow strip of beach ridges. Seyabor and Izah *et al.*, (2017) reported important Niger Delta mangroves to include *Rhizophoraracemosa*(tall red mangrove), *R. mangle* and *Rhizophoraharrisonii* (short red mangrove),*Avicenniagerminans*(white mangrove), and *Laguncylariaracemosa*etc. Typically the genus Rhizophoraand Avicennia account for a significant mangrove species found in the Niger Delta region. In the Niger Delta, freshwater (10,000km^2) and mangroves are separated by transition wetlands dominated by *Dalburgerescatophylum*, *Machaerumlunatus* and *Pandanus* spp.Other species such as *Nypafruticans* are also found in the mangrove ecosystem of the Niger Delta.

Freshwater forest

The vegetation of freshwater forest characterized by tall trees such as *Musangacecropioides*, *Annonasenegalensis*, *Anthocliestavogelii*, *Eleaisguineensis*, *Harunganamadagascariensis, Juncus*sp, *Pandanus*sp, *Raphiahookeri*,*R. vinifera*and *Tectoniagrandis*. The majority of the plant species on the area are used as fuel food, medicine, boat carving and for protecting the shoreline. Mortality and decline in species abundance along temperature gradients of the transects of gas flaring had been attributed to significantly lower leaf chlorophyll content which suggests that these families are more sensitive to changes in environment conditions caused by gas flaring. Literature had provided evidence of decreases in plant diversity and richness along temperature gradients of thetransects of gas flaring in a characteristic plant family-specific response to high temperature ecosystems. Despite the capacity of vegetation for fast acclimation and certain stress tolerance mechanisms, vegetation usually responds to sudden short-term or long-term stressors with reduced cell activity and plant growth or even plant mortality. The stress factors vary in their intensity and duration which can cause damage to plants. Different plant species respond differently to a particular stressor. Furthermore, the nature, intensity and length of exposure are factors that influence the stress level on the vegetation.

Thermal effects of gas flaring on soil, air and vegetation

Sampling and measurements had been carried out in the areas at the distances of 70, 90, and 130 m from the flare with the strong, moderate, and weak heating effects, respectively (Obi and Osang, 2015, Fawole *et al.*, 2016). In the zone of the maximum heating effect, the soil temperature was by 1.3^{0}C higher, and the rate of CO_2 emission from the surface was greater by 18% compared to the zone withweak impact of the flare. Along with increasing CO_2 emissions, organic matter accumulated due to increasing the stable pool.The parameters of the microbial biomass, basal respiration, and the input of labile organic matter pool increased with the distance from the flare.Biological activity of the soils was assessed in the zones with strong, moderate, and weak impact of the flaring flare. The heat effect was found to lead to significant changes in the indices of the soil biological activity (ref). The soil Corg content and the rate of CO_2 emission from the soil surface decreased in accordance with a decrease in the soil temperature with the increasing distance from the flare. By contrast, theopposite tendency was revealed for the microbial biomass, basal respiration, and labile organic matter pool, with minimum values in the soil most strongly exposed to the flaring effect. Along with the increase in CO_2 emission from the soil, organic matter accumulated due to the increase in the input of the stable pool from vegetation biomass thus the intensification of the carbon cycle in the presence of the flare whichis accompanied by additional CO_2 fixation in plant biomass and carbon sequestration in the soil due to its accumulation in the stable pool.

The result shows that Atmospheric Temperature Ta (ºC) and Soil Temperature Ts (º C) tends tonormalize at about 29 and 27^0C at 2000 m respectively away from the flare point. Hence thermal equilibrium within gas flaring facilities environment would be altered. The increases intemperature has negative effect on man and his environment, especially on the socio-economicactivities of the inhabitants. The Intergovernmental Panel on Climate Change predicts that subjecting crops to temperatures above 30 °C for a long time can have a range of negative effects on crops production. These effects can reduce production in plant productivity in the future.

There is an urgent need for research on all these aspects to be expanded within the region, and for actions to be taken to reduce emissions and associated impacts.

CONCLUSIONS

The impacts of acid rain on physical structures, soil, air water and vegetation cover and elevated temperature-enhanced deforestation and biodiversity losses is most severe close to gas flaring stack. Studies had identified plant species that are resistant to air pollutants and high temperature in the environments around gas flaring facilities, the need for and deployment of specific plant species for phytoremediation.

Gas flaring can also cause deforestation and acid rain while exploitation of crude oil and associated gas flaring is a major contributor of acid rain in the Niger Delta region of Nigeria. Reductions in volume of gas flare can be achieved by utilizing micro-gas turbines, re-injection and pursued as part of a new agenda for responsible governance in Nigeria. The localised and inhomogeneous spatial distribution of air pollutants from gas flares can exert significant impact on climatic conditions at a local scale. The Niger Delta region is one of the most productive in terms of diversity of flora and fauna but the most fragile ecosystem in Nigeria. The area is rich in vegetationwith several pharmacological properties and water resources.Several oil and gas installations are found in the region. Gas is used by gas-turbine for electricity generation, despite the huge source of gas available for electricity, the gas is constantly flared into the environment.About 10 – 40% of natural gas produced is under-utilized and therefore flared intothe environment. Gas flaring are known to have impact on air quality, physical infrastructure, biodiversity compositionincluding plants and animals especially insects, impacts on human health and water resources especially rainwater. Acid rain has been widely attributed to impact of gas flaring especially in the Niger Delta region of Nigeria. On water quality, gas flaring alters ions especially sulphate, carbonate, nitrate, pH, conductivity, leadand iron concentration especially in rainwater. The menace of gas flaring is associated with loss of vegetation cover, reduced growth and productivity/yield of crops and forest tree species probably due to changes in soil quality parameters.Furthermore, it is well established that higher concentration of air pollutants have detrimental effects on crops and forest species.

Gas flaring could alter soil quality parameters including physiochemical and microbial characteristics. Somenotable soil quality parameters such as pH, temperature, soil moisture, soil microbial population are commonly impacted by gas flaringSoil quality parameters from flaring sites such as temperature and bulk density decreased with distance from the flare point while other such as CEC, organic matter, moisture content etc) increases with distance. Soil nutrient status changes around gas flaring environment compared to the soils outside.

The effects of gas flaring varied especially on soil characteristics especially the nutrient related characteristics may affect the crop productivity indirectly.Microbes being unique, other changes in the soil properties could alter the microbial diversity and function and hence their role in nutrient and biogeochemical cycling.It is has been established that increasing efforts be focused on the sustainable exploration/exploitation of natural resources especially crude oil (petroleum) and that gas obtained from petroleum-based activities should either be used by a gas turbine for electric power generation or processed for domestic and industrial purposes. Furthermore, the Environmental law Enforcement Agencies, especially DPR (Department of Petroleum Resources), should be more involved in enforcing all existing environmental laws on gas flaring so as to take care of the community's basic amenities and advise for a strong technological bases that harness Nigeria's gas potentials. Also, frequent and routine physical, microbiological and chemical analysis of the roofing sheets and water, soil and air should be carried out to determine the impacts of petroleum-based activities on the components and integrity of the ecosystem.

REFERENCES

Abua, M. A. and Ashua, S. W. (2015). The Impact of Gas Flaring on Plant Diversity in Ibeno Local Government Area.*Journal of Agriculture and Ecology Research International,* 4 (1): 10-17.

Aigberua, A. O., Ekubo, A. T., Inengite, A. K. and Izah, S. C. (2017). Assessment of some selected heavy metals and theirpollution indices in an oil spill contaminated soil in the NigerDelta: a case of Rumuolukwu community. *BiotechnologicalResearch,* 3 (1): 11- 19.

Amadi, A. N. (2014). Impact of Gas-Flaring on the Quality ofRain Water, Groundwater and Surface Water in Parts of EasternNiger Delta, Nigeria.*Journal of Geosciences and Geomatics,* 2(3): 114-119.

Ana, G., Sridhar, M. and Emerole, G., (2012).Polycyclic aromatic hydrocarbon burden in ambient air in selected Niger Delta communities in Nigeria. Journal of the Air &Waste Management Association, 62(1): 18-25.

Dung, J. E., Bombom, S. L. and Agusomu, D. T. (2008).The effects of gas flaring on crops in the Niger Delta, Nigeria.*GeoJournal*.**73**: 297–305.

Ede, P. N. and Edokpa, D. O. (2015). Regional Air Quality of the Nigeria's Niger Delta. *Open Journal of Air Pollution,* 4:7-15.

Edino, M. O., Nsofor, G. N. and Bombom, S. L. (2010).Perceptions and attitudes towards gas flaring in the Niger Delta, Nigeria.*Environmentalist*.**30:** 67–75.

Edwards, P., Young, C., Aikin, K., deGouw, J., Dubé, W., Geiger, F., Gilman, J., Helmig, D., Holloway, J. and Kercher, J., (2013). Ozone photochemistry in an oil and natural gas extraction region during winter: simulations of a snow-free season in the Uintah 1009 Basin, Utah. Atmospheric Chemistry and Physics, 13(17): 8955-8971.

Efe, S. I. (2010). Spatial variation in acid and some heavy metalcomposition of rainwater harvesting in the oil producing regionof Nigeria.*Natural Hazard*, DOI 10.1007/s11069-010-9526-2.

Emam, E. A. (2015). Gas Flaring In Industry: An Overview.*Petroleum and Coal*, 57 (5): 532-555.

Emumejaye, K. (2012). Effects of Gas Flaring on Surface andGround Water in Irri Town and Environs, Niger-Delta, Nigeria.*IOSR Journal of Environmental Science, Toxicology and FoodTechnology*, 1 (5): 29-33.

Ezenwaji, E. E., Okoye, A. C. and Otti, V. I.(2013).Effects ofgas flaring on rainwater quality in Bayelsa State, EasternNiger-Delta region, Nigeria.*Journal of Toxicology andEnvironmental Health Sciences*, 5 (6): 97-105.

Fawole, O.G, Cai, X.M.& Mackenzie, A.R.(2016). 'Gas flaring and resultant air pollution: A review focusing on black carbon' Environmental Pollution. 216, 182-197. DOI: 10.1016/j.envpol.2016.05.075

Huang, K.and Joshua S. Fu, J.S. (.2016). A global gas flaring black carbon emission rate dataset from 1994 to 2012. Sci Data. 3: 160104.doi: 10.1038/sdata.2016.104.

Lichtenthaler H. K. (1996).Vegetation Stress: an Introduction to the Stress Concept in Plants. Journal of Plant Physiology.148(1–2):4–14.

Nigerian National Petroleum Corporation (NNPC).Annual statistical bulletin.1st Edition.Corporate planning anddevelopment division (CPDD) (2006 – 2014).

Nwankwo, C. N. and Ogagarue, D. O. (2011).Effects of gasflaring on surface and ground waters in Delta State Nigeria.*Journal of Geology and Mining Research,* 3 (5): 131-136.

Nwanya N. (2011). Climate change and energy implications of gas flaring for Nigeria.I*nternational Journal of Low-Carbon Technologies*. 6 (3, 1);193–199. https://doi.org/10.1093/ijlct/ctr007

Obanijesu, E., Adebiyi, F., Sonibare, J. and Okelana, O., (2009). Air-borne SO2 Pollution Monitoring in the Upstream Petroleum Operation Areas of Niger-Delta, Nigeria. Energy Sources –A. 31(3): 223-231.

Obi, E. O. and Osang, J. E. (2015). Thermal effect of gas flaring activities in ogba-egbema-ndomi community, rivers state, NigeriaInternational Journal of Energy and Environmental Research 3 (3), -11

Seiyaboh, E.I and Izah, S.C. (2017). A Review of Impacts of Gas Flaring on Vegetation and Water Resources in the Niger Delta Region of Nigeria.*International Journal of Economy, Energy and Environment*.2(4), 48-55.doi: 10.11648/j.ijeee.20170204.11.

Sonibare, J., Adebiyi, F., Obanijesu, E. and Okelana, O., (2010). Air quality index pattern around petroleum production facilities. Management of Environmental Quality. 21(3): 379-392. 1211

Ubani, E. C. and Onyejekwe, I. M. (2013). Environmental impact analyses of gas flaring in the Niger delta region ofNigeria. *American Journal of Scientific and Industrial Research,* 4 (2): 246-252.

MAPPING *SERIPHIUM PLUMOSUM* ENCROACHMENT IN MOUNTAINOUS GRASSLANDUSING SPECIES DISTRIBUTION MODELLING

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Abstract
Accurate information on the distribution of invasive native speciescould provide important and effective procedures for managing savannah environment, especially in difficult mountainous terrains. The study detected and mapped Serethium plimosum within a mountainous area and linked these data to the environmental conditions at each location to predict the potential distribution using a MaxEnt niche model. We also explored the differences in the environmental determinants of the distribution of Serethium plimosum. The AUC value of 0.927 estimated for the species distribution indicated that the model fit well to the data used. Our findings indicated that Serethium plimosumpreferred areas with higher temperature, moderate rainfall and optimum soil moisture range. It also suggested that the projected conditions of increasing temperature and fire events, could promote widespread gain of suitable habitats and niche space for the species, particularly in areas of optimum soil moisture conditions. We proposed that the extent of suitable habitats for Serethium plimosumhas implications forunderstanding the potential effect of the interaction within socio-ecological systems under global change.

Keywords: *ENM, Serethiumplimosum, Environmental conditions; Ecological niche, Maxent*

INTRODUCTION

Species encroachment is often seen as one of the most extensive forms of degradation threatening socioeconomic and ecological systems (Ruiz Beltran, 2015). Effective management of invasive species requires accurate and adequate knowledge on the spatial distribution and density of these species (Underwood, 2002). Remote sensing has been successfully applied in mapping the distribution of native invasive species (Joshi, 2004). In various studies, canopy characteristics and leaf traits promote vegetation discrimination based on leaf spectral signature at the species level (Castro-Esau, 2008, Oldeland, 2010). Different studies have been conducted using multispectral sensors to detect or map the spread of invasive species (Huang, 2002, Laliberte *et al.,* 2004) and many classification methods have been used over the years to discriminate these species (Omer, 2015). Red and infrared band region provides the core data for species discrimination but for multispectral images, the challenge still remains for individual species detection (Shang and Chisholm, 2014). Multispectral imagery accumulates difficulties when identifying species from a heterogeneous landscape due to their coarse resolutions.

Classification processes using multispectral imagery tend to over-classify individual species making more pixels of these species than they actually are (Lawrence *et al.,* 2006). Accuracy assessment when mapping encroaching species is therefore impacted by the spatial and spectral resolution of remote sensor (Shang and Chisholm, 2014; Dubula *et al.,* 2016). Moreover, mapping using sensors can also be difficult due to various slopes, shades and illumination in mountainous terrain which can be time-consuming and also very expensive (Dorren, 2003). In this study, we assessed the distribution of *Serethium plimosum* using known presence locations together with fire and other environmental variables representing climate and soil moisture content using the species distribution modeling (SDM) approach.SDM also alternatively known as Ecological niche modeling (ENM) or environmental niche/species distribution model is a numerical predictive modelling tool that combines observations of species occurrence or abundance with environmental estimates.

Thespecies distribution model allows predicting distributions of species across thelandscape as well as interpolating/extrapolating between a limited numbers of species occurrences in space and time (Elith and Leathwick, 2009). Such modeling tool helps to increase our understanding of the ecosystem and the different interacting factors. SDM techniques continue to evolve with an increasingly broad range of applications from conservation planning (Allen et al. 2001; Scoble and Lowe 2010), to predicting species colonization and abundance (Peterson 2003; Peterson and Robins 2003; VanDerWal *etal.,* 2009), predicting disease outbreaks, (Peterson et.al, 2002) and understanding phylogeographic patterns (Rodder *etal.,* 2010). Methods of producing SDMs vary with the type of data available, purpose, and software used. Machine-learning approaches for SDM such as the Maxent method used in this study holds great promise for helping to link descriptions of ecological pattern to ecological mechanism (Perry et al., 2012).We used the Maxent model in this study because it has been shown to perform better in modeling habitat distribution in comparison with other methods, especially with small sample sizes relative to other modeling methods (Pearson *etal.,* 2004; Philips *etal.,* 2006; Elith *etal.,* 2011). Maxent (Philips *etal.,* 2006) uses presence-only data to predict the distribution of a species based on the theory of maximum entropy. The program attempts to estimate a probability distribution of species occurrence that is closest to uniform while still subject to environmental constraints (Elith *etal.,* 2011). There are only a few studies modelling the potential impacts of environmental variables on the distribution of *Serethium plimosum* in grassland mountainous region of South Africa. However, no modeling analyses for the distribution of *Serethium plimosum* at the Golden Gate Highland National Park (GGHNP) have been documented so far.

MATERIALS AND METHODS

Study area

The Golden Gate Highland National Park (GGHNP) which falls under the grassland biome of South Africa was established in 1963 for the purpose of conserving the grasses and sandstone formation hence it's named the montane and afro- alphine grassland biome (SANPark, 2012) (Fig. 1). It is situated between 28°27' S - 28°37' S and 28°33' E - 28°42' E at the montane area on the eastern part of the Free State (SANPark, 2012). The park is characterized by rainfall season stretching from September to April with a mean annual ranging from 1800 to 2000 mm and is thus categorized as a dry sub-humid region (Fig.2a). Summers are temperate with mean temperature ranges from 13 to 26 ^{0}C and winters are cold with mean temperature ranges from 1 to15^{0}C. The park area is further divided into four zones, including low-intensity leisure, high-intensity leisure, remote and quiet buffer zones. There are five vegetation types that are found in the park: Basotho montaneshrubland is vulnerable, Eastern Free State Sandy Grassland is endangered vegetation type, others such as the Basotho highland basalt, Northern Drakensberg Highlands Grassland and Drakensberg-AmatholeAfromontaneFynbos are considered poorly protected (SANPark, 2012). Poaceae with 55 genera and Asteraceae with 51 genera are some of the largest plant families found in the park and the majority of the plants are mostly flat with rivers and gorges (SANPark, 2012). One of the most dominant and aggressive invasive in South Africa is *Serethium plimosum* which is commonly known as Slangbos (Snyman, 2009). The species had encroached severely in the grassland biome within the provinces of South Africa include Free- State, Gauteng, Mpumalanga, Eastern Cape, KwaZulu-Natal and North West (Snyman, 2010). Due to the complexity of *Serethium plimosum* encroachment into the grassland biome, mapping is required for better management and effective control measures in areas such as GGHNP. The encroachment of *Seriphiumplumosum* may have significant impact on future fire spread in the grassland biomes, especially in the study area, hence, the need for mapping this species for improved management has become very important especially in the face of the ever changing climate. Mapping the distribution of *Serethium plimosum using* remote sensing provides a baseline for monitoring future expansion, the effectiveness of control efforts, and assists in identifying targets for control activities (Dieter, 2009b).

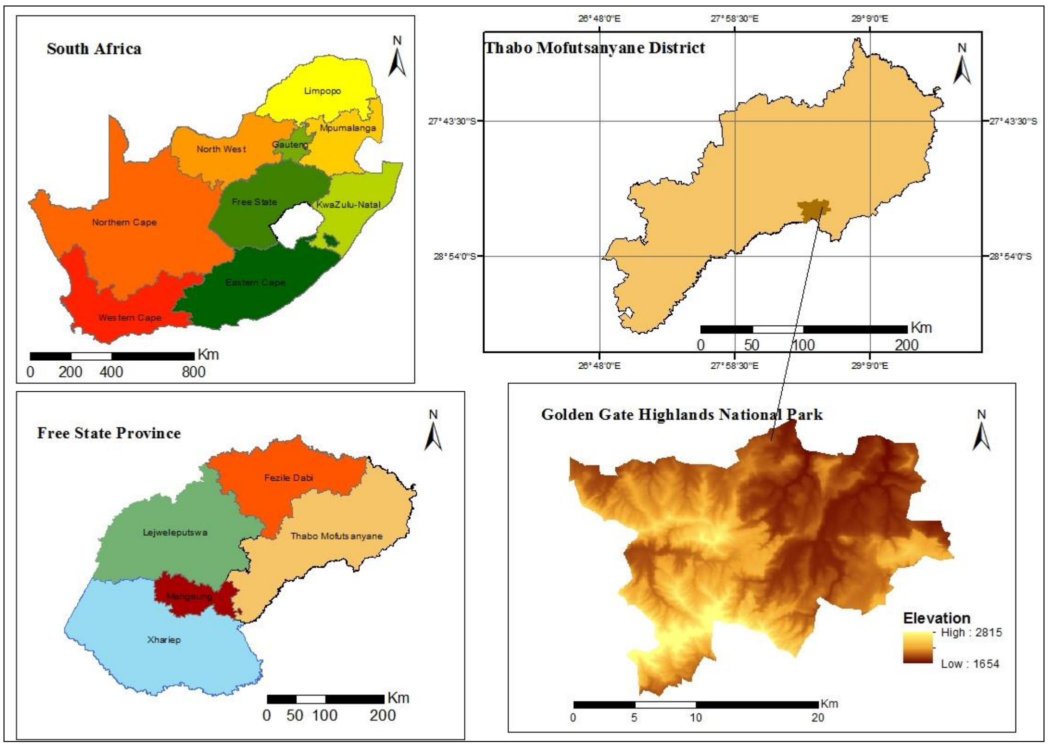

Fig. 1: The Golden Gate Highland National Park, South Africa

Datasources and data preparation

Species occurrence data collection: The occurrence locations of *Serethium plimosum* in the GGHNP region were collected in a field survey across the park during the summer season of October/November 2016. The transect lines used for sampling were those were originally laid out by the park management to adequately sample the different habitat types and to cover the spatial extent of the reserve (Kraus 1997; Smith *et al.*, 2012). We located and walked transect the lines using an ESRI Arc pad in which the previously digitized transect lines and 5 m buffers were stored.We sampled all individuals of the selected species found within a 5 m width on either side of the line. We sampled 60 transects with an average length of 3 km and covering a total length ofabout 40 km. We recorded and georeferenced all natural populations and isolated individuals of *Serethium plimosum*totaling 124 records in the GGHNP, resulting in a detailed distribution map.Environmental variables including; temperature, rainfall, topography, and vegetation indices all influence species/fire distribution andthe inclusion of remotely sensed variables as predictors in species distribution models improves prediction accuracy and refines the mapped distribution range of the species. (Zimmermann *et.al.*, 2007, Franklin 2009, Bobrowski *et al.*, 2018). The climatic and other environmental variables were obtained as follows: day and night land surface temperature data were obtained from the MODIS Terra Land Surface Temperature and Emissivity 8-Day Global 1km product (MOD11A2.006); rainfall data (Fig.2) was obtained from the Climate Hazards Group Infrared Precipitation with Station data (CHIRPS); topographic data including elevation and slope were obtained from the Shuttle Radar Topographic Mission Digital Elevation Model(SRTM DEM),Normalized difference vegetation index (NDVI), Normalized difference water index (NDWI) and the Normalized difference built-up index (NDBI). The (NDVI), (NDWI), and the were derived from the Landsat8-OLI dataset obtained from the United States Geological Survey (USGS) and downloaded from Google Earth Engine platform(Google earth 2015).All the environmental layers were resampled into the same projection information and were converted into the ASCII raster data format required by Maxent.

Maxent modeling of*Serethium plimosum*distribution

The Maxent model was fitted to our data using 75% of the species occurrences (training points). The predictive power of models was assessed by cross-validations using the 25% remaining occurrences (test points) not used to fit the model and a set of 1000 random locations representing background (or pseudo-absence) points (Philips et.al. 2006).The fitted parameters were used in the model to produce a raw probability map that underwent a transformation to produce the so-called “logistic” output (Philip and Dudik, 2008). The mapped value of each cell of this output represented an estimate of relative probabilities ranging from 0 to 1, and a high value of the Maxent function at a particular location indicates suitability. Model predictions were then checked against real observations using the area under the curve (AUC) of a receiver operating characteristics (ROC) plot (Albert-Green et.al. 2013). Using Maxent generated response curves, relationships between locational suitability for *Serethium plimosum* and environmental variables were determined (Fig. 2). Generally, the AUC value which ranges from 0.5 to 0.7, 0.7 to 0.9, and more than 0.9imply that the model accuracy is low, moderate, and high respectively (Hosmer and Lemeshow, 2000). The AUC value and the maximum kappa value were used to measure the performance of the predicted model in the study.

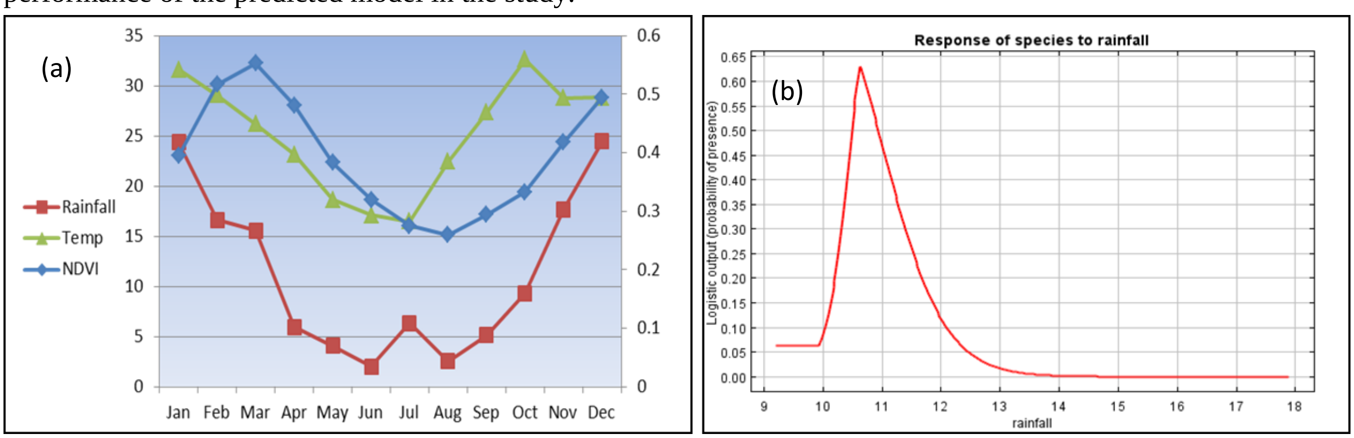

Fig. 2(a): Monthly pattern of rainfall temperature and NDVI in GGHNP (b) response curve for rainfall

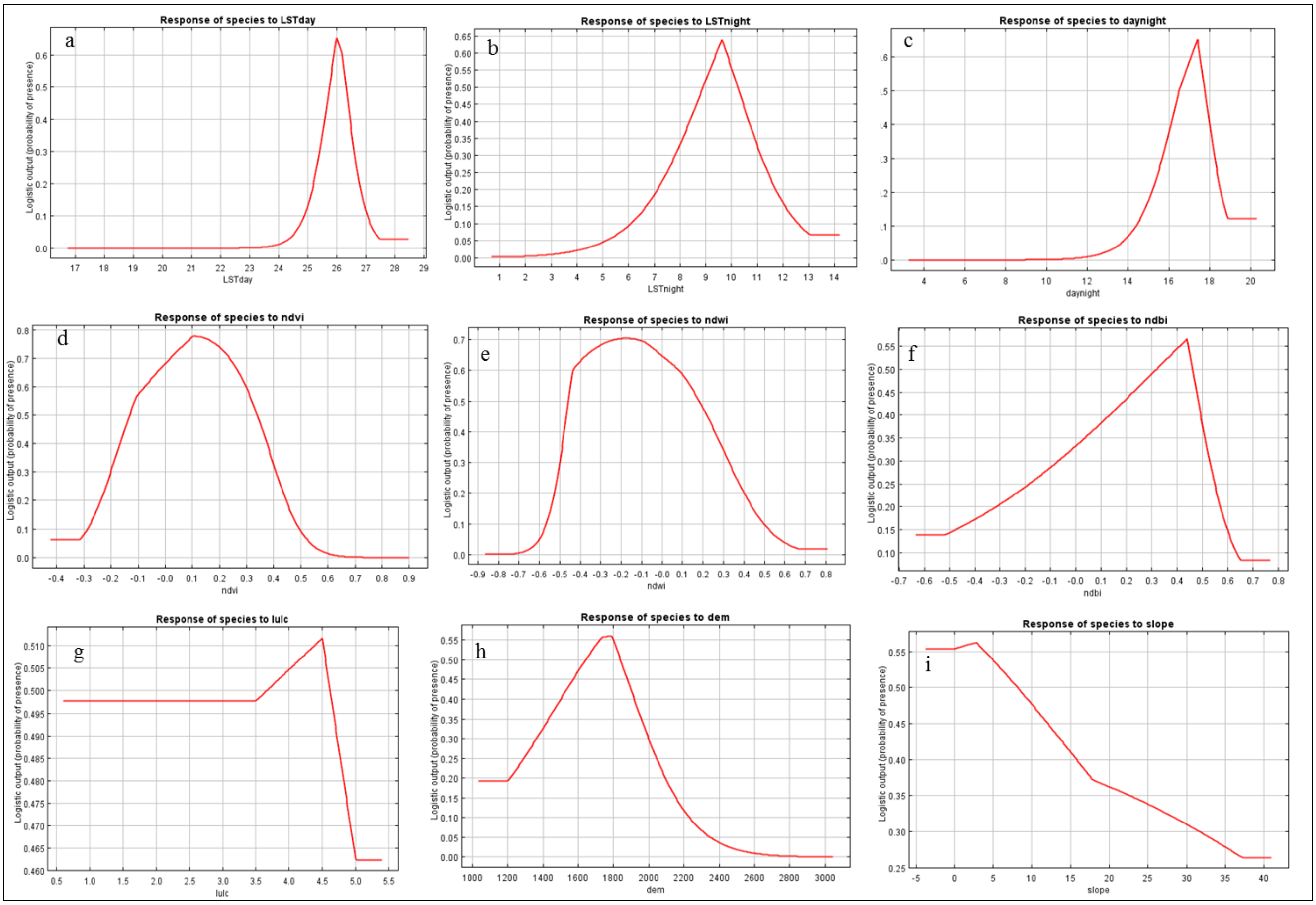

Fig. 3: Logistic output probability response curve of presense for (a)land surface temperature day; (b) Land surface temperature night (c) fdaynight temperature (d)NDVI ; (e) NDWI; (f) NDBI; (g) LULC (h) elevation; (h) slope

RESULTS AND DISCUSSION

Variables Contribution and Model Fitting

The AUC values for *Serethium plimosum* indicated that the model fit well to the data used (i.e.0.98) which is higher than 0.5 of a random model. The probability distribution maps produced by MaxEnt indicated that the species is restricted mainly to the north and the eastern sections of the park with only a small patch in the western and southern sections (Fig. 4). However, the species had a wider predicted distribution to the northwest portion which is known for its high-intensity leisure than the northeast with lower intensity leisure where it was predicted to be less common. Most of the distribution however occurs especially towards the border of the park (Fig.4). In the model, day land surface temperature has the highest AUC value, indicating that a larger proportion of the predictive power of the model was due to this variable. Rainfall was the next most important as a predictor, followed by NDWI, the difference between day and night temperature and slope. The NDBI, NDVI, LULC and elevation ranked last in order of importance, indicating that these variables had little effect on *Serethium plimosum* distribution. (Fig.5).

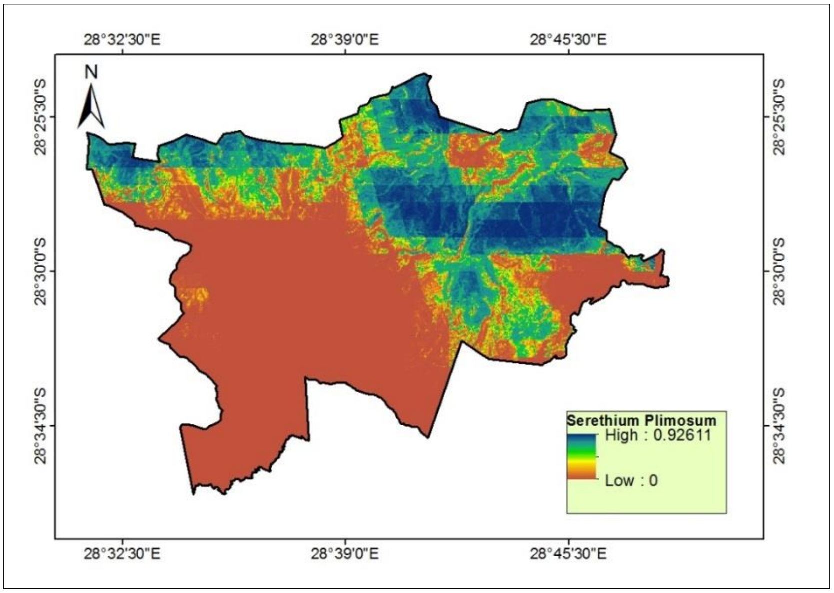

Fig. 4: Probability of occurrence or habitat suitability maps produced by MaxEnt for *Serethium Plimosum.* A probability of one indicates a high likelihood of finding the species within the raster square, and zero indicates that it is unlikely that the species will be found there.

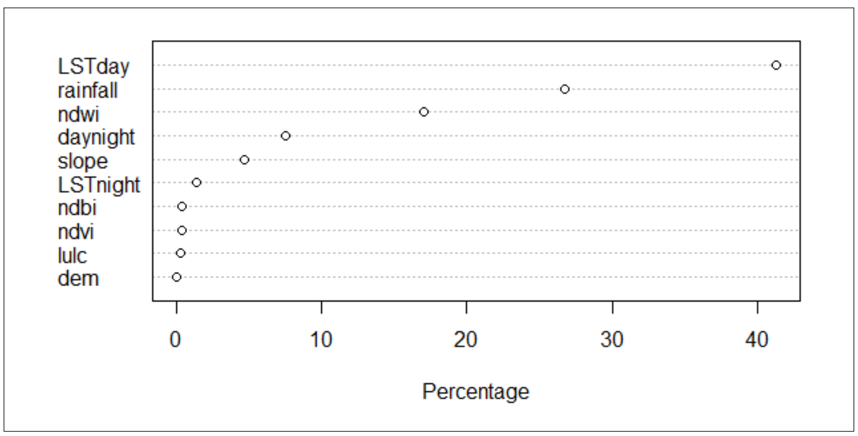

Fig.5: Variable contribution to model performance

The contribution of environment variables in the model suggested that land surface temperature, rainfall and NDWI are the strongest determinants of*Serethium plimosum* distribution in the study area (Figure 2). *Serethium plimosum* is, therefore, more likely to survive more mostly in areas occurring on terrain facing suntraps with higher temperature due to higher solar incidence and comparatively drier surface (De Vasconcelos, 2001; Holden *et.al.*, 2009). Although,*Serethium plimosum* were predicted to be found in areas with gentle slopes, our analysis further revealed that thespecies tends to avoid higher slopes and elevations which are predominant in the southern, most primitive and remote area of the park. The probability of occurrence of *Serethium plimosum* was therefore noted to be strongly influenced by areas of more intense human activities within the park. Species occurrence was also observed to be higher in areas where the NDWI is high - suggesting that soil moisture content isalso a limiting factor for its distribution. Surprisingly, *Serethium plimosum*distribution was lower in areas with high rainfall intensity mostly at higher elevations in the remote southern parts. This could be explained by the reduced human influence, loweraccessibility and remoteness of the terrain. However, in areas with low to moderate rainfall at lower elevations where there is a higher difference between day and night temperature, increased grazing activities and human influence on the landscape may explain the higher distribution of the species. Evidence from climate change projections suggested that increasing temperatures and changes in vegetation use and management could lead to a further increase in large fire events (IPCC, 2013). One explanation forthe distribution of *Serethium plimosum*in these areas recently affected by disturbancesis that the post-fire species and vegetation densities may be becoming gradually more tailored to the emerging climate (Overpeck *et al*, 1990, Millar *et al*, 2007). Hence, wildfires may become more critical for shaping future distribution of *Serethium plimosum* in mountainous grassland ecosystems even in areas where fire disturbance is currently low. It is therefore plausible tosay that increase in temperatures and fire events, as well as changes in vegetation use and land management will probably lead also to further spread of *Serethium Plimosum* (IPCC, 2013).

CONCLUSIONS

Maps for invasive species presence are needed for management purposes in a conservational and protected area. Based on the goodness of fit of the model, the results of the study have shown that SDM modelling is reliable to detect and map the distribution of *Serethium plimosum* which is a native invasive species found in the GGHNP. Our results indicated that *Serethium plimosum* is restricted mainly to the northern portion of the park with higher intensity leisures, human contact and grazing activities. The results also showed that day land surface temperature,, rainfall and NDWI which is a proxy for soil moisture content are the strongest determinants of habitat suitability in the study area.The fire vulnerability data, as an indicator of ecosystem susceptibility to wildfires, indicates that fire may play a more critical role for shaping future distribution of *Serethium plimosum* especially inmountainous grassland ecosystems even in areas where fire disturbance is currently low. Our results also indicated that these conditions could promote widespread gain of suitable habitats and niche space for the species, particularly in areas of optimum soil moisture conditions. The restricted extent of suitable habitats for *Serethium plimosum*, thereforehas implications for our understanding of the potential effect of interaction between human and ecological dimensions of socio-ecological systems on species distribution. More studies are needed to evaluate the impact of future climates using higher-resolution models as they become available, for a more effective and reliable future invasive and fire management planning. Data with higher resolution and a longer historical period can improve the prediction ability of the model, to provide a better forecast of *Serethium plimosum* distribution. The findings of this study can be used to establish what mitigating measures might be possible to reduce the encroachment of *Serethium plimosum*in protected mountainous areas. Mitigation measures such as the identification of additional localities where *Serethium plimosum* is likely to spread to; or in the priority selection in support of more intensive protection of smaller, high-value areas, for introduction, cultivation and the conservation management of such rare or endangered species that might otherwise be displaced.

REFERENCES

Albert-Green, A., Dean, C.B., Martell, D.L., Woolford, D.G. (2013). A methodology for investigating trends in changes in the timing of the fire season with applications to lightning-caused forest fires in Alberta and Ontario, Canada. *Can. J. For.Res.* 43, 39–45.

Allen CR, Pearlstine LG, Kitchens W.M. (2001). Modeling viable mammal populations in gap analyses. *Biological Conservation* 99:135-144.

Bobrowski, M., Bechtel, B., Böhner, J., Oldeland, J., Weidinger J., and Schickhoff. U., (2018). Application of Thermal and Phenological Land Surface Parameters for Improving Ecological Niche Models of *Betula utilis* in the Himalayan Region. *Remote Sens.* 10: 814.

Castro-Esau, K. L. K., M. (2008). Tropical dry forest phenology and discrimination of tropical tree species using hyperspectral data hyperspectral remote sensing of tropical and sub-tropical forests.

De Vasconcelos, M.J.P., Silva, S., Tome, M., Alvim, M., Pereira, J.C. (2001). Spatial prediction of fire ignition probabilities: Comparing logistic regression and neural networks. *Photogramm. Eng.Remote Sens*. 67, 73–81.

Dieter, J. (2009b). Bankruptbush (slangbos) - A silent threat to grassland? Newsletter of the grassland society of Southern Africa, 9, 40-42.

Dorren, L. K. A. M., B; Seijmonsbergen, C. A (2003). Improved Landsat-based forest mapping in steep mountainous terrain using object-based classification. *Forest Ecology and Management.* 183, 31-46.

Dubula, B., Gebremariam, S., Isaac, T. and Rampedi, T. (2016). Assessing the Potential of Remote Sensing to Discriminate Invasive Seriphium Plumosum from Grass. *South African Journal of Geomatics*, 5:2.

Duro, D. C., Franklin, S. E. & Dubé, M. G. (2012), A comparison of pixel-based and object-based image analysis with selected machine learning algorithms for the classification of agricultural landscapes using SPOT-5 HRG imagery. *Remote Sensing of Environment.* 118, 259-272.

Elith, J., Leathwick, J. R. & Hastie, T. (2008). A working guide to boosted regression trees. *Journal ofAnimal Ecology*, 77: 802-813.

Elith, J., Phillips, S.J., Hastie, T., Dudík, M., Chee, Y.E., Yates, C.J. (2011). A statistical explanation of Maxent for ecologists. *Divers. Distrib.* 17: 43–57.

Elith, J., R, J., &Leathwick. (2009). Species Distribution Models: Ecological Explanation and Prediction Across Space and Time. *Annu. Rev.Ecol.Evol. System*, 40:677-97.

Franklin, J. (2009). Mapping species distributions: Spatial inference and Prediction; Ecology, Biodiversity and Conservation. Cambridge University Press; Cambridge, UK, 2009.

Holden, Z.A., Morgan, P., Evans, J.S (2009). A predictive model of burn severity based on 20-year satellite-inferred burn severity data in a large southwestern US wilderness area *Forest Ecology and Management* 258: 2399–2406.

Hosmer, D.; Lemeshow, S. (2000). Applied Logistic Regression; Wiley-Interscience: New York, NY, USA ; p. 392.

Huang, C., Davis, L.S., Townshend, J.R.G.(2002). An assessment of support vector machine for land cover classification. *International Journal of Remote Sensing*, 23: 725- 749.

Joshi, C. L. J., Van Duren, I. C. (2004). Remote sensing and GIS application for mapping and spartial modelling of invasive species. In: RESOURCES, D. O. N. (ed.). The Netherlands: International Institude for Geo- Information Science and Earth Observation.

Laliberte, A. S., Rango, A., Havstad, K. M., Paris, J. F., Beck, R. F., Mcneely, R. & Gonzalez, A. L. (2004). Object-oriented image analysis for mapping shrub encroachment from 1937 to 2003 in southern New Mexico. *Remote Sensing of Environment*, 93: 198-210.

Lawrence, R. L. W., S. D., Sheley, R. L. (2006). Mapping invasive plants using hyperspectral imagery and Breiman Cutler classification (Random Forest). *Remote Sensing of Environment*, 100: 356-362.

Lawrence, R., Bunn, A., Powell, S.,& Zambon, M. (2004). Classification of remotely sensed imagery using stochastic gradient boosting as a refinement of classification tree analysis. *Remote sensing of environment*, 90: 331-336.

Novack, T., Esch, T., Kux, H. & Stilla, U. (2011). Machine learning comparison between WorldView-2 and QuickBird-2-simulated imagery regarding object-based urban land cover classification. Remote Sensing, 3: 2263-2282.

Odindi, J., Elhadi, A., Ngubane, Z.,Mutanga, O., Rob, Slotow,R.(2014). Comparison between WorldView-2 and SPOT-5 images in mapping the bracken fern using the random forest algorithm. *Journal of Applied Remote Sensing*, 5.

Oldeland, J. D., Wesuls, D., Jurgens, N.(2010). Mapping bush encroaching species by seasonal differences in Hyperspectral Imagery. *Remote Sensing*, 2: 1416-1438.

Omer, G. M., O; Abdel-Rahman, F.M., Elhadi, A.(2015). Performance of Support Vector Machine and Artificial Neutral Network for Mapping Endengered tree species Using WorldView-2 data in Dukuduku Forest, South Africa. *Journal of selected topics in applied earth observations and remote sensing.*

Oumar, Z.,& Mutanga, O. (2013). Using WorldView-2 bands and indices to predict bronze bug *(Thaumastocoris peregrinus)* damage in plantation forests. *International Journal of Remote Sensing*, 34: 2236-2249.

Pearson, R.G., Dawson, T.P., Liu, C. (2004). Modelling species distributions in Britain: a hierarchical integration of climate and land-cover data. *Ecography*, 27:285-298.

Perry, G.L.W.; Millington, J.D.A. (2008). Spatial modelling of succession-disturbance dynamics in forest ecosystems: Concepts and examples. Perspect. Plant Ecol. Evol. Syst. 2008, 9, 191-210.

Peterson, A. T. (2001). Predicting species' geographic distributions based on ecological niche modeling. *Condor* 103:599–605.

Peterson, A.T (2003). Predicting the geography of species' invasions via ecological niche modeling. *The Quarterly Review of Biology*, 78:419-433.

Peterson, A.T., Robins, C.R.(2003). Using ecological-niche modeling to predict barred owl invasions with implications for spotted owl conservation. *Conservation Biology*, 17:1161-1165.

Peterson, A.T., Sánchez-Cordero V., Beard C.B., Ramsey J.M.(2002). Ecologic niche modeling and potential reservoirs for Chagas disease, Mexico. *Emerging Infectious Diseases*, 8:662-667.

Phillips, S.J., Anderson, R.P., Schapire, R.E. (2006). Maximum entropy modeling of species geographic distributions. *Ecol. Model.* 190, 231–259.

Phillips, S.J.. Dudik, M.(2008). Modeling of species distributions with Maxent: New extensions and a comprehensive evaluation. *Ecography*, 31: 161–175.

Rödder, D., Weinsheimer, F., Lötters. S. (2010). Molecules meet macroecology: Combining species distribution models and phylogeographic studies. *Zootaxa*, 60:54-60.

Ruiz Beltran, P. A. (2015). Mapping of Vegetation Types and Bush Encroachment In Namibia

SANPARK (2012). Golden Gate Highlands National Park Management Plan.

Scoble. J., Lowe A.J. (2010). A case for incorporating phylogeography and landscape genetics into species distribution modelling approaches to improve climate adaptation and conservation planning. *Diversity and Distributions*, 16:343-353.

Shang, X., Chisholm, L. A. (2014). Classification of Australian native forest species using hyperspectral remote sensing and machine-learning classification algorithms. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 7: 2481-2489.

Smith, A., Page, B., Duffy, K., and Slotow, R. (2012). Using Maximum Entropy modeling to predict the potential distributions of large trees for conservation planning. *Ecosphere*3(6):56.

Snyman, H. (2009). Germination potential of *Seriphium plumosum* (bankrupt bush, slangbos or vaalbos). *Grassroots*, 9: 43-48.

Snyman, H. (2010). Allelopathic potential, seed ecology and germination of the encroacher shrub *Seriphium plumosum.African Journal of Range & Forage Science*, 27: 29-37.

Underwood, E. U., S; Dipietro, D. (2002). Mapping non-native plants using hyperspectralimegery. center for spartial technologies and remote sensing.

VanDerWal, J., Shoo, L.P., Johnson, C.N., Williams, S.E. (2009). Abundance and the environmental niche: environmental suitability estimated from niche models predicts the upper limit of local abundance. *The American Naturalist*, 174:282-291.

Zimmermann, N.E., Edwards, T.C., Moisen, G.G., Frescino, T.S., Blackard, J.A.(2007). Remote sending-based predictors improve distribution models of rare, early successional and broadleaf tree species in *Utah. J.Appl. Ecol.*, 44, 1057-1067.

PROTECTING WEST AFRICAN FOREST AND WATERSHEDS (WETLANDS)

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Abstract

While biodiversity and ecosystem servicesderived from the natural environment are the backbones of West African rural livelihood, unsustainable exploitation of natural resources, conflicts and climate change threatenthe continued provision of ecosystem services. Evaluating the effectiveness of environmental conservation projects is central towards designing and scaling-up successful conservation projects. Using secondary literature and project reports, wereviewed ongoing and completed conservation projectsin the West African sub-region related to forest andwatersheds (wetlands). Scientific work on incentivesfor ecosystem services in sub-Saharan Africa typicallyfocuseson Southern and Eastern Africa, leaving Western Africa underserved. This study fills this literature gap by compilinglessons from conservation projects in West Africa tooffer region-specific incentives that should inform the design of conservation projects in the region.

Keywords: *Biodiversity, Ecosystem Services, West Africa, Incentives, Sustainable Development Goals.*

INTRODUCTION

Tisdell (2012) and Bolt *et al.* (2016) describes Biodiversity as a stock of living resources determined by nature as well as, to some extent, human activity. Ecosystem Services (ES), on the other hand, are biodiversity flows beneficial to man.Ecosystem services include provisioning services: food, drinking water, medicine, and hydroelectric power; regulating services: carbon sequestration, climate regulation clean air and water; cultural services: tourism, religious and cultural benefits; supporting services: agriculture, soil formation, flood and erosion control (Aglanu, 2014). In West Africa, watersheds (wetlands), forest and vegetationare biodiversity hubs and primary providers of ESs. These hubscharacterizethe environmental landscape in West Africa and are crucial to the livelihood of its citizens.

However, the integrity of these biodiversity hubs is at serious risk.The occurrence of invasive species as well as industrial and pesticide discharge are threatening the quality and volume of native flora and fauna speciesresiding in watersheds and wetlands across sub-Saharan Africa(Kabii, 1996, Ferraro 2009). Consequently, these havedegraded and reduced the size of biodiversity hubs in parts of West Africa (Aglanu, 2014).Hillstrom and Hillstrom, (2003) show that close to 90% of West Africa´s original forest has disappeared with portions of thenaturalforest existing only in Cote dʼIvoire, Nigeria and Cameroon. Over-exploitation of forest resources, mining, agricultural expansion, hunting and population growth isfragmenting tropical forests and driving biodiversity losses (IUCN, 2015). Theselossesthreatenboth wildlife and people in West Africa whose livelihood depends on ESsand the future generations.

In response to these threats, governments, and private sector organizationsin developing countries are implementing environmental conservation policies and programstoregulate and preserve biodiversity resources and raise awareness of threats facing biodiversity hubs (Benjamin 2012; Benjamin and Blum 2015). For example, conservation programssuch as Reducing Emissions from Deforestation and Forest Degradation (REDD), Plus REDD+, Payments for Ecosystem Services (PES) and Forests and National Park protections laws,are increasingly being implemented to protect biodiversity spots and curtail the over-exploitation of forest resources (Bond *et al.* 2009, Cerbu *et al.*, 2011).Reviews of the implemented policies and programs are becoming common because programs and policies must adapt to the changing environmental, institutional and economic conditions surrounding these programs.Findings from the reviews uncover up-to-date, comprehensive information and provoke discussions absent in individual case study research (Jindal *et al.*, 2008). The results of reviews therefore guidepolicymakers in the design and implementation of new programs as well as adjustingand scaling-up pilot programs.

In Africa, the fewreviews of ecosystem services and conservation programs in Africa concentrate onEastern and Southern Africa,(see Jindal *et al.*, 2008; Bond *et al.*, 2009; Ferraro, 2009; Wangai *et al.*, 2016; IIED, 2017).Results from Jindal *et al.*,(2008) showed the implementation of conservation programs in Africa lag behind other developing parts of the world. According to Ferraro (2009), poverty alleviation and equity are dominant themes in watershed programs in Africa. Both studies demonstrated that strict regulatory requirements and poor technical knowledge limit opportunities to trade for ecosystem services and implement trading schemes in Africa. Wangai *et al.*, (2016) argued sustainability in Africa depends on the assessment of ecosystem services, while highlighting the dominance of provisioning ecosystem services in conservation programs in East and South Africa.

These studies also lamented the dearth of conservation programs and information on those programs in other parts of Africa. Indeed, extensive literature search revealed few studies (see Bond *et al.*, 2009) have reviewed conservation programs in West Africa. Given the growing interest in conservation policies and programs in West Africa, it is important that this gap is filled. Assessing the effectiveness of these programsunderscorestheir contribution towardsprotecting biodiversity, combating poverty, promoting sustainable agriculture and gender equality, in addition to achieving the Sustainable Development Goals (SDGs).

This studyreviews fill the gap on the ongoing (and defunct) policies and programs that protect watersheds (wetlands) and forests in West Africa. We draw attention to the activities of these programs;highlight theiroutcomes and challenges to offer region-specific incentives that inform the design of conservation projects in West Africa.Incentives, in this study, refer to mechanisms, andmaterial benefits that motivate environmental conservation. In a review of conservation programs in Asia, Latin America and Africa, Bond *et al.*, (2009) discovered incentives are more effectiveenvironmental conservation measures compared to previous conservation approaches. They, however, caution that for incentives to achieve their goals, certain economic, cultural and institutional conditions need to be considered beforehand. In evaluating conservation programs in West Africa, wetease out those critical cultural, economic and institutional conditions crucial to successful environmental conservationprograms in the region. In different parts of Africa, dependence on ESs differs as socioeconomic conditions, geography and vegetation changes, creating slight differences in priorities for each region (Egoh *et al.*, 2012). Our findings should inform the implementation of conservation initiatives in Africa, andtarget potential project sponsors and managers seeking to design and finance projects in West Africa. Revealed the rest of the study is organized as follows. Section 2 introduces the materials and methods used in this study. Section 3summarizes ongoing (and completed) conservation projects in West Africa.This section focuses on the objectives of these programs, the ecosystem services they provide, the institutional actors involved in the projects, their outcomes and the challenges they faced. Section 4discusses various incentives for increasing investments in environmental conservation and projects in West Africa, while Section 5 concludes the paper.

MATERIALS AND METHODS

In putting together this study, a desk review of reports on active and defunct conservation programs in West Africa was conducted. According to Bryman and Bell (2007), qualitative reviews attempts to understand the meaning of and contextualize events and processes. We find this approach suited to the aims and scope of this study. This process unfolded in two stages.

In the first stage, we searched for information on environmental conservation programs implemented in West Africa. The search focusedonconservation projects that transformed vegetation and forest cover,i.e., deforestation, afforestation and watershed protection projects. Project implementation and evaluation reports published by the implementing agency were consulted to obtain information on these projects.[1]Thiswas supportedby information from peer-reviewed articles investigating these projects. The Watershed markets database, The Economics of Ecosystem and Biodiversity (TEEB), Forest trends, Global Environmental Facility (GEF) and the United Nations Framework Convention on Climate Change (UNFCCC) websites were consulted for additional information.

A multi-criteria analysis was employed to evaluate these programs and collect the necessary information (Booth *et al.,* 2016). Information on the location of each project, motivation behind its formation, program design, program objectives, ESs, costs, actors involved – both implementers and beneficiaries was gathered. Information on the environmental, economic and social outcomes of each program as well as the challenges each program faced were also collected.

In the second stage, we consulted reports and documents on ongoing conservation projects in other parts of Africa and developing regions of the world. The information obtained from these projects were combined with information from our case studies in West Africa to structure the discussion on incentives for conservation projects in West Africa and make policy recommendations.

Conservation projects in West Africa

Compared to Latin America and Asia, there are few conservation programs in Africa. Only 3% of Agriculture, Forest and Land use projects under the Clean Development Mechanisms (CDMs) are in Africa,whilemajority of the Voluntary Carbon projects are in Asia and Latin America (Jindal *et al.,* 2008; ACAD, 2017). Furthermore, about 13% of global Watershed protection programs are situated in Africa (IIED, 2017). West Africa's share of those programs is small becausemostprojectsare established in East and South Africa.

From the literature search, we identified 14 ongoing and defunct land-use conservation programs in West Africa (table 1). We acknowledge that there are a number of other projects supported by the Forest Carbon Partnership Facilities (FCPF) program across West Africa under the REDD+,We should note that 33 of the 234 CDM projects in Africa are in West Africa, with about 582,000 Certified Emissions Reductions Certificate (CERs) issued,i.e. 5% of total CERs in Africa (ACAD,2017). Most of these projects, however, are not land-use conservation projects, but thermal, hydro, and renewable energy projects.

Table 1: Conservation projects in West Africa

Project	Location	Source(s)
A sustainable management program (SANREM).	Mali	Roncoli *et al*, 2007. Jindal *et al*, 2008.
Acacia Community carbon plantation	Niger	Masiga, 2012
Carbon Sequestration and Sustainable Agriculture	Senegal	FAO, 2004
Carbon Sequestration pilot projects in West African Savannah Optimum	Mali, Benin, and the border between Ghana and Burkina Faso	FAO, 2004
Guinean Forests Hotspots	Guinea, Sierra-Leone, Liberia, Ghana, Cote 'd' Ivoire, Togo, Benin, Nigeria, Sao Tome and Principe	IUCN, 2015
Participatory Rehabilitation of degraded lands project	Senegal and Mauritania	Jindal *et al*, 2008. Kane *et al*, 2010.
Rehabilitation of degraded pasture land project	Burkina Faso	Plan Vivo 2017
Senegal Plantation Project	Mali	Jindal, 2008; Masiga, 2012
Sequestration of carbon in soil organic matter program (SOCSOM)	Senegal	FAO, 2004; Jindal *et al*, 2008
Sourou Valley Wetlands valuation project	Burkina Faso	Somda and Nianogo, 2010
Sustainable energy management project	Burkina Faso	Jindal *et al*, 2008
The Ghana Cocoa Carbon Initiative (GCCI)	Ghana	Katoomba XV, 2009; Asante *et al*, 2012
The Gola REDD project	Sierra-Leone	RSBP, 2013
Village based management of woody savannah and the establishment of woodlot for carbon sequestration project	Benin	FAO, 2004, Jindal *et al*, 2008; Masiga, 2012

Types of Project

Based on their activities, the conservation programs in West Africa were different and fall under various project types. The sustainable management program, sequestration of carbon in soil organic matter program, Sourou Valley Wetlands project, Carbon Sequestration and Sustainable Agriculture program, and Carbon Sequestration projects in Mali, Senegal, Burkina-Faso, Senegal and Benin respectivelywere experimental or research projects (table 1 for full names). Their goal was to assess the economic and ecological potential of variousagro-ecological zones to sequestrate carbon. The Gola REDD+ project in Sierra Leone was conceived as a REDD+ project, while the Ghana cocoa carbon initiative is attempting to modify its activities to fit into the REDD+ framework. The regional program to manage the Guinean forest hotspots programcombines social, economic development and environmental conservation objectives, and bears a strongresemblance to an Integrated Conservation Development Projects (ICDPs).

The Acacia carbon projects in Niger and Senegal, plantation project in Maliare funded by the Biocarbon fund managed by the World Bank.Achats Services International sold the carbon credits from the Nigerien project, while the credits from the Malian project remained with the World Bank. The sustainable energy management project in Burkina Faso was implemented under the Activities Implemented Jointly (now Joint Implementation) framework of the Kyoto Protocol, meaning they are Kyoto compliant. Similarly, the Plan-Vivo project in Burkina Faso was implemented under the Plan Vivo Voluntary Carbon Market requirements, with Plan Vivo managing the carbon credits. The remaining projects, the Participatory Rehabilitation of Degraded Lands in Mauritania and Senegal, and the Village Based Management of Woody Savannah in Benin have features synonymous with programs that remunerate ES providers for adopting sustainable land-use activities (or PES). However, in this instance, socioeconomic development was a primary objective along with environmental conservation.

The size of land enrolled in these projectsvaries between 10,000 and 126,000 ha. Operational costs range fromUS$143,000 USD for the Sustainable Management Project in Mali toUS$4-8 millionUSD for the Participatory Rehabilitation of Degraded lands project implemented in Senegal and Mauritania. The Guinea Forest Hotspots program initially costs US$8.3 million dollars over ten years, but the program was recently extended till 2021 with an additional US$9 million dollars bringing thetotal cost to US$15.2 million dollars.

Institutional Actors

Similar to the findings of Ferraro (2009), the conservation programsin Africa were mainly financed by external bodies. These funds ranged from climate funds,e.g., Biocarbon climate fund managed by the World Bank, to funding from United Nations agencies; and foundations such as McArthur. Funds from foreign government agencies such as the United States Agency for International Development (USAID), governments of Norway, Japan and Luxembourg and the European Union were used to develop and implement other projects. Foreign research institutes,e.g., National Aeronautics and Space Administration (NASA) and various university departments financed most of these research projects. Programs were also sponsored with funds from international agencies and Non-Governmental Organizations (NGOs) such as Global Environment Facility and Conservation International. In addition to funding, these NGOsalso act as intermediaries, playing support roles. Theyinitiate, implement and monitor programs, as well as sensitize, train and acquaint participating communities with sustainable land-use practices. Theseactivities helped toreduce the environmental conservation know-how deficit among ES providers and induced the rise of local NGOs and civil society organizations. NGOs were sometimes joined in this supporting role by host governments in each program locale, from the national to the local level.

Challenges

Unsurprisingly, the leading challenge program developers faced was the poor technical know-how among local partners.The poor technical know-how manifested in terms of little knowledge of sustainable land-use practices and monitoring, reporting and verifying greenhouse gases.Thissupports the findings of Mbow *et al.*, (2012) that while basic knowledge of forest management activities is not particularly new in sub-SaharanAfrica, locals are unfamiliar with activities such as green accounting, establishing baselines for additionally, monitoring and verifying carbon offsets. The poor technical know-how oftenslows down technology uptake by program participants (Sokona and Denton, 2001). Organizing training seminarsto close this knowledge gaptranslates to higher costs of operating the program.

In addition, the legal and institutional framework in West Africa constituted another challenge. These challenges are conflicting legal frameworks defining property rights. Clearly defined property rights and access to resource use are crucial to establishing conservation programs, and conflicts between state and customary property rights laws in West Africa undermine this concept (Mantlana, 2011). Both frameworks in West Africa tend to subordinateenvironmental conservation, and instead promote economic development (UNEP, 2012). This made introducing conservation activities (e.g., avoided deforestation and reforestation) very difficult in areas that previously favored logging and timber companies. For example, this was noticeable in Ghana where legal and cultural frameworks supported the exploitation of trees (to promote economic growth) which threatened to undermine the Ghana Cocoa Carbon Initiative program. Managing the conflicts over land rights among communities was another institutional challenge. This situation exacerbates when conflicts among multiple stakeholders with divergent interests arise over access to the resources present on those lands.

Finally, the inability of conservation payments to adequately compensate ES providers and cover opportunity costs was another limiting factor. Furthermore, corruption that disrupts equitable transfer and distribution of payments from programs to participating communities constitutes another challenge (Mbow *et al.*, 2012). All these challenges significantly raise the costs of implementing conservation programs in West Africa. Hence potential project investors are reluctant to invest in conservation projects in West Africa.

Incentive Mechanisms

The development and promulgation of the Kyoto protocol engendered various frameworks that support programs developed solely for environmental conservation. These frameworks such as Clean Development Mechanisms (CDMs) and Voluntary Carbon Standards (VCS),established markets for ecosystem services and biodiversity protection. Marketsoperating under CDM and VCS frameworks allow developed countries to channel fundsto developing countries to financially support carbon sequestration projects that protect forests and watersheds. Carbon stored in these projects are then sold on market exchanges by developed countries to meet their emission obligations.

The UNFCCC developed REDD, and later the REDD+ frameworksto reduce emissions from forest degradationand promote sustainable forest management. Like CDMs and VCMs, REDD+ facilitates the sale of carbon credits in carbon exchanges or markets. The difference is that the requirements for monitoring, reporting and verifying carbon credits under these frameworks decrease in rigor from CDMs to VCMs and REDD+. Under these frameworks, PES, Payment for Watershed Services (PWS) and carbon forestry programs among other programs, have been introduced in developing countries.

Unruh (2008),Ferraro (2009) and Mbow *et al.*,(2012) highlights several challenges impeding the implementation of conservation programsin Africa. In both the private sector and government agencies, knowledge gaps existon how to execute and administer processes linked to, and policies that promote conservation: establishing ESs baselines; monitoring, reporting and verifying ESs produced and awareness of sustainable land-use activities (Mbow *et al.*, 2012). The latter challenge becomes noticeable when the rigorous process of complying with CDMs, VCMs, REDD+, and other markets for public goods requirements becomes necessary. Tradeoffs between environmental goals and developmental goals promulgated by governments to combat food insecurity and reduce poverty hinder conservation. In our case study, the GCCI in Ghana exemplifies this tradeoff. Working around this tradeoff is difficult because three-quarter of poor West Africans live in rural area and depend on ESs provided by the environment to sustain their livelihood (GEF, 2010).

However, governments in West Africa are making several policy moves to tackle these problems. This policy moves point to several targets outlined in the SDG 13 to alleviate the negative impact of climate change. Specifically, governments at different levels are incorporating conservation measures into development plans and strategies.According to Asiyanbi *et al.,* (2017) all the countries in West Africa have joined the Forest Partnership Carbon Facility (FPCF) and UN-REDDREDD+ readiness platforms except Mauritania. A third REDD+ platform, Forest Investment Program (FIP), is investing in forest management projects in Burkina-Faso, Ghana and Ivory Coast. In addition to the Gola REDD+ project from our case studies, about 10 REDD+ demonstration pilot projects are underway in Liberia, Ghana, and Nigeria (Cerbu *et al.,* 2011; FCPF, 2017).

The increasing number of REDD+ programs is closing local knowledge gap regarding conservation practices, green accountingand raising awareness on climate change. Countries are required to articulate in concrete terms, strategies and plans for tackling forest degradation, protect watershedsand reduce carbon emissionsto qualify for REDD+ programs. These plans and strategies are changing theinstitutional landscapein West African countriestowards conservation. For example, Asiyanbi *et al.*, (2017) in their evaluation of the REDD+ strategic framework in Nigeria and Ghana discovered that previous forest laws that favor logging companies were restructured to push forward responsible forest stewardship. They also found various institutions nest together to lay the groundwork for REDD+, and that actors at the local or regional level are actively involved or even drive the process. This decentralized decision-making trend is also consistent with observations from our case studies in Mali and Senegal (FAO, 2004; Roncoli *et al.*, 2007). Burkina-Faso and Liberia recently reformed their land tenure laws in 2009 to promote the responsible use of natural resources byrecognizing and empowering customary laws above state laws (RRI, 2015; Plan-Vivo, 2017).

Therefore, what incentive mechanisms are better positioned to take advantage of the evolving environmental conservation landscape in West Africa? Kroeger and Casey (2007) highlight three general incentivesthat underpin conservation initiatives: direct payments, compensation based welfare measures and biodiversity protection. Protecting biodiversity hubs and their Essentials strict regulations that restrict the ability of ES providers to access ESs supporting their livelihood. This issue becomes more pronounced since governments own most lands and forests that support poor ES providers (RRI, 2015). Hence, regulations guiding natural resource use are difficult to enforce because they are subject to political pressure (Wunder *et al.*, 2008). In instances where regulations are enforced, ESs providers often exploitopen lands thereby creating leakages.

On the other hand, direct payments and welfare measures, in the West African socioeconomic context, are more attractive avenues to pursue conservation. This is because they compensate ES providers for alternative forgone and switching to new production practices. Examples include compensatory programs like PES, PWS and Community-Based Forest Management (CBFM) programs. PES according to Wunder (2013) transfers payments from ES users to providers with payments conditional on an agreed process for managing natural resources. The institutional arrangement underpinning PES and PWS is flexible enough to leverage funding from CDMs as well VCMs and REDD+ frameworks. If implemented under the right circumstances, direct payments and welfare based programs could be beneficial to both the environment and participating communities (see Pagiola *et al.,* 2005; Hejnowicz *et al.,* 2014).

CONCLUSION

This study reviewed on-going and completed forest and watershed (wetlands) projects in West Africa and their corresponding financing mechanism. From the lessons gleaned from the projects,we outline several incentive measures tailored to address region-specific challenges and inform prospective conservation projects in West Africa. We basically considered incentive mechanisms. We argue that both environmental conservation and economic objectives should proceed together. The current movement towards restructuring existing laws and institutions in West Africa to accommodate conservation programs needs to continue. The ability to finance thesemechanismsdepends on this movement and signals to potential investors the embrace of sustainable land use activities. Regarding, specific incentives, it is crucial to design and implement incentive mechanisms that build on already existing location systems and platforms. This engenders trust and facilitates uptake of program activities and conservation principles. Intermediaries are also needed to reduce knowledge gaps among potential ES providers in the communities and link them to potential buyers/users of ES who will fund programs. Articulating equity goals, fair distribution of costs and benefits, and participatory decision-making should feature prominently in thesemechanisms (Benjamin *et al.,* 2018).

REFERENCES

ACAD. (2017). *Carbon Markets and Africa: A Quick Fact Sheet for Journalists.* United Nations Environmental Programme and RISO Centre. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Carbon%20Market%20Quick%20Facts%20%20ACF%202012.pdf.

Aglanu, L. (2014). Watersheds and Rehabilitations Measures. *A Review Resources and Environment, 4(2),* 104-114.

Asante, W., Anim, E., & Asare, R. (2012). *Institutional Innovations In Africa Smallholder Carbon Projects: Case study Cocoa Carbon Initiative.* CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Asiyanbi, A., Arhin, A., & U, I. (2017). REDD+ in West Africa: Politics of Design and Implementation in Ghana and Nigeria. *Forests*, 1-24. doi:10.3390/f8030078.

Benjamin, O. (2012). Improving credit allocation to sustainable agriculture in Sub-Saharan Africa: Review of bio-based economy benefits. *OIDA International Journal of Sustainable Development, 4*, 16-24.

Benjamin, O., & Blum, M. (2015). Participation of smallholders in agroforestry agri-environmental scheme: A lesson from the rural mount Kenyan region. *The Journal of Developing Areas 49(4)* , 127 – 143.

Benjamin, E. O., Ola, O., & Buchenrieder, G. (2018). Does an agroforestry scheme with payment for ecosystem services (PES) economically empower women in sub-Saharan Africa?. Ecosystem Services, 31, 1-11.

Bolt, K., Cranston, G., Maddox, T., McCarthy, D., Vause, J., Vira, B., . . . Pearce-Higgins, J. (2016). *Biodiversity at the heart of accounting for natural capital: the key to credibility.* Cambridge Conservation International.

Bond, I., Grieg-Gran, M., Wertz-Kanounikoff, Hazlewood, P., Wunder, S., & Angelsen, A. (2009). *Incentives to sustain forest ecosystem services A review and lessons for REDD.* Natural Resouce Issues No. 16. International Institute for Environment and Development, London, UK, with CIFOR, Bogor, Indonesia, and World Resources Institute, Washington D.C., USA.

Booth, A., Anthea, S., & Diana, P. (2016). *Systematic approaches to a successful literature review. Second Edition.* Sage.

Bryman, A., & Bell, E. (2007). *Business research methods.* Oxford: Oxford University Press.

Cerbu, G., Swallow, B., & Thompson, D. (2011). Locating REDD: A global survey and analysis of REDD readiness and demonstration activities. *Environmental Science and Policy 14,* 168-180.

Egoh, B., O'Farrell, P., Charef, A., Gurney, L., Koellner, T., Abi, H., . . . Willemen, L. (2012). An African account of ecosystem service provision: Use, threats and policy options for sustainable livelihoods. *Ecosystem Service 2,* 71-81.

FAO. (2004). *A review of carbon sequestration projects.* Rome: Food and Agriculture Organisation.

FCPF. (2017). *REDD+ Countries.* Forest Carbon Partnership Facility. Retrieved June 3, 2017. https://www.forestcarbonpartnership.org/redd-countries-1.

Ferraro, P. J. (2009). Regional review of payments for watershed services: Sub-Saharan Africa,. *Journal of Sustainable Forestry, vol. 28(3),* 525-550.

GEF. (2010). GEF's programmatic approach to biodiversity conservation in west and central Africa. Available from: http://www.thegef.org/gef/sites/thegef.org/files/publication/westafrica-BIO.pdf.

Hejnowicz, A., Raffaelli, D., Rudd, M., & White, P. (2014). Evaluating the outcomes of payments for ecosystem services programmes using a capital asset framework. *Ecosystem Services 9*, 83–97.

Hillstrom, K., & Hillstrom, L. C. (2003). *Africa and the Middle East: A Continental Overview of environmental issues.* Denver Oxford: ABC-CLIO.

IIED. (2017). *Watershed Markets*. Retrieved on July 22nd 2017 from Watershed Markets: http://www.watershedmarkets.org/casestudies.html.

Innis, P. (2015). *Watershed-based payment for ecosystem services in Liberia: Examining prospects and challenges for implementation in the St. Paul River Basin.* Lund, Sweden: The International Institute for Industrial Environmental Economics.

IUCN. (2015). *Ecosystem Profile: Guinean Forests of West Africa Biodiversity Hotspot.* Critical Ecosystem Partnership Fund. Available at http://www.cepf.net/SiteCollectionDocuments/guinean_forests/EN_Guinean_Forests_Ecosystem_Profile.pdf.

Jindal, R., Swallow, B., & Kerr, J. (2008). Forestry-based carbon sequestration projects in Africa: Potential benefits and challenges. *Natural Resources Forum 32* , 116–130.

Kabii, T. (1996). An overview of African wetlands. In A. Hails, *Wetlands, Biodiversity and the Ramsar Convention,* (pp. pp. 1–4). Ramsar Convention Bureau, Gland (1996), www.ramsar.org, Ch. 3.

Kane, N., Toure, O., & Quiroga, E. (2010). *Conservation of Biodiversity through Participatory Rehabilitation of Degraded Land in Arid and Semi-Arid Cross-Border Zones of Mauritania and Senegal Final Project Evaluation.* United Nations Development Programme and Global Environmental Facility.

Katoomba. (2009). *Sweetening the Deal for Shade-Grown Cocoa: A Preliminary Review of Constraints and Feasibility of 'Cocoa Carbon' in Ghana.* The Katoomba Group.

Kroeger, T., & Casey, F. (2007). An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecological Economics 64(2), 321-332*.

Mantlana, B. (2011). *Readying Africa for REDD+*. -COP 17- Heinrich Böll Foundation.

Masiga, M. (2012). Payments for Environmental Services in Sub-Saharan Africa: Taking Stock and Generating Evidence for Incraesed Investmentand Development of PES. In H. Mogaka, J. Okeyo-Owuor, & A. Kipkoech, *Payment for environmental services Laying the ground work* (pp. 83-105). ASARECA.

Mbow, M., Skole, D., Dieng, M., Justice, C., Kwesha, D., Mane, L., El Gamri, M., Von Vordzogbe, V., &Virji, H. (2012). *Challenges and Prospects for REDD+ in Africa: Desk Review Of REDD+ Implementation in Africa.* Copenhagen: GLP Report No. 5. GLP-IPO.

Pagiola, S., Arcenas, A., & Platais, G. (2005). Can Payments for Environmental Services Help Reduce Poverty? An Exploration of the Issues and the Evidence to Date from Latin America. *World Development Vol. 33, No. 2*, 237–253.

Plan-Vivo (2017). Rehabilitation and sustainable management by AGED of degraded pastures in the Sahel region of Burkina Faso. Available online http://www.planvivo.org/docs/PDD-Rehabilitation-of-Degraded-Pastures-AGED.pdf

Roncoli, C., Jost, C., Perez, C., Moore, K., Ballo, A., Cisse, S., & Ouattara, K. (2007). Carbon sequestration from common property resources: Lessons from community-based sustainable pasture management in north-central Mali. *Agricultural Systems 94*, 97–109.

RRI. (2015). *Who Owns the Land in Africa? Formal recognition of community-based land rights in Sub-Saharan Africa.* Washington D.C: Rights and Resources Group.

Sokona, Y., & Denton, F. (2001). Climate change impacts: can Africa cope with the challenges? *Climate Policy*, *1:1*, 117-123.

Tisdell, C. (2012). *Economics, Ecology and the Environment.* Working Paper No. 186, The Nature of Ecological and Environmental Economics and its Growing Importance. The University of Queensland. Available online: https://ageconsearch.umn.edu/record/140865/files/WP186.pdf

UNEP. (2012). *Environmental Accounting of National Economic Systems: An Analysis of West African Dryland Countries within a Global Context* . Nairobi: United Nations Environment Programme.

Unruh, J. (2008). Carbon sequestration in Africa: The land tenure problem. *Global Environmental Change 18* , 700–707.

Wangai, P., Burkhard, B., & Mueller, F. (2016). A review of studies on ecosystem services in Africa . *International Journal of Sustainable Built Environment 5*, 225–245.

Wunder, S. (2013). When payments for environmental services will work for conservation. *Conserv. Letters 6*, 230-237.

Wunder, S., Engel, S., & Pagiola, S. (2008). Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecological Economics*, 834-852.

THE EFFECT OF DIETARY SUPPLEMENTATION OF STONE BREAKER (*Phyllantus niruri*) LEAVES SINGULARLY OR COMBINATION WITH ERYTHROMYCIN ON SURVIVAL RATE AND FINGERLINGS PERFORMANCE IN *Clarias gariepinus*

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Abstract
An experiment was conducted to evaluate the effect of dietary Stone Breaker Leaves (SBL) and Erythromycin (ERY) supplementation on growth performance and survival rate of Clarias gariepinus fed stone breaker leaves feedstuff- based diet. Five diets were fed to C. gariepinus (4.28±0.01g) for a period of 8 weeks; control (0%), SBL2 (1%), SBL 3 (2%), ERY 4 (2%) and SBL+ERY 5 (2%). Weight Gain (WG), Specific Growth Rate (SGR), Protein Productive Value (PPV), Feed Conversion Ratio (FCR), temperature, pH and dissolved oxygen were measured. Data were analyzed using descriptive statistics and ANOVA at P=0.05. Fish fed control diet had higher weight gain when compared to the treated groups. The treated groups had better PPV and FCR when compared to the control and there were significant difference (P <0.05) among the dietary groups. Fish fed 1% SBL diet resulted in a significant increase in survival rate over fish fed control diet. The water quality parameters such as temperature, pH and dissolved oxygen were within recommended values for cultured fish. These results indicated that using SBL as a supplement in plant – based diets may be useful in improving acceptability, survival rate and performance of cultured C. gariepinus fed low cost plant – based diet.

***Keywords**: Clarias gariepinus, Performance, Survival rate, Water quality, Phyllantus niruri*

INTRODUCTION

Fish is an excellent and relatively cheap source of animal protein. Fish production through aquaculture is one of the fastest growing food producing sectors, providing an acceptable supplement and substitute to wild fish (Jadhav, 2006). Fish and other aquatic products provide at least 20% of protein intake for a third of the world's population, and the dependence is highest in developing countries (Aly, 2008).

Small-scale Fisheries are by far the most important for food security. They supply more than half of the protein and minerals for over 400 million people in the poorest countries of Africa and other part of the World (Food and Agriculture Organisation, FAO, 2012). Furthermore, Fisheries and Aquaculture directly employ over 36 million people worldwide, 98 % of them in developing countries. They also indirectly support nearly half a billion people as dependents or in ancillary occupations (Aly, 2008). Fish is important in bridging the gap between the demand and supply of protein because of its multifarious economic advantages and nutritional significance (Jadhav, 2006).

Environmental circumstances such as poor water quality, fluctuations in temperature, poor nutrition, overcrowding, poor handling and transportation common in intensive fish farming possess stressful conditions to the fish making the fish more susceptible to a wide variety of pathogens. Natural alternatives such as the inclusion of plant materials in fish feed formulation do not only have antimicrobial potential but have also been found to have other properties such as growth promoter, digestive stimulant, anti-inflammatory, antioxidant and anti-carcinogenic (Zheng *et al*., 2001)

Phyllantus niruri (Stone breaker) leaves as natural product plant immune-stimulants can be used as a growth promoter and in health management in fish but, there is little information on utilization of *P.*

niruri in *C. gariepinus*, the aim of the present study was therefore carried out to assess the efficacy of *P. niruri* on growth performance and survival of *C.gariepinus* juvenile fed low cost plant – based diet.

MATERIALS AND METHODS

Plant collection, identification and preparation

*Phyllantus niruri*was collected in Igodan Lisa Okitipupa, Ondo State, Nigeria and plants were identified at the herbarium unit of Department of Biological Sciences, Ondo State University of Science and Technology (OSUSTECH), Okitipupa where a voucher specimen was kept for future reference. The *P. niruri* leaves samples were washed in distilled water, air dried, and grounded into powder. The extraction of *P. niruri* leaves were done as described by Olusola *et al*., 2017. The air – dried extracts of *P. niruri* leaves were kept in a separate container and store at 25°Cuntil required.

Experimental system

The experiment was carried out in ten plastic experimental tanks of 55 litres for 8 weeks in the Fisheries and Aquaculture Laboratory. Water supplied was from OSUSTECH water station (borehole). Tanks were cleaned of solids debris every 3 days throughout the period of the experiment to maintain relatively uniform physiochemical parameters and also to prevent fouling that may result from food residues and faeces.

Experimental fish

Clarias gariepinus were obtained from Agricultural Development Programme (ADP) fish farm, Alagbaka, Ondo State and were acclimated in experimental tanks for a period of 21 days and fed commercial diets, coppens. *Clarias gariepinus* (4.28±0.01g) were stocked in 10, 55 litres tanks at a density of 15fish/tank. Fish were fed twice daily at 3% body weight (08:00 and 18:00 hrs) and they were weighed at the beginning of the study and weekly. Measurement of the weight change was performed weekly and the feeding rate adjusted weekly according to the new body weight.

Diets formulation

Five dietary treatments were fed to *C. gariepinus* for a period of 8 weeks in a completely randomized design. The diets were formulated at 45%crude protein. The primary ingredient (*P. niruri*) was added to the diets at 1% and 2% of the diet. The dietary ingredients were mixed and cold pelleted at the Fisheries and Aquaculture Laboratory using Hobart A- 200 T pellet mill. The pelleted diets were sun dried and store in airtight containers at room temperature until required (Table 1).

Table 1: Gross composition (%) of experimental diet (100g) fed to *C. gariepinus* fingerlings

INGREDIENTS	Control (0%)	SBL2 (1%)	SBL3 (2%)	ERY4 (30mg/kg)	(SBL+ERY) 5 (2%)
Fish meal	16.79	16.79	16.79	16.79	16.79
Soybean	42.60	42.60	42.60	42.60	42.60
Yellow maize	16.31	16.31	16.31	16.31	16.31
Millet	16.31	15.31	14.31	14.31	14.31
Starch	1.00	1.00	1.00	1.00	1.00
Vegetable oil	2.00	2.00	2.00	2.00	2.00
DCP	2.00	2.00	2.00	2.00	2.00
Vit-min premix	3.00	3.00	3.00	3.00	3.00
Stone breaker leaves	-	1.00	2.00	-	1.00
Erythromycin 30mg/kg	-	-	-	2.00	1.00
TOTAL	100.00	100.00	100.00	100.00	100.00

Note: SBL= Stone breaker leaves and ERY= Erythromycin, DCP= Di calcium phosphate, Vit-premix for vitamin and minerals premix. Each 2.kg of premix contain; 12.5 million international unit (MIU); D_3, 2.5 MIU;E, 40g; K_3 2g; B1,5.5g;BB6,5g; Niacin 55g; Calcium Pantothenate 11.5g; Chlorine chloride 500g; Folic acid, Biotin,0.08g;Manganese, 120g; Iron, 100g; Zinc, 80g, Copper,8.5g; Iodine, 1.5g;Cobalt,0.3g;Selenium, 0.12g; Anti-oxidant, 120g.

Experimental Analyses

Biological evaluation

At the end of the experiment, Fish were evaluated for:

- weight gain (g) = final body weight - initial body weight;
- weight gain (%) = 100 (final body weight - initial body weight)/initial body weight;
- specific growth rate (SGR) = 100 (loge final body weight - loge initial body weight)/time (days);
- feed conversion ratio (FCR) = dry weight of feed fed (g)/fish weight gain (g);
- protein efficiency ratio (PER) = wet body weight gain (g)/crude protein fed;
- protein productive value (PPV) = 100(final fish body protein - initial body protein)/crude protein intake;
- survival (%) = 100 (initial number of fish stocked - mortality)/initial number of fish stocked,
- protein intake = (feed intake × percent protein in diet)/100 and
- Nitrogen metabolism = (0.549)(a + b)h/ 2 Where, a= initial mean weight of fish; b= final mean weight of fish; h= experimental periods in days..

Experimental design and statistical analysis

A completely randomized design was used. Experimental diets and fish carcasses were analyzed for proximate composition before and after the experiment according to the methods of Association of Official Analytical Chemists [AOAC] (2005). Data were analyzed using one - way analysis of variance (ANOVA) with Statistical Package for Social Science version 20.0 and Duncan multiple range tests were used to compare the means at each period and results were considered statistically significant at the 5% level.

RESULTS AND DISCUSSION

Proximate Composition of Experimental Diets

The proximate composition of the diets showed that highest value of crude protein was recorded in diet SBL (1%) and SBL (2%) while lowest in the ERY 4 diet as shown in the table 2. All diets shows that there were significant differences in the value of crude protein ($P < 0.05$) and the treated groups recorded highest ash content and lowest in control with significant difference ($P < 0.05$) among the dietary treatments.

Table 2: Proximate composition of experimental diet

Parameter	Control	SBL2 (1%)	SBL3 (2%)	ERY4	(SBL+ERY)5
Moisture	9.46 ± 0.00^{a}	10.20 ± 0.00^{b}	10.30 ± 0.05^{c}	9.49 ± 0.05^{a}	9.44 ± 0.00^{a}
Crude protein	44.70 ± 0.00^{b}	45.60 ± 0.05^{e}	45.50 ± 0.01^{d}	41.40 ± 0.01^{a}	45.20 ± 0.00^{c}
Ether extract	3.76 ± 0.00^{b}	4.13 ± 0.01^{c}	4.13 ± 0.01^{c}	3.65 ± 0.00^{a}	3.81 ± 0.01^{b}
Ash	10.80 ± 0.05^{a}	11.20 ± 0.00^{b}	11.20 ± 0.00^{b}	11.30 ± 0.50^{c}	11.80 ± 0.05^{d}
Crude Fibre	4.65 ± 0.01^{c}	4.74 ± 0.00^{d}	4.39 ± 0.01^{a}	4.55 ± 0.001^{b}	4.52 ± 0.01^{b}
NFE	26.69 ± 0.06^{d}	24.09 ± 0.01^{a}	24.46 ± 0.01^{b}	29.66 ± 0.01^{e}	25.26 ± 0.01^{c}

SBL= Stone breaker leaves, ERY= Erythromycin, NFE=Nitrogen free extract. The above values are mean of duplicate data, mean value in each row with similar superscripts are not significantly different (P >0.05).

Proximate Composition of the Fish Before and After Experiment

The result of the proximate composition of fish before and after the experiment is presented in Table 3. The values obtained after the experiment for the tested parameters were generally higher than the value obtained before the experiment. SBL3 (2%) recorded the highest value of crude protein and lowest in control while ERY 4 record the highest ash and lowest in SBL2 (1%). Moisture content was highest in ERY4 and lowest in SBL 2(1%).

Table 3: Proximate composition (%) of the fish before and after experiment

Parameters	Before	Control	SBL2 (1%)	SBL3 (2%)	ERY4	(SBL+ERY)5
Moisture	6.48 ± 0.00^{f}	6.43 ± 0.00^{c}	5.92 ± 0.02^{a}	7.32 ± 0.00^{d}	11.11 ± 0.00^{e}	6.33 ± 0.01^{b}
Crude protein	45.41 ± 0.00^{a}	64.91 ± 0.50^{b}	65.34 ± 0.01^{c}	68.36 ± 0.00^{f}	66.36 ± 0.00^{d}	67.54 ± 0.01^{e}
Ether extract	3.59 ± 0.05^{a}	3.79 ± 0.05^{b}	4.34 ± 0.00^{f}	4.02 ± 0.51^{d}	4.23 ± 0.00^{e}	3.87 ± 0.00^{c}
Ash	3.72 ± 0.02^{b}	3.72 ± 0.02^{b}	7.72 ± 0.02^{e}	3.59 ± 0.05^{a}	5.40 ± 0.05^{c}	7.42 ± 0.01^{d}
NFE	40.80 ± 0.01^{d}	20.80 ± 0.01^{c}	16.70 ± 5.50^{b}	16.70 ± 0.06^{b}	20.75 ± 0.00^{c}	14.90 ± 0.55^{a}

Keys: SBL= Stone breaker leaves, ERY= Erythromycin, NFE=Nitrogen free extract. Mean of duplicate data, mean value in each row with similar superscripts are not significantly different (p>0.05)

Growth Performance and Nutrient Utilization of* C. gariepinus *fed with the Experimental

Fish fed control diet had the highest body weight gain and the lowest was recorded in ERY 4. There were significant differences (P < 0.05) among the dietary groups. Generally, the treated groups showed better performance in feed conversion ratio, protein productive value when compared to the control and there were significant differences (P < 0.05) among the dietary groups (Table 4).

Table 4: Growth performance and nutrient utilization of *C. gariepinus* fed with the experimental diet for 8 weeks

Parameter	Control	SBL2 (1%)	SBL3 (2%)	ERY 4	(SBL+ERY)5
Initial body weight (g)	4.28 ± 0.00^{a}	4.28 ± 0.01^{a}	4.28 ± 0.02^{a}	4.28 ± 0.02^{a}	4.28 ± 0.01^{a}
Final body weight (g)	10.95 ± 0.00^{e}	7.88 ± 0.00^{d}	7.68 ± 0.00^{b}	5.58 ± 0.00^{a}	7.78 ± 0.00^{c}
Body weight gain (g)	6.65 ± 1.17^{e}	3.58 ± 0.02^{d}	3.38 ± 0.22^{b}	1.28 ± 0.19^{a}	3.48±0.19c
Body weight gain (%)	154.65 ± 0.71^{e}	83.26 ± 0.47^{c}	78.49 ± 1.00^{b}	59.19 ± 0.19^{a}	111.86 ± 0.93^{d}
Feed conversion ratio	2.75 ± 0.49^{d}	2.67 ± 0.07^{c}	2.36 ± 0.15^{b}	0.37 ± 0.06^{a}	0.34 ± 0.02^{a}
Survival rate (%)	90.00 ± 0.33^{a}	100.00 ± 0.00^{c}	93.33 ± 0.00^{b}	93.33 ± 0.00^{b}	93.33 ± 0.00^{b}
Specific growth rate (g)	0.72 ± 0.20^{c}	0.46 ± 0.00^{b}	0.45 ± 0.03^{b}	0.25 ± 0.07^{a}	0.45 ± 0.18^{b}
Nitrogen metabolism	234.12 ± 0.02^{e}	187.15 ± 0.08^{d}	183.70 ± 0.50^{b}	151.50 ± 0.50^{a}	185.31 ± 0.05^{c}
Protein productive value (g)	43.80 ± 0.00^{b}	43.71 ± 0.01^{a}	50.41 ± 0.05^{e}	47.13 ± 0.01^{c}	47.94 ± 0.00^{d}

SBL=Stone breaker leaves, ERY= Erthytromycin. Mean of duplicate data, mean value in each row with similar superscripts are not significantly different (p>0.05).

Water quality parameters of experimental tank

The values obtained in the temperature, pH and dissolved oxygen were relatively closed within the treatments (Table 5). The highest temperature value of 26.71^{0}C was obtained in SBL 2 and lowest of 25.99^{0}C was obtained in ERY 4 while the highest Hydrogen ion concentration (pH) of 7.72 was obtained in (SBL + ERY) 5 and lowest of 7.53 was obtained in ERY 4

Table 5: Water quality parameters of experimental tank for 56 days

Treatment	Parameters	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Mean
	Temp (^{0}C)	25.07±0.05	26.80±0.05	27.90±0.06	25.70±0.20	26.07±0.04	26.80±0.05	27.20±0.01	26.57±0.05	26.51±0.02^b
Control	pH	7.20±0.01	7.74±0.44	7.83±0.26	7.25±0.03	8.14±0.01	7.74±0.44	7.75±0.28	7.71±0.08	7.67±0.01^{bc}
	DO (mg/l)	6.68±0.01	6.76±0.03	6.67±0.01	6.70±0.02	6.73±0.08	6.79±0.01	6.78±0.04	6.80±0.02	6.74±0.01^a
	Temp (^{0}C)	26.07±0.04	26.80±0.05	26.80±0.05	27.90±0.06	27.00±0.00	26.80±0.05	25.70±0.20	26.58±0.10	26.71±0.04^d
SBL2 (1%)	pH	8.14±0.01	7.20±0.01	7.74±0.44	7.83±0.26	8.10±0.05	7.20±0.01	7.25±0.03	7.59±0.01	7.63±0.09^b
	DO (mg/l)	6.95±0.03	6.99±0.02	7.19±0.05	7.15±0.02	7.12±0.03	7.35±0.01	7.16±0.08	7.21±0.03	7.14±0.01^c
	Temp (^{0}C)	27.20±0.01	26.32±0.80	27.00±0.00	26.07±0.04	25.70±0.20	26.32±0.80	26.80±0.05	26.55±0.03	26.50±0.07^b
SBL3 (2%)	pH	7.75±0.28	7.78±0.44	8.10±0.05	8.14±0.01	7.25±0.03	7.78±0.44	7.20±0.01	7.52±0.01	7.69±0.05^{bc}
	DO (mg/l)	6.92±0.03	6.98±0.01	6.99±0.01	7.16±0.03	7.10±0.06	7.09±0.05	7.08±0.02	7.07±0.08	7.05±0.03^b
ERY 4	Temp (^{0}C)	26.80±0.05	26.07±0.04	25.70±0.20	25.07±0.05	25.70±0.20	25.60±0.20	26.32±0.80	26.65±0.15	25.99±0.05^a
	pH	7.74±0.44	8.14±0.01	7.25±0.03	7.20±0.01	7.25±0.03	7.35±0.03	7.78±0.44	7.50±0.11	7.53±0.04^a
	DO (mg/l)	6.62±0.01	6.75±0.02	6.79±0.02	6.78±0.01	6.73±0.01	6.75±0.04	6.79±0.02	6.72±0.01	6.69±0.02^a
(SBL+ERY) (2%)	Temp (^{0}C)	25.70±0.20	26.80±0.05	26.32±0.80	27.90±0.06	26.32±0.80	26.87±0.00	26.32±0.10	26.58±0.03	26.60±0.10^c
	pH	7.25±0.03	7.74±0.04	7.78±0.02	7.83±0.26	7.78±0.14	7.88±0.01	7.78±0.00	7.75±0.05	7.72±0.05^c
	DO (mg/l)	6.64±0.02	6.77±0.01	6.69±0.02	6.80±0.01	6.79±0.02	6.82±0.01	6.76±0.03	6.77±0.04	6.76±0.03^a

Key: SBL=Stone breaker leaves, ERY= Erthytromycin, Temp= Temperature, pH= Hydrogen ion concentration, DO = Dissolved Oxygen, the above values are mean of duplicate data, mean values in each column with similar superscript are not significantly different (P> 0.05).

The proximate composition of experimental diet of this study supports the growth of *C. gariepinus* fingerlings which falls between the range of crude protein requirement for catfish 28-50%CP as reported by Chukwukadibia, (2016) and it also align with the report of Eyo, (1995) that for maximum growth rate, fry, fingerlings and juveniles must have a diet in which nearly half of the digestible ingredient that consist balance protein.

The result of proximate composition of fish showed better performance in the parameters assayed after the experiment when compared to control and before experiment. The treatments with *P. niruri* (stone breaker) leaves inclusion group obtained significantly higher value (P <0.05) of crude protein when compared with the control and before experiment. Diet with Stone breaker leaves recorded higher value of crude protein and this could be that the free amino acid was better utilized and growth stimulant constituent present in Stone breaker leaves. Fish fed diet of the combined group relatively showed higher value compared to those of individual treatment. It could be suggested that this plant and antibiotic has a combination effect. Generally, treated groups, showed higher performance compared to control and the value obtained before experiment. The present study is similar to the report of Fafiolu *et al.*, (2006) and who reported higher value of crude protein among treated groups when compared with the control. The present study also aligned with the report of Sunitha *et al*., (2017) who reported increase in the crude protein of the fish, *Cyprinus carpio*when fed with *P. niruri.*

The growth performance and nutrient utilization of *C. gariepinus* fed experimental diet revealed that control had better weight gain than the treated groups but there were significant differences (P <0.05) among the dietary groups. However, the treated groups had better feed conversion ratio and protein productive value than the control and they were significantly different (P <0.05) among the dietary groups. The result of survival shows that the treated groups had better survival of 100.00±0.00% in SBL (1%) when compared to control (90.00±0.00%) and there were significant difference (P <0.05) among the dietary treatments. The result of the present study supports the work of Sunitha *et al*., 2017 who reported that incorporation of *P. niruri* in the feed, stimulates better consumption, improves assimilation, enhances growth and increases the protein content of the fish, *Cyprinus carpio*. However, the report of the present study was in agreement with the report of Fafiolu *et al*., (2006). During the feeding trials, water quality parameters in all the treatments were within the recommended range required by *C. gariepinus* and this result is in accord with the report of Adamu *et al*., (2017), Olaifa *et al.*, (2012) and Boyd (1981) who reported 25^{0}C -28^{0}C, 6 -7.5mg/l and 6.5-8.0 for temperature, dissolved oxygen and pH respectively for *C. gariepinus* juveniles.

CONCLUSION

Stone breaker leaves and Erythromycin appear to provide stimulating effect on the parameters assayed. Hence, it can be used as a potential tool for growth promoter, enhance survival and increase productivity in fish farming.

REFERENCES

Adamu, K. M, Aliyu-Paiko, M, Abdullahi, F and Mustapha, A. Y. (2017). Effects of *Azadirachta indica* Leaf Powder on some Biochemical Parameters of the African Catfish (*Clarias gariepinus*).*Nigerian Journal of Basic and Applied Science*, 25(2): 41-50 DOI: http://dx.doi.org/10.4314/njbas.v25i2.6

Aly, S. M. Y., Ahmed, Y., Ghareeb, A. A and Mohammed, M. F. (2008). Studies on *Bacillus subtilis* and *Lactobacillus acidophilus* as potential probiotic on the immune response and Resistance of Nile tilapia (*Oreochromis niloticus*) to challenge infection, *Fish and Shellfish immunology,* 25: 128-136.

Association of Official Analytical Chemist, AOAC (2005). Official methods of analysis (W. Horwit zeachtor) 18th edition A.O.A.C Washington, DC: 129-146

Boyd, C. B. (1981). Water quality management in pond culture, research and development. Agricultural Experimental Station University of Auburn Alabama USA: 35-45.

Chukwukadibia, T. M. (2016). Fish farming- The value chain approach. *In. Him. Resources*, 276pp.

Eyo, A. A. (1995). Fish feed and feeding practices in Nigeria In: Report of national Aquaculture Diagnostic Survey; May – July 1994 [Edited by Ayeni, J.S.O] National Institute of Fresh water Fisheries Research, New Bussa, Niger State Nigeria Pp 41 -51.

Fafiolu, A. O. , Oduguwa, O. O. , Bamgbose, A. M. , Oso, A. O. , Isah, O. A. , Olatunji, J. E. N and Jegede, A. V. (2006). Feeding value of mango leaf (*Mangifera indica*) for growing rabbits. *J. Anim. Vet. Adv*., 5 (10): 800-804

Food and Agriculture Organization (FAO) 2012. World review of fisheries and aquaculture 1:148.

Jadhav, V.S, Khan S. I, Girkar M. M and Gitte, M. J. (2006). The role of immune stimulants in fish and shrimp aquaculture. Aquatic animal health, *Aquaculture Asia Magazine*, July – September 2006:24 – 27

Olaifa F. E, Ajayi, F. R, Taiwo, V. O and Bello O. S. (2012). Growth response and nutrient utilization of *Clarias gariepinus* on feeds supplemented with African oil bean (*Pentaclethra Macrophylla* Benth) seed residues. *Global Science Books: FOOD* 6.1: 44 - 48

Sunitha, C, Mettilda, S and Vinoliya, J. (2017). Effect of dietary intake of *Phyllanthus niruri* L. on fingerlings of freshwater fish, *Cyprinus carpio* L. *International Journal of Fisheries and Aquatic Studies*, 5(1): 352-359

Zheng, M., Wang, X., Templaton, L. J, Samulski, D. R., Larossa, R. A. and Storz, G. (2001). Microarray-Mediated Transcriptional Profiling of the *Escherichia coli* Response to Hydrogen Peroxide. *Applied and Environmental Microbiology*, 183 (15): 4562-70.

ASSESSMENT OF SUSTAINABLE TOURISM PRACTICES FOR SUSTAINABLE DEVELOPMENT OF IDANRE HILLS AND RESORT CENTRE

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Abstract
Tourism industry is a multidimensional sector that plays an important role of sustainable development at all levels in strengthens the local economy and identity. This study is aimed at assessing the sustainable tourism practice in Idanre hills and resort centre with a view to develop possible strategies for sustainable development at this tourist destination. A total number of two hundred (200) questionnaire were administered out of which one hundred and eight six were recovered representing 93.00%. While correlation Coefficient (r) analysis was used in the validation of the hypothesis and other data were descriptively analysed and presented in form of tables. Findings revealed that the level of understanding of sustainable practice is low (72% of Residents, 70% of the staff and 82% of the tourists). If Idanre hills and resort centre is properly sustained, it will be of great economic benefits to the individual, family and the society. It was concluded that sustainable development of Idanre hills and resort centre need vigorous efforts of all stakeholders to adequately monitor and implement its sustainable practices. There is need to increase the level of awareness of sustainable practices of Idanre hills and resort centre based on international acceptable standard so that more number of people come up to its understanding.

***Keywords**: Development, Economy wellbeing, Sustainable practices and Tourism Industry*

INTRODUCTION

Background of study

Tourism is a multidimensional activities of temporary short-term movement of the people to destinations outside the place where they normally live and work and the activities they take during their stay at these destination for the undertaking of recreation, business, relaxation etc without remuneration (Suleiman, 2010). These activities spread through many lives, communities, nations, regions, natural, man-made and business activities etc (Sudhir, 2013).

Toward the economy wellbeing (goal 8), the tourism industry is one of the world's largest industries with a world trade contribution (direct, indirect and induced) of over 7.6 trillion U.S. dollars in 2016 ranged in terms of accommodation, transportation, entertainment and attractions etc of direct economy contribution of approximately 2.3 trillion U.S. dollars that year. A number of countries such as France, Egypt and the United States of America are consistent popular tourism destinations but other, less well-known countries as Nigeria are quickly emerging in order to reap the economic benefits of the tourism industry. Thus, the tourism industry globally has continue experience steady growth almost every year with International tourist arrivals increased from 528 million in 2005 to 1.19 billion in 2015 with global international tourism revenue reached approximately 1.26 trillion U.S. dollars, having almost doubled since 2005.

Figures were forecasted to exceed 1.8 billion by 2030 (Makoondlall-Chadee, Bokhoree and Sumputh, 2017).

Sustainable Development has always been a major objective of the development of the tourism industry as specified by Sustainable Development Goals (SDGs) as emphasized in goal number 3 (good health), 8 (decent work and economic growth), 13 (climate action) and 17 (partnerships to achieve the goals). To this fact, natural and cultural attractions of Tourism Industry derivatives play an important role of sustainable development at all levels from the global highlights of world tourism resources to attractions that strengthen the local economy and identities (UNESCO and MGIEP, 2017).

In Nigeria, tourism industry and its derivatives has the capability of huge relief of providing employment, revenue, social cohension among others if necessary attention of sustainable tourism practices is given. Thus, for economy wellbeing of the host community (goal 8), Idanre hills has been generating a lot of direct revenue into treasury of Ondo State Government.

This research tends to achievethe need (why) for sustainable development and practices as emphasized in the sustainable development goals (SDGs), to reveal the levels of knowledge / awareness of sustainable development toward Idanre hills and resort centre and to make known the possible strategies of sustainable tourism practices for Idanre hills and resort centre. The null hypothesis of the study; there is no significant relationship between sustainable tourism practices of Idanre hills and resort centre and the economic well being of the community while the alternative hypothesis; there is significant relationship between sustainable tourism practices of Idanre hills and resort centre and the economic well being of the community.

Statement of Problem

The study is imperative for the reasons that natural and cultural tourism resources in associated tourist sites / destinations have not been given adequate attention and advancement by the Government; even as many of the tourist attractions / destinations have been ignored, threatened, gone into extinction or not known due to lack of sustainable practices, persistence political instability and change in Government and inadequate infrastructural facilities that do have negative impacts on the natural and cultural tourism resources (Olagbade, 2017); (Oluwalana, 2016).

Thus, it was observed that there are numerous researchers such include (Anifowose and Kolawole, 2014); (Nwanne, 2017) and (David, 2018) have written about the Idanre hills and resort centre but only focus on its beautification as a tourist destination and its geo-tourism potentials but do not discuss its possible sustainable tourism practices.

The concept of Sustainable Development

Sustainable development is a concept that was recognized for the first time in 1987. This was followed with the publication of Brundtland report (the Rio Conference Earth Submit held in 1992) that warned of the impeding negative effects of development of the consequences of economic growth and globalization and that which tried to find possible solutions to the challenges that are caused by human desires for living (Fadipe, 2014).

Thus, sustainable development is concerned with the promotion, development and conservation of environment in the society for the benefits of people and likewise preserving the environment for future purposes (Adenike, 2018).

Sustainable development is refer to all the coordinated efforts / activities and action plan that reduce the negative consequences on natural environment despite of high volume of human activities on the physical (natural) environment (Ikusemiju, 2016).

Nevertheless, sustainable development involves programme that actively follow eco – friendly guidelines and practice of environmental management (Agenda 21) through environmental improvement and demonstrating efforts of acquiring techniques related to best practices in environmental management (Noor and Kumar, 2014).

Tourist attractions of Idanre Hills, Ondo State

Based on natural and man - made features, the tourist attractions of Idanre hills and resort centre are as follow:

1) Great 660 steps in ascending and descending the hills
2) Apara Stream
3) First Primary School known as Igbooere Primary School.
4) Native court of law
5) Ancient Owa's Palace
6) Chief Lorin house
7) Colonial Chalets / building
8) Arun River
9) Kings' Burial habitation
10) Aghagha Rock
11) Agbogun foot print
12) Uden Shrine
13) Unreadable inscription
14) Numerous flora and fauna etc.

The need (why) for sustainable development as emphasized in the sustainable development goals (SDGs)

Sustainable development in the context of Idanre hills and resort centre has a number of objectives / goals to achieve that include the following:

1. To achieve balance and stability between the environment, economy and social – political sustainability (Rieder, 2012).
2. To meet the desires of the present generation without comprising the survival of the future generations (Ikusemiju, 2016).
3. To protect and control the earth's limited resources (Adenike, 2018).
4. To establish stable relationship between human activities and the natural resources (Rieder, 2012).
5. To make available the same quality of natural endowment to the future generation.
6. Because, it is right thing to do.
7. In order to maximize social and economic benefits of natural environment to host community and visitors and minimize the negative effects (Rieder, 2012).

Obtainable Practices in Idanre hills and Resort centre

1) Tree felling / logging
2) Bush burning
3) Blight properties
5) Poaching
6) Graffiti
7) Land Pollution

4) Artificial feeding of animals 8) Exploitation for fuel wood

Possible strategies for Sustainable Tourism Practices for Idanre hills and Resort centre, Ondo State

1) Background information should be provided to educate visitors on how to behave properly while observing or visiting the tourist site at the beginning and at the end to facilitate understanding (Guide for Sustainable Tourism Best Practices, 2019).
2) Signs should be provided at the tourist site and should not be nailed directly to the trees. Thus, signs should be visible, supported by graphic means and strictly followed.
3) Artificial feeding of animals under the disguise of waste should be avoided except it is done through seedling and planting food plant (Guide for Sustainable Tourism Best Practices, 2019).
4) Enhanced information village / centre should be established to keep information available about the importance of the tourist centre.
5) Bush burning, Commercial noise and lighting should be avoided from distracting wildlife.
6) The host community of Idanre should get involved in sustainable development initiatives.
7) Adequate ways of waste disposal should be provided and specific action for re-use of paper, containers etc.
8) Closure of the tourist site should be encouraged either permanently or temporarily for a certain period.
9) Observation of clean up exercise monthly or as the case may be.

MATERIAL AND METHODS

The Study Area

The Idanre Hill is one of the most beautiful natural landscapes in Ondo State consists of high plain with spectacular valleys interspersed with iceberg of about 3,000 ft above sea level and houses a unique ecosystem upon which the cultural landscape has integrated. It is located in Idanre town of land area 1,585 km^2 (619 sq miles) and on the coordinates 9°08'N and 5°08'E with a population of 129,024 based on the 2006 population census (Ajiola, 2015

The population of the study was a survey of Residents of Idanre, Staff and Tourists at the Idanre hills and resort. The researchers in the selection of two hundred (200) respondents utilized stratified sampling technique in selection of 100 residents representing 50% of the entire population based on National Population Census. All the 10 staff were selected representing 100% while 90 tourists representing 10% of the 900 tourists were selected based on stratified sampling.

Thus, the data gathered through the administration of 200 questionnaires of which only one hundred and eight six (186) were recovered comprising of 10 questionnaires from staff representing 100%, 89 questionnaires representing 99% from tourists and 87 questionnaires representing 87% from residents were presented and analyzed with the use of simple percentage method. Meanwhile, Correlation coefficient (r) analysis was used in the validation of hypothesis, which assisted in a logical conclusion.

However, the **Sample Size (n)**of Yamane Taro model (Grupta and Kapoor, 2014) was adopted based on National Population Commission 2006 Census was as follow:

where N = Population of study,

$$\text{Sample Size (n)} = \frac{N}{1+N(e)^2}$$

1 = a Constant and e = Sampling error (5%

$$\text{Sample Size (n)} = \frac{129024}{1+129024(0.05)^2}$$

Therefore; **Sample Size (n)** = **200**.

RESULTS AND DISCUSSION

Level of knowledge / awareness toward maintaining and accepting Idanre hills and resort centre for the future generations

In the resident class,20 respondents representing 23% agreed that the level of knowledge and awareness of sustainable development of Idanre hills and resort centre is high while 63 respondents representing 72% were of the opinion that the level is low and 4 respondents representing 5% do not know about the awareness. Thus, in staff class; one (1) respondents representing 10% agreed that the knowledge / awareness is high while 7 representing 70% agreed is low and 2 respondents representing 20% do not have the knowledge. In tourists category; 11 respondents representing 12% agreed that the level of knowledge / awareness is high, 73 respondents representing 82% agreed is low and 5 respondents representing 6% do not know about the awareness; (Table 1).

The aforementioned is in line with Dang (2017) that states that many people have low understanding of awareness as most are not familiar with "sustainable tourism practices" but only familiar with "environment".

Table 1: Level of awareness

Frequency (Returned in %)			
Variables	**Residents**	**Staff**	**Tourists**
High	20 (23%)	1 (10%)	11 (12%)
Low	63 (72%)	7 (70%)	73 (82%)
Not known	4 (5%)	2 (20%)	5 (6%)

Source: Fieldwork (2018)

Levels of practices in making Idanre hills and resort centre to be sustainable and improve the economic livelihood of the host community; *(For Staff Only).*

One (1) respondent representing 10% agreed that the levels of practices in making Idanre hills and resort centre to be sustainable and improve the economic livelihood of the host community is high while 8 respondents representing 80% were of the opinion that the levels of practices is low. Thus, one (1) respondent representing 10% was of the opinion that the levels of practices in making Idanre hills and resort centre to be sustainable and improve the economic livelihood of the host community is not known; (Table 2).

The aforementioned indicated that there are possible practices for sustainable development of tourist sites but the difficulty of such practices is that they are neither adequately known, transparent nor monitored (Huang, 2017).

Table 2: Level of practise in making Idanre Hill sustainable

Frequency (Returned in %)			
Variables	**Residents**	**Staff**	**Tourists**
High	-	1 (10%)	-
Low	-	8 (80%)	-
Not known	-	1 (20%)	-

Source: Fieldwork (2018)

Test of Hypothesis / Validation of Results

H_0: There is no significant relationship between sustainable tourism practicesof Idanre hills and resort centre and the economic well being of the host community.

H_1: There is significant relationship between sustainable tourism practicesof Idanre hills and resort centre and the economic well being of the host community.

Table 3: Summary of Correlation coefficient (r) tables of relationship between sustainable tourism practices of Idanre hills and resort centre and the economic wellbeing of the host community

Variables	Coefficient correlation (r)	P - Value	Remark	Decision
Recognition	1.000	0.000	H_0 is rejected	Significant
Participation	0.753**	0.000	H_0 is rejected	Significant
Relevance	0.680**	0.000	H_0 is rejected	Significant
Impacts	0.557**	0.000	H_0 is rejected	Significant
Perception	0.370	0.000	H_0 is rejected	Significant

*Correlation is significant at 0.05, **Correlation is significant at 0.01

KEY: S= Significant, NS= Not Significant

$P < 0.01$; Ho is rejected (Significant) but $P > 0.01$= Ho is accepted (Not Significant)

$P < 0.05$; Ho is rejected (Significant) but $P > 0.05$ or equal 0.05 = H_1 is accepted (Not Significant)

From the study, it was discovered that the rational responses of respondents about Idanre hills and resort centre showed clearly that the levels of understanding of sustainable tourism practices toward Idanre hills and resort centre is low / stumpy. Thus, if Idanre hills and resort centre is properly sustained; it will be of great economic benefits to individual and family such as in employment generation, improved social infrastructure etc.

CONCLUSION AND RECOMMENDATIONS

Tourism industry is a huge market with amalgamation of several interest that must be sustainable development activated to help rebound the economy well being of the society without jeopardising the future generation. Thus, Sustainable tourism practices / guidelines and its management are relevant to Idanre hills and resort centre and all other forms of tourism in all types of tourist destinations.

Therefore, sustainable development of Idanre hills and resort centre need vigorous efforts of all stakeholders and well-built acceptance of its sustaining process that must be adequately implemented, monitored and enhanced through relevant agencies.

Based on the study, the researchers recommended the following:

- There is need to increase the level of awareness of sustainable practices of Idanre hills and resort centre based on international acceptable standard so that more number of people come up to its understanding.
- There is need to adopt the possible strategies for the sustainable practices of Idanre hills and resort centre by the staff management at the tourist site.
- Sustainable development programme on Idanre hills and resort centre should be organized continuously for all stakeholders (residents, staff, tourists, hotels, restaurants etc) in order to participate in the development of tourism activities in Idanre.
- Integrated and local content approach to sustainable tourism practices and management should be extended to few hotels and restaurants in Idanre so as to attract more tourists and make the tourists to have a long stay or experience.

REFERENCES

Adenike D. A. (2018). Sustainable Tourism Development in Nigeria; Sustaining Hospitality and Tourism in a challenging Economy, in Okhira Adebimpe (Ed.) Ado – Ekiti, De-Lius Printers.

Ajiola F. O. (2015). Indigenous Social and Economic Structures in Pre-colonial Idanre land. An Article published in The Nigerian Journal of Economic History; Research Gate Publication.

Anifowose A.Y.B and Kolawole. F. (2014). Appraisal of the Geo-tourism Potentials of the Idanre Hills, Nigeria; An Article accepted for publication of the European Association for Conservation of the Geological Heritage. Research Gate Publication.

Dang. B. (2017). Traveller's Awareness and Attitude towards environmentally Sustainable Tourism in Helsinki; Bachelor Thesis; Degree Programme in Hotel, Restaurant and Tourism Management, University of Applied Sciences, Haaga-Helia Publication.

David Tokunbo (2018). Idanre hills; where Old World wonders are preserved at hilly Peaks inhabited by a warring god. Sunnews online Newspaper.

Fadipe. A.S (2014). Tourism Destination Management: A Guide to Policy Makers and Destination Managers, 1st Edition, Ilupeju, Prince of Prints Limited.

Guide for Sustainable Tourism Best Practices (2019). New York, Published by Rainforest Alliance.
Gupta. S. C. and Kapoor V. K. (2014). Fundamentals of Applied of Statistics, Revised Edition, New Delhi, Sultan Chand and Sons Publications.
Huang Wei (2017). Good Practice in Sustainable Tourism; Thesis for Master of Science in Environmental Management and Polices, Lund, Lund City University.
Ikusemiju T.M (2016). The Relevance of Green Initiatives in the Hospitality Industry. "A case study of selected Hotel Organizations in the Administrative zones of Osun State, Nigeria". A publication in HATMAN, Journal of Hospitality and Tourism Management Association of Nigeria.
Makoondlall-Chadee .T, Bokhoree. C. And Sumputh. D. (2017). A System Thinking Approach towards promoting Sustainability in Tourism Industry, Mauritius; University of Technology.
Noor N. And Kumar D. (2014). Eco - friendly activities vs Eco - friendly attitude; Travellers intention to choose Green Hotels in Malaysia. A Journal Publication, World Applied Sciences Journal. Vol. 30, University of Utara, Malaysia.
Nwanne Chuks (2017). Destination: Idanre hills: Travel and Tourism, The Guardian Newspaper.
Olagbade. A. (2017). Insecurity, Poor Infrastructure killing tourism in Nigeria, Punch Newspaper.
Oluwana Sam (2016). Expert proffers Solution to Tourisms; The Guardian Newspaper
Rieder L. G. (2012). Strategic Tourism Planning for Sustainable Destination and Sites, 6th UNWTO Executive Programme, Bhutan.
Sudhir Andrew (2013). Introduction to Tourism and Hospitality Industry, 6th Edition, New Delhi, Jain Book Depot.
Suleiman. A. G. (2010). Understanding Recreation, Leisure and Tourism Practices in Nigeria, Revised Edition, Zaria, Ahmadu Bello University Press Limited.
UNESCO and MGIEP (2017). Sustainable Development; A Guide to Embbeding, 1st Edition, New Delhi, Published by UNESCOMGIEP.

SUSTAINABLE UTILIZATION OF TOURISM RESOURCES AND INCLUSIVE RECREATION PARTICIPATION IN ONDO STATE, NIGERIA.

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Abstract

Endowment of tourism destination with natural and cultural features is a clear indication of its potential to attract tourists thereby facilitating successful tourism development. The major objective of this study was to assess the sustainable utilization of some tourism resources and their level of maintenance in selected towns in Ondo State for sustainable use. Purposive sampling of four (4) major tourism destinations, the King's palace in Akure (popularly called Deji's palace), The Owo Museum and Natural Monument in Owo, the T.A. Afolayan Wildlife Park at the Federal University of Technology, and Idanre hills (popularly called Oke Idanre). In the state was carried out and three research instruments were employed in collecting data including structured questionnaire, personal interviews and secondary data. A total of one hundred (100) structured questionnaires were administered to tourists in the selected sites. The data collected were analyzed and presented descriptively in form of tables and charts. Findings revealed information on the utilization rate of these sites in the following proportions; Idanre hills (63%), T.A Afolayan Wildlife Park (47%), Owo museum and Monument (52%) and Deji's palace (32%). Findings equally revealed that 38% of visitors to Idanre hills were mostly attracted by the historical and cultural feature at Idanre hills, while at T.A. Afolayan Park 22% of the visitors were attracted by the fauna resources, While 14% of the visitors were attracted by the historical features at Deji's palace and 26% by the cultural history and artifacts present at the Owo museums and Monuments. There is need to intensify efforts to improve on the management and maintenance of the resources in the selected sites to make them more attractive to tourist , increase utilization rate thereby increasing revenue generated by the government.

Keywords: *Idanre hills, Resources, Sustainable utilization, Tourists*.

INTRODUCTION

Tourism is identified as an effective way to revitalize the economy of any destination as noted by Long (2012) and widely acknowledged as one of the fastest growing industry globally (Raymond, 2001; Basu, 2003, Ozgen, 2003; Chockalingam and Ganesh, 2010). Tourism has become one of the economic sectors that generates income and maintains conservation of protected areas. Tourism is in most cases predominantly for recreational or leisure purposes (WTO, 2002). The World Tourism Organization defined Tourists as people who travel to stay in places outside their usual environment for not more than a year for leisure, business and other purposes. Tourism embraces a vast and diverse range of activities depending on the purpose of visit. Several reasons have been given for which people visit tourism destinations which are; Leisure; Recreation; Pilgrimage; Medical treatment; Family affairs; Festival;

Sporting events; Conference; and Educational. Others range from large scale mass package tour to a small individual tailored holidays, from international domestic visit to family and friends, from international or intercontinental journey to business trips, from sports, nature, health or alternative holidays for culture or adventure.

Tourism as an industry has been given prominence by government by the promulgation of decree no, 54 of 1976, which established the Nigeria Tourist Association. Although tourism is still being developed in the country, there is now a new government policy on trade and tourism which recognizes the vast potential of the sub-sector. To boost the level of private sector by introducing concessionary tax incentives, and soft loans with period of moratorium to potential investors (UNESCO, 2007).
The World Travel and Tourism council estimates revenue related to tourism and travel in Nigeria exceeded $10 billion in 2007 and accounted for approximately 6% of the gross domestic product (World Travel and Tourism Council, 2007). Tourism in Nigeria centers largely on cultural events, due to the country's ample amount of ethnic groups, but also includes rainforests, savannah, waterfalls and other natural attractions Archibong, 2004).

When making an investigation on tourism resources for the purpose sustainable utilization, it is necessary and essential to mention the various aspects of tourism, types of tourism and tourism resources. Within the context of tourism, it is compatible to study the various recreational centers as they provide sites of attractions to tourists. Hence, tourism impact on physical development, rural integration and provision of opportunities cannot be over emphasized. Transportation, accommodation, communication and other related sectors are composite in demand when tourism as an industry is being developed.

Ondo State is endowed and blessed with tourism resources in its own capacity both natural and man-made. Much concentration is still on cultural tourism, it is about promoting the culture through festivals and celebrity, if properly managed and utilized, it could play a crucial role in the development and promotion of tourism in Ondo State and the state also has natural resources which are natural phenomena that are usually of interest to tourism worldwide and which if developed, will help to generate employment for the people and boost the local economy. This research is to assess the sustainable utilization of some tourism destination resources in Ondo State such as Idanre hills, T.A. wildlife park in the Federal University of Technology, Akure, Deji of Akure palace and Owo museum. All these tourism potentials makes Ondo State a hospitable state and the local norms and values combined with peaceful environment full of loving and friendly people makes her a good and sustainable tourism destination.

MATERIALS AND METHODS

The Study Area

The Study was carried out in four selected tourism destinations in Ondo State and they include, Idanre hills, T.A Wildlife Park at the Federal University of Technology, Akure, Owo Museum and Monument and Deji's palace Akure.

Idanre hills

The relics of the old Idanre town located at the top of the hill became a prominent tourist destination in Nigeria and was added to UNESCO World Heritage Tentative List on 8th October 2007 (Omole and Owoeye, 2010). Idanre hills consist of high plain with spectacular valleys interspersed with in selbergs of about 3,000ft above sea level. Its physical attributes include Owa's palace, shrines, old court, Agboogun footprint, thunder water (Omi Aopara) and burial mounds and grounds and high up in one of the hills, you will find a fascinating abandoned ancient village. The flora and fauna are unique, and the indigenous mammals such as the tailess hyrax, still populate the rocks. The temperature is fairly moderate between 16° and 30° and the humidly is high. The Idanre hill area cover a 50km radius and takes a total of three days to be thoroughly traversed.

T.A Wildlife Park and Museum

The park was created by Federal University of Technology, Akure for the main purpose of training students. It is presently serving as both in situ and ex situ conservation purposes. Some parts of the par are designed as Zoological (Ex-situ) the other parts serve as undisturbed semi-wild area or sanctuary (in-situ). The park receives over 300 visitors in a month and over 2000 in a year (Oladeji and Adedapo, 2014).This Wildlife Park is located at the Federal University of Technology Akure and covers a total area of 8.91 hectare, it is a lowland tropical rainforest located on elevation 1200 m above sea level (Olaniyi, 2015). The minimum temperature is 21°C while the maximum temperature is 32°C.It is a typical South-West Nigeria climate. The vegetation is a combination of tropical trees, shrubs and herbaceous plants in great diversity such as *Tetrapleura tetraptera*, *Trichilia emetic*, *Khaya ivorensis*, *milicia excelsia*, *Aspilia Africana*. It is dominated with fauna resources which include: bush-buck, grasscutter, giant rat, squirrel, duicker, mona monkey, patas monkey.

Owo Museum and Monument

Owo museum and monument was founded in 1968 to accommodate the antiquities which were formerly in the Olowo (king's) palace. The museum contains significant archeological artifacts and ethnographic materials discovered in and around Owo. The Owo site was first excavated in 1969 -1971 by Ekpo Eyo under the auspices of the department of Antiquities of the government of Nigeria. Due to the location of Owo (between the two famous art centers of Ife and Benin) the site reflects the artistic traditions of Ile-Ife and Benin kingdoms. Important discoveries include terracotta sculptures dating from 15 century. The museum has been preserved to serve as a place for visitors to have a taste of historical values of the people of Owo and the neighboring towns and villages (Ileoje, 1978).

Deji's Palace,Akure

The palace of the Deji of Akure (The king) has been declared the second National Monument in Ondo State Nigeria by Federal Government. The 700 year old palace located in the heart of Akure the state capital contains about eighteen to twenty two court yards and each of the court yards is used for specific ceremony or for the living of the Oba's household. The palace has an impressive low Zinc ceiling and this feature is seen throughout the palace and there are massive pillars which support the palace as well. The palace is a living heritage as well as a cultural and spiritual magnet which attracts the people (Ministry of Tourism and Culture (2013).

Three methods of data collection were employed as stated or highlighted below

Administration of structured Questionnaire**:** This was done to get relevant information on various tourism resources in some selected places in Ondo State and how it can be sustainably utilized. A total number of 100 well-structured questionnaires were randomly administered with 25 at each tourist destination which include, Owo museum, Deji's palace, Idanre hills and T.A. Wildlife Park, FUTA.

In addition to the use of structured questionnaire, oral interview was employed to complement information obtained from the staff at the various tourism destinations.

Secondary data was collected from Ondo State Ministry of Culture and Tourism and consultation of relevant literature review. In -depth review of literatures was undertaken in order to gain background knowledge and other relevant information on the area of study.The data collected were descriptively analyzed using Statistical Packages for Social Scientist (SPSS) version 21.

RESULTS AND DISCUSSION

The research findings revealed demographic information of the respondents in the tourist centers where the research work was carried out. The tourists that visited the centers are mostly young people (41%). Only a few adults (5%) who are above 45 years of age visited the tourism destination. The adults may be occupied with their job; most of them may have only the weekend to rest.

The largest percentage (39%) of the respondents visited for the purpose of pleasure/relaxation/fun at the T.A. Afolayan Park in FUTA, while 19% of them visited for sightseeing. This result shows that tourist centers are not only utilized for relaxation purposes but also for research. 32% of the respondents visited for educational and research purposes; young tourists are seen as individual tourists those who mostly are keen to participate in tourism activities for several purposes such as education and cultural tourism (Du Cros & Jingya, 2013; Boukas, 2013). Only a small fraction (8%) visited to attend festival at the Deji's palace and at Owo museum. Information obtained through analysis of the secondary data collected on the visitors to Owo Museum revealed that the place has been experiencing poor patronage over the years for instance both adult and children have very low records from 2010 to 2013. In 2012, the highest number of children tourist was recorded with an average of 23 tourists. The reason for the low tourist record might be probably due to little awareness and or poor tourism development, poor infrastructural development, poor accessibility and non-maintenance of resources (Arowosafe et al, 2013). Tourist centers are supposed to attract tourists and should appeal to their desires.

Table 1: Demographic information of respondents

Variables	Frequency	%
Gender		
Male	48	48.0
Female	52	52.0
Age range		
20-25 years	25	25.0
25-35 years	41	41.0
35-45 years	29	29.0
45-55 years	4	4.0
above 55 years	1	1.0
Marital status		
Single	42	42.0
Married	53	53.0
Divorced	2	2.0
Widowed	3	3.0
Education		
Primary education	2	2.0
Secondary education	8	8.0
Tertiary education	66	66.0
Others	24	24.0
Religion		
Christianity	58	58.0
Islam	40	40.0
Traditional	2	2.0
Occupation		
Civil servant	31	31.0
Self employed	31	31.0
Student	38	38.0
Place of residence		
Within Ondo state	69	69.0
Outside Ondo state	28	28.0
Others	3	3.0

Table 2: Rate of visit to tourism resources

	Frequency	%
First time visit		
Yes	68	68.0
No	32	32.0
Frequency of visit		
Weekly	3	3.0
Monthly	38	38.0
Annually	7	7.0
Special occasion	38	38.0
Others	14	14.0

Table 3: Purpose of visiting

	Frequency	%
Sight seeing	17	17.0
Pleasure/relaxation/fun	39	39.0
Research	32	32.0
Festival	2	2.0
Official	8	8.0
Travelling	2	2.0

The perceived response to utilization level as presented in Table 4 revealed that 43% of the visitors perceived that the tourism destinations were highly utilized. Also the majority 33% of the visitors believed that there is need for sustainable utilization of the tourism destination. Low resources utilization is an indicator of poor management and which will cause a setback to tourism development. There should be an increasing need for the utilization of tourism resources as this will continue to bring the consumer to the resources and open up new areas and explore new resources as stated by Ibimilua, (2009). He also said almost any place in the world can become an attraction as long as it is packaged well and sold to its niche market; the people for whom the attraction is best suited.

Result shows as seen in Table 6 revealed that only 12% of the tourist indicated that there is very high accessibility level to the resources, while 27% perceived a high accessibility to tourism resources.

However, a majority 49% believed that accessibility of tourism resources is just average. This finding agrees with the observation made by Omole et al, (2013) who stated that their general Observation during the research on marketing tourists potentials of Ondo state revealed the problems of inadequacy of link roads and transportation challenges, poor water supply at tourist centre and poor office and accommodation for tourists' staff and problems of parking spaces.

Table 4: Tourist's perception on level of utilization of tourism resources

	Frequency	%
Very high	24	24.0
High	43	43.0
Average	27	27.0
Low	6	6.0

Table 5: Tourist's perception on need for utilization of resources

	Frequency	Percentage
Very high	23	23.0
High	33	33.0
Average	43	43.0
Low	1	1.0

Table 6: Tourist's perception on the accessibility of tourism resources in Ondo State

	Frequency	Percentage
Very high	12	12.0
High	27	27.0
Average	49	49.0
Low	5	5.0
Very low	7	7.0
	100	100.0

Recreational activities of tourist

The recreational activities of tourist ranged from watching animals, to sightseeing, hill climbing and visit to historical shrine. A larger percentage (31%) of the visitors enjoyed seeing the natural environment of the tourist centers, this might be as a result of the natural feature and the comfort they enjoy while exploring the environment (Table 7). About 16% enjoyed hill climbing while 27% enjoyed visit to historic shrine.

Table 7: Recreational activities of tourist

	Frequency	Percentage
Watching animals	26	26.0
Sight seeing	31	31.0
Climbing	16	16.0
Visit to historical shrine	27	27.0

Most attractive features

At the tourism centers where this research work was carried out, the attractive features identified include artifacts, art works, natural features, animals, culture and tradition and historical features. The result presented in Table 8 shows that majority 22% of the visitors are most attracted to the natural features and animals present at these centers, and the least number of visitors enjoyed the culture and traditional aspect of the tourism centers.

Table 8: Visitors' perceived most attractive feature of the tourist center

	Frequency	%
Artifact/art works	18	18.0
Natural features	22	22.0
Animals	22	22.0
Culture/tradition	12	12.0
Historical features	26	26.0

Challenges

There are various challenges faced by tourists in the different centers across the state. These problems obtained from personal observations and personal interview, include poor maintenance and management of tourism resources, lack of directional signs, and poor accessibility in terms of road networks, inadequate facilities, lack of accommodation and lack of restaurant at the tourist centers.

CONCLUSION

This research work has assessed the sustainable utilization of tourism resources in Ondo State, Nigeria. It was observed that tourism resources in Ondo State are developing at a very slow rate. And that the rate utilization is average which is an indication that people expect the tourism to be better developed so it can attract more visitors. Also the study revealed some management challenges such as bad roads, lack of adequate accommodation, non availability of nearby restaurants and lack of directional signs to guide visitors. This study therefore recommends that the challenges should be looked into and solutions made available so that these tourism resources can be sustainably utilized.

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REFERENCES

Arowosafe, F.C., Agbelusi, O.A, and Omole, F.K. (2013). Infrastructural development as a Veritable tool for Tourism development in Ondo State. Journal of Tourism, Hospitality and Sports, Vol. 1. Pp 36-42.

Basu, P. K. (2003). Is Sustainable Tourism Development Possible? Broad Issues Concerning Australia and Papua Guinea. In R. N. Ghosh, M. A. B. Saddique& B. Gabbay (Eds.), *Tourism andEconomic Development: Case Study From Indian Region*. Hampshire, England.

Boukas, N. (2013). Youth Visitors' Satisfaction in Greek Cultural Heritage Destinations: The Case of Delphi, Tourism Planning & Development, 10(3): 285-306.

Chockalingram, M. &Ganesh, A.A. (2010). Problems encountered by tourists *business and Economic Horizons, 3(3), 68-72.*

Du Cros, H., & Jingya, L. (2013). Chinese Youth Tourists Views on Local Culture, Tourism Planning & Development, 10(2): 187-204.

Ibimilua, A.F, (2009). Tourism participation: Attractions, influences and key trends in Ekiti State, Nigeria. *African Research Review*, Ethiopia, Vol. 3 (3) Pp 244-258

Long, P. H. (2012). Tourism Impacts and Support for Tourism Development in Ha Long Bay, Vietnam; An Examination of Residents Perceptions. *Asian Social Sciences, 8*(8), 28-29.

Ministry of Tourism and Culture (2013): Tourism in Ondo State,Nigeria. http:// www.ondostate.gov.n

Oladeji, S.O. and Adedapo, O.O. (2014): Performance and visitor's satisfaction of recreationfacilities and services in Akure Metropolis: A veritable tool for impact studies inUNDP MDGS' cities in Nigeria. *British Journal of Economics, Management andTrade*, .4(8): 1230-1250.

Olaniyi, O.E., Esan, D.B., Odewumi, O.S., Oladeji, S.O. and Oyeleke, O.O (2016). Ecotourism Resource Mapping of T.A. Afolayan Wildlife Park in Ondo State, Nigeria. Proceedings of NTBA/NCCB Joint Biodiversity Conference held at University of Ilorin, Kwara State, Nigeria between 20th-22nd June, 2016. Pp 21-30

Omole, F.K., Amodu, I.E., Olanibi, J.A., and Emmanuel, A.A. (2013). Marketing the tourist potentials in Ondo State, Nigeria for effective development. *Journal of Tourism, Hospitality and sports*. Vol.1.

Özgen, S. (2003).Designing for Sustainable Tourism Developments Case Studies of Greek Islands. Paper presented at the 5th European Academy of Design Conference, Design Wisdom Barcelona, 28-30 April 2003.Pp .135.

Raymond, Y. C. (2001). Estimating the Impact of Economic Factors on Tourism; Evidence from Discussion, Paper No. 900. Yale University. HongKong. *Tourism Economics*, 7(3), 277-293.

UNESCO World Heritage Centre (2007). Publication on Ecotourism in Central and South Asia. (2007): Project on the Development of Cultural Ecotourism in the Mountainous Regions of Central and South Asia. Pp.45

WTO. (2002). Tourism and Poverty Alleviation. World Tourism Organization, Madrid, Spain, Pp.42-65. "2012 Tourism Highlights. "UNWTO. June 2012. "2012 Tourism Growth". UNWTO.

BIOLOGICAL ASSAY OF SOIL RESIDUAL ACTIVITY OF NICOSULFURON WITH OKRA (*Abelmoschus esculentus M.*) IN SOUTHWESTERN NIGERIA.

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Abstract

Nicosulfuron is a widely used herbicide for selective weed control in maize following which vegetable crops may be sown to succeed maize in rotation under rainfed multiple cropping. This study examined under screenhouse conditions, the soil residual activity of nicosulfuron at the recommended dose of 60 g a.i.ha^{-1} applied at intervals of 0, 3, 6, 9 and 12 weeks before planting on okra. Results indicated that nicosulfuron significantly ($p < 0.05$) reduced okra height, number of leaves and total crop leaf area in all herbicide treatments relative to the control. At harvest, plant height and the number of leaves per plant were found to be linearly and positively correlated with time interval between nicosulfuron application ($p \leq 0.001$; $r = +0.95$ and $+1.00$ respectively). Also, linear and positive correlations with time interval between nicosulfuron application were obtained for pod fresh weight, pod length and pod diameter (($p \leq 0.001$; $r = +0.95$, $+0.99$ and $+1.00$, respectively). It was concluded that okra should not be sown immediately on the field in which nicosulfuron has been used to avoid crop injury and yield reduction. A lag period should be given for the soil to regain its microbial competence and adequate detoxification to be able to support a sensitive crop like okra.

Keywords: *Bioassay**,** Nicosulfuron, okra, residual activity, sulfonylurea.*

INTRODUCTION

Soil microflora including bacteria, fungi, protozoa, algae and virus forms a vital component of agro-ecosystem and is responsible for many critical and fundamental soil functions such as nutrient-cycling, soil-fertility, improving plant productivity through enhanced availability of limited nutrients and decomposition of organic as well as inorganic materials. Physical soil properties such as its structure, porosity, aeration and water infiltration are also favorably affected by soil organisms through the formation and stabilization of soil aggregates (Zhong and Cai 2007). At the same time soil microbial community is instrumental in pursuing eco-friendly practices like detoxification (bioremediation) of soils contaminated with toxins and undesirable components due to human activities (Canet *et al*., 2001) as well as biocontrol of phytopathogens. Anything that affects microbial activities might therefore affect the function of soils not only in nutrient cycling and availability but may also reduce the buffering capacity of the soil with consequent inability to detoxify the soil of pollutants.

Experimental evidences have established the fact that the use of pesticides affects the structural and functional properties of microbial communities in soil (Nicholson and Hirsch 1998; Yang *et al*., 2000; Bohme *et al*., 2005) and at the same time creates nutrient-imbalance in agricultural soils. The buffering capacity of the soil if hampered may result in serious negative effects on especially sensitive plants. The consequences could be so serious that the *FAO Guidelinesfor the Registration and Control of Pesticides* (Atlas, 1978), which are followed by national registration schemes, require studies of the effects of candidate compounds on soil activities.

This requirement has led to considerable research on the impact of pesticides on soil and their fate and degradation following single applications for short periods (Camper, 1991). Sulfonylurea herbicides have been shown to affect soil microbial activity in varying degrees. Bensulfuron-methyl, nicosulfuron and rimsulfuron treatments have been found to decrease significantly the abundance of bacteria in top soil (Saeki & Toyota, 2004; Djuric & Jarak, 2006). Also, metsulfuron-methyl and rimsulfuron have been observed to cause significant change in the content of microbial biomass and enzymatic activity in soil (Vischetti *et al*., 2000; Zabaloy *et al*., 2008). Bioassays based on sensitive species have also been used frequently to quantify the residues of sulfonylurea herbicides (Ajit *et al*., 1998). Susceptible species used include maize, lentil, sunflower, turnip, and sugarbeet. At the moment, information on effect of nicosulfuron residues on the growth of most vegetables grown in the tropics is grossly lacking. Since any of these vegetables may be sown after maize crop in which nicosulfuron has been used for selective weed control, it then becomes necessary to gain an insight into its soil residual activity on their growth in order to prevent crop injury. Consequently the objectives of the present study was to examine under screen house conditions the soil residual activity of nicosulfuron on the growth and yield of okra, an important vegetable crop contributing substantially to the human diet as a main constituent in soup and stew in the tropics (Tindall, 1968).

MATERIALS AND METHODS

A study was carried out at the screenhouse of the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure (7º 16ᴵ N, 5º 12ᴵ E) located in the rainforest vegetation zone of Nigeria. In the screenhouse temperature and relative humidity fluctuated between 25-35ºC and 58-85%, respectively, during the experiment. The soil used was a sandy loamy. The herbicide used is 75% water dispersible granule formulation of nicosulfuron. Seeds of an okra variety (Yeleen) was obtained from Agritropic Nig. Ltd, Ibadan, Nigeria. The experiment was laid out in a completely randomized design with three replicates per treatment.

The study involved application of nicosulfuron at the recommended dose of 60g a.i.ha^{-1} applied at time intervals of 0,3,6,9 and 12 weeks before sowing okra seeds in 4 litre plastic pots filled with forest top soil. Spraying was carried out with a knapsack sprayer fitted with polijet nozzles calibrated to deliver 200l ha^{-1} of the spray solution at a pressure of 200kPa.The experiment included a control without herbicide application. Seeds of okra were sown in each pot at the rate of 5 seed per pot, and emerged seedlings were later thinned to two plants per pot. Watering of the pot was done every other day commencing from the day of sowing up to the time experiment was terminated at 10weeks after sowing. No fertilizer application was made. Ten seeds were placed in filter paper and folded inside three different petri dishes. 8ml of distil water were added to each and covered with lid and were kept in a cabinet. It was observed for germination percentage for 7days using the formula: Number of plantlet x 100.

Data collected on okra include weekly measurements of plant height and counts of number of leaves per plant over a period of 8 weeks. Leaf area was measured using standard method. Data were collected for total crop leaf area, stem girth and fresh pod weight at the end of the experiment.Data collected were submitted to analysis of variance and significant treatment means were separated using LSD at 5% probability level (Little and Hills, 1978) in addition to Duncan's Multiple Range test n.Simple linear correlation and regression analysis between growth and yield components and time interval between nicosulfuron applications were performed with a scientific calculator (Casio fx-7400G PLUS)

RESULTS AND DISCUSSION

Table 1 shows the effect of soil residual activity of nicosulfuron on okra plant height measured weekly over a period of eight (8) weeks after sowing. There were significant differences ($p<0.05$) among the treatments with the control consistently recording the tallest plants. Among the herbicide treatments, plant height decreased in the order of decreasing time interval with the result that the shortest plants were recorded in the treatment of zero week after treatment. Plant height measured at the first week after sowing shows that significant reduction in plant height was only recorded for nicosulfuron treatment at 0 WAT. However, treatment of soil with nicosulfuron at 12 weeks before sowing did not significantly influence plant height compared to the control in most parts. At the termination of the experiment (8 WAS), height reductions of 10. 8, 7, 6, 2 % were recorded as a result of planting okra seeds in soil treated with nicosulfuron at 0, 3, 6, 9 and 12 weeks before sowing.

Table 2 shows the effects of nicosulfuron residue on number of leaves per plant measured over a period of eight weeks after sowing. There were significant differences in the number of leaves per plant throughout the evaluation period with the control recording the highest number of leaves per plant. However, number of leaves was found to be consistently increasing with increase in weeks after sowing okra seeds starting from the first week after sowing up to the termination of the experiment.

Table 1. Effects of nicosulfuron residues on the plant height (cm) of okra

	Weeks After Sowing							
WAT	1	2	3	4	5	6	7	8
0	4.57^{b}	9.03^{d}	11.20^{d}	17.60^{d}	23.37^{c}	31.40^{c}	44.33^{c}	55.53^{c}
3	8.17^{a}	11.90^{c}	14.00^{c}	19.40^{c}	24.07^{c}	32.27^{c}	44.57^{c}	56.37^{bc}
6	8.37^{a}	12.99^{b}	14.77^{b}	21.00^{b}	26.53^{b}	35.17^{b}	45.33^{c}	57.17^{bc}
9	8.60^{a}	13.17^{b}	15.07^{b}	21.20^{ab}	27.57^{ab}	35.43^{b}	47.17^{b}	57.80^{b}
12	8.77^{a}	13.67^{a}	15.37^{b}	21.53^{ab}	28.17^{ab}	37.17^{b}	49.50^{a}	60.17^{a}
Control	8.97^{a}	13.97^{a}	16.67^{a}	22.20^{a}	29.20^{a}	39.70^{a}	50.25^{a}	61.33^{a}

Means in a column with the same letter (s) are not significantly different by Duncan Range Test ($p\leq0.05$), WAT = weeks after treatment

Table 2 Effect of nicosulfuron on Leaf number per plant of okra

	Weeks After Sowing							
WAT	1	2	3	4	5	6	7	8
0	1.92^{c}	2.50^{c}	4.67^{b}	5.67^{b}	6.17^{c}	7.17^{c}	7.67^{c}	8.00^{a}
3	2.53^{b}	3.17^{bc}	4.83^{b}	6.33^{ab}	6.67^{bc}	7.33^{bc}	7.83^{c}	8.33^{a}
6	2.67^{b}	3.42^{bc}	5.00^{b}	6.50^{a}	7.00a^{bc}	7.67^{abc}	8.17^{bc}	8.67^{a}
9	2.80^{ab}	3.50^{ab}	5.00^{b}	6.50^{a}	7.00a^{bc}	7.67^{abc}	8.17^{bc}	9.00^{a}
12	2.87^{ab}	3.67^{ab}	5.83^{a}	6.83^{a}	7.33^{ab}	7.83^{ab}	8.67^{ab}	9.33^{a}
Control	3.05^{a}	3.92^{a}	6.17^{a}	7.00^{a}	7.67^{a}	8.00^{a}	9.17^{a}	9.33^{a}

Means in a column with the same letter (s) are not significantly different by Duncan's Multiple Range Test ($p \leq 0.05$), WAT = weeks after treatment

The regression of plant height (*Y*) against the time interval between nicosulfuron applications (X) is shown in table 3. Results indicated significant positive relationships throughout the evaluation period with the correlation coefficients and corresponding prediction equations presented in the table. Regressing number of leaves per plant(Y) against time interval between nicosulfuron applications (X) also showed significant positive relationships throughout the evaluation period with the correlation coefficients and corresponding predicted equations presented in Table 3.

Table 3: Simple regression and correlation between growth parameters of okra (*Y*) and time interval between nicosulfuron application before sowing (*X*) (n=5)

	Plant height		Number of leaves	
WAT	r	Regression equation	r	Regression equation
1	+0.79	Y=5.930+0.294x	+0.90	Y=2.124+0.072x
2	+0.90	Y=10.042+0.352x	+0.92	Y=2.718+0.089x
3	+0.88	Y=12.2+0.314x	+0.88	Y=4.568+0.083x
4	+0.93	Y=18.214+0.322x	+0.92	Y=5.868+0.083x
5	+0.98	Y=23.3242+0.463x	+0.96	Y=6.304+0.088x
6	+0.97	Y=31.348+0.490x	+0.96	Y=7.202+0.055x
7	+0.95	Y = 43.59+0.43x	+0.96	Y=7.634+0.078x
8	+0.96	Y=55.266+0.357x	+1.00	Y=8.000+0.111x

WAS----weeks after sowing, r = correlation coefficient

Results of the effects of nicosulfuron treatments on the yield attributing parameters of okra indicated significant differences among the treatments in terms of leaf area, pod fresh weight, pod length and pod diameter (Table 4). The foregoing parameters were significantly higher in the control than in the herbicide treated pots. Among the nicosulfuron treated soils, yield parameters were found to decrease in a manner consistently related to plant height and the plant leaf number.

Treating soil with nicosulfuron at intervals of 0, 3, 6, 9 and 12 weeks before sowing okra seeds reduced okra pod weight by 67, 50, 49, 41 and 16 %, respectively compared to the control treatment. Linear correlation and regression analyses between these parameters and time interval between nicosulfuron applications indicated significant positive correlations with prediction equations shown in Table 5.

Table 4: Effects of nicosulfuron residue on the yield components of okra at harvest

Sowing period	Stem girth (cm)	Leaf area per plant (cm^2)	Pod fresh weight per plant (g)	Pod length (cm)	Pod diameter (cm)
0WAT	0.74^{c}	317.98^{c}	12.38^{f}	2.90^{f}	2.14^{e}
3WAT	0.75^{c}	329.91^{c}	18.59^{e}	3.30^{e}	2.43^{de}
6WAT	0.81^{c}	343.18^{c}	19.29^{d}	4.30^{d}	2.69^{cd}
9WAT	0.90^{bc}	393.10^{b}	22.13^{c}	4.97^{c}	2.97^{c}
12WAT	1.05^{ab}	429.22^{b}	31.39^{b}	5.93^{b}	3.33^{b}
CONTROL	1.23^{a}	485.58^{a}	37.48^{a}	6.67^{a}	4.27^{a}

Means in a column with the same letter (s) are not significantly different by Duncan's Multiple Range Test ($p \leq 0.05$), WAT = weeks after treatment

Table 5: Simple regression and correlation between growth and yield components of okra (*Y*) and time interval between nicosulfuron applications (*X*) (n=5)

Growth and yield components	Correlation coefficient (r)	Regression equation
Stem girth per plant (cm)	+0.95	Y=0.70+0.03X
Pod fresh weight per plant (g)	+0.95	Y=12.44+1.39X
Pod length	+0.99	Y=2.73+0.26X
Pod diameter	+1.00	Y=2.13+0.10X
Leaf area per plant (cm^2)	+0.96	Y=305.5+9.52X

The present study has clearly demonstrated that okra is sensitive to nicosulfuron residue in the soil as observed in the negative responses of okra growth and yield parameters to the herbicide. The significant differences recorded in plant height, number of leaves, stem girth and leaf area throughout the evaluation period suggested that nicosulfuron residue may affect the growth and yield of okra (Rahman & James 1994, 2002). However, The lack of differential influence of the various nicosulfuron treatments on the growth parameters of okra at 1 WAS suggested that the adverse effects of the herbicide on seed germination and seedling establishment of okra was more pronounced than that caused by its metabolites. The values obtained among the treatments in plant height, stem girth, leaf area and number of leaves per plant, as well as the results of the regression analysis suggested that the ability of nicosulfuron to exert phytotoxic effects on okra appears to be related to the length of time of nicosulfuron application before sowing okra seeds. Plant height and other growth parameters were found to reduce in the order of decreasing time of application before sowing, thus confirming that nicosulfuron residue in the soil may affect okra plant if grown to succeed maize in rotation where nicosulfuron had been employed to control weeds (Nicholls *et. al*.1987; Sarmah *et al*.1998). The significant reductions recorded in the plant vegetative growth parameters observed in this study partly corroborated earlier report by Rahman & James (1994), that nicosulfuron can persist in the soil at concentrations large enough to damage sensitive crops in rotation. This was confirmed in this study by the presence of significant differences in the influences of the nicosulfuron treatments on okra growth parameters up until the eighth WAS. This observation suggests that residues of nicosulfuron were either still toxic to the plants at this time regardless of the time of application before sowing, or that the plant did not recover from the adverse effects of the herbicide all through its life cycle. It may therefore be necessary to plan the space between maize harvest and the time of okra planting since time of nicosulfuron application in maize must be synchronized with maize growth to ensure efficacy. The success of post-emergence weed management often depends upon application timing and weed seedling size. If the application is too early in the season, the short residual life means that it fails to control subsequent weed germination. Conversely, late applications suffer reduced efficacy as the weeds exceed the 200 mm tall recommended size (Carey & Kells 1995; Williams & Harvey 2000). Adejoro *et al*. (2018) suggested a period of fallow be observed before the next crop in rotation when nicosulfuron is applied to control weeds in a short season crop like maize.

CONCLUSION

It is evident from the results obtained in this study that it is not safe to sow okra immediately after harvest of a crop in which nicosulfuron had been used for weed control. The twelve weeks of maize growth on the field also seemed not to be enough for the degrading microorganisms to perform their buffering functions of making the soil safe for a sensitive vegetable crop like okra. Further research are however suggested (1) to get minimum safe period between nicosulfuron application and the introduction of vegetable crops e.g. okra and (2) to determine the response of such crops to diuron application under field conditions.

REFERENCES

Adejoro S. A, Adegaye A. C, and Sonoiki D.S (2018) Soil microbial community response to compost addition to micosulfuron contaminated soil. Journal of Agricultural Studies, Vol. 6 (4), 67-81

Ajit K. Sarmah A.B.D, Rai S. Kookana A .C, and A. M. Alston A. B (1998) Fate and behaviour of triasulfuron, metsulfuron-methyl, and chlorsulfuron in the Australian soil environment: a review. Aust. J. Agric. Res., 49, 775-790.

Atlas, R.M., (1978), Assessment of pesticide effects on non - target soil microorganisms, Soil Biol. Biochem, 10, 231–239.

Bohme L, Langer U, Bohme F (2005) Microbial biomass, enzyme activities and microbial community structure in two European long-term fi eld experiments. Agric Ecosyst Environ 109:141–152.

Camper, N.D., (1991) Effects of pesticide degradation products on soil microflora, ACS Symp. Ser. 459, 205–216.

Canet R, Birrnstingl J.G, Malcom D.G, Real-Lopez J.M, Beck A.J (2001) Biodegradation of polycyclic aromatic hydrocarbons (PAHS) by native microfl ora and combinations of white-rot fungi in a coal-tar contaminated soil. Bioresour Technol 76:113–117.

Carey J. B., Kells J. J. (1995). Timing of total postemergence herbicide applications to maximize weed control and corn (*Zea mays*) yield. Weed Technology 9: 356-361.

Djuric, S. & Jarak, M. (2006). The effect of sulfonylureaherbicides on the microbial activity in soil under maize. *Annals of the Faculty of Engineering Hunedoara*, *4*(2), 93-96.

Little, T.M., Hills, F.J., (1978). Agricultural Experimentation: Design and Analysis. Wiley, New York 350pp.

Nicholls PH, Evans AA, Walker A (1987). The behavior of chlorsulfuron and metsulfuron in soils in relation to incidents of damage to sugar beet. Proceedings of the 1987 British Crop Protection Conference--- Weeds: 549-556.

Nicholson P. S, Hirsch P. R. (1998). The effects of pesticides on the diversity of culturable soil bacteria. J Appl Microbiol 84:551–558.

Rahman A, James T. K (1994). Field persistence of some maize herbicides in two soils. Proceedings of the 47th New Zealand Plant Protection Conference: 6-10.

Rahman A, James T.K (2002). Minimizing environmental contamination by selecting appropriate herbicide dose. In: Kookana RS, Sadler R, Sethunathan N, Naidu R. ed. Environmental protection and Risk Assessment of Organic Contaminants. Science Publishers Inc., Enfield, NH, USA.Pp. 209-224.

Saeki, M. & Toyota, K. (2004). Effect of bensulfuron-methyl (a sulfonylurea herbicide) on the soil bacterial community of a paddy soil microcosm. *Biology and Fertility of Soils, 40*, 110-118. doi: 10.1007/s00374-004-0747-1

Sarman A. K, Kookana R. S, Alston A. M (1998). Fate and behavior of triasulfuron, metsulfuron methyl and chlorsulfuron in the Australian soil environment: a review Australian Journal of Agricultural Research 49:775-790.

Tindall, H .D. (1968). Commercial Vegetable Growing. Oxford University Press, London 300pp.

Vischetti, C., Perucci, P. & Scarponi, L. (2000). Relationship between rimsulfuron degradation and microbial biomass content in a clay loam soil. *Biology and Fertility of Soils, 31*, 310- 314.

Williams B J, Harvey R. G (2000). Effect of nicosulfuron timing on wild-proso millet (*Panicum miliaceum*) control in sweet corn (*Zea mays*). Weed Technology 14:377-382.

Yang Y. H, Yao J, Hu S, Qi Y (2000) Effects of agricultural chemicals on DNA sequence diversity of soil microbial community: a study with RAPD marker. Microb Ecol 39:72– 79

Zabaloy, M. C., Garland, J .L. & Gomez, M. A. (2008). An integrated approach to evaluate impacts of the herbicides glyphosate, 2,4-D and metsulfuron-methylon soil microbial communities in the region, Argentina. *Applied Soil Ecology, 40*, 1-12. doi: 10.1016/j.apsoil.2008.02004

Zhong W. H, Cai Z. C. (2007). Long-term effects of inorganic fertilizers on microbial biomass and community functional diversity in a paddy soil derived from quaternary red clay. Appl Ecol 36:84–91

EFFECT OF ILLEGAL HUMAN ACTIVITIES ON WILDLIFE CONSERVATION IN GUMTI AND MAYO-SELBE RANGE OF GASHAKA GUMTI NATIONAL PARK, TARABA STATE. NIGERIA.

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Abstract

*Studies on the on the illegalhuman activities in Gashaka Gumti National Park -GGNP. was carried out between February and June, 2016. The studies was undertaken to derive information on the various illegal activities by carried out by human in the study area. , assess the extent of plant utilization by human and determine the relative abundance of wild animal/birds species within the study area. The study was carried out using plot sampling techniques. The objective was achieved using descriptive analysis (percentage, tables and chats). The result gathered shows that Gumti and Mayo-Selbe Range ofGashaka-Gumti National Park are currently faced with illegal activities. Among the various human illegal activities carried out in the area, logging (30.43**%), ** fuel wood collection (15.22**%)**, grazing (19.56**%)**, and farming (15.22**%), ** had the greatest impact on biodiversity conservation which will result to land degradation in future if nothing is done to mitigate it. The number of illegally utilized plants species counted are totaled 123 stumps, a density of 307 stumps/ha. The frequency of plants exploitation in the park indicates that species such as Anogeisus leiocarpus, Khaya senegalenses, Afzelia africana and Brachystegia eurcoma arehighly exploited having a (9.52%) relative frequency of use, this implies that effort should be geared towards protection of these species for the benefits of the protected area. Wild animal species are not quite abundant because a lot of the animals were not easily sighted. Although Warthog had a relative abundance of 15.25% being the highest, while TortoiseandMonitor Lizard had (0.85%) relative abundance respectively. There is no significant different (P>0.05) between the plots in the abundance of wild animal's species that utilizes the area. Therefore, the park authority should intensify anti-poaching patrol so as to stop humans from entering the park for any illegal activities.*

Keywords: *Human activities, wildlife, Gumti and Mayo-Selbe Range, Gashaka-Gumti National Park*

INTRODUCTION

In recent times, biodiversity has become easy targets for human over-exploitation due to burgeoning human populations and the quest for a "better life" through improvements in science and technology. Biodiversity, therefore, is being exploited at much faster rates than ever before with negative implications for sustainable human livelihood (Wuver and Attuquayefio 2006). Wuver and Attuquayefio (2006) stated that biodiversity is facing a decline of crisis proportions which could ultimately lead to mass extinctions in the very near future. For instance in Ghana, increasing evidence indicates that the rate of environmental degradation has increased in recent times, with previously rich forests being converted to savanna woodland and existing savanna woodlands converted into near desert (Wuver and Attuquayefio (2006).

Virtually all human activities can affect wildlife populations either positively or negatively. Examples include activities that directly alter the structure and composition of the landscape, such as agriculture, forestry, livestock grazing, and unregulated off-road vehicle use. In general, these are land use or land management practices that change the trajectory of ecological succession, including altering the dominant plant communities and the abiotic features of a site. The ecological effects of these activities on vertebrates are readily apparent and have been relatively well studied (Lichstein *et al*., 2002).Those that cause changes to an animal's behavior; Examples include recreational activities such as hiking, wildlife viewing, and boating – all common activities for visitors in parks. As recreational use increases in wilderness and other protected areas, sensitive wildlife species may be increasingly affected by these activities (Steidl and Anthony, 2000). Although effects of these activities are typically of short duration, cumulatively they can effect wildlife populations adversely in both the short- and long-term (Robert and Brian, 2006).

Nigeria is blessed with very rich biological diversity. As a result of the wild variety in physical environment, climate and vegetation zones, the country is endowed with a great variety of ecosystems and habitats and a number of unique species that are found only in Nigeria (Ezealor, 2002). Over the years many of the Nigerian plants species of economic important have been lost or reduced in number as a result of over exploitation or degradation of the ecosystem. Anthropogenic activities such as illegal grazing, farming, and poaching have caused a concern for conservation particularly grazing, where the herdsmen have not only grazed in the park but attacked Park staff when confronted (Akinsoji *et al.*, 2016). Satellite imagery survey of GGNP, shows that during most of the dry season, green vegetation was absent in up to one fifth of the park (Gumnior and Sommer 2000). This was attributed largely to human activities such as cattle grazing and bush burning. Gumnior and Sommer (2012) further confirmed environmental degradation detected in previous imagery, and established a trend of degradation in the newer scenes.

According to Nigerian Environmental study/Action Team -NEST (1991) indiscriminate bush burning and clearing in Nigerian have led to the loss of about 350,000 hectares of forest and natural vegetation annually, this leads to loss of many economic plants. Human activities that affect wildlife and their habitat are pervasive and increasing e.g. agricultural practices, livestock grazing, logging, uncontrolled bush burning as well as mining cause's changes in the behaviour of individual animals and these results to local extinction and global extinctions (Chapin. *et al*., 2000). Hence it is important to study illegal activities in the area to help us ascertain the best management practices that will help to boost the park conservation programs. The objectives of this study include; To identify the various illegal activities by human on biodiversity conservation in the study area and also to assess the extent of plant utilization by human in the area.

MATERIALS AND METHODS

The Study Area

Gashaka Gumti National Park is the largest and most diverse National Park in the Nigeria covering an area of approximately 6670sq, km. the park is split between Adamawa and Taraba states. It is located in the northeast of Nigeria between latitude 6°.55' N and 8°.05' N, and longitudes 11°. 11' E and 12°. 13' E with the federal republic of Cameroon as its eastern border. The parks name is derived from two of the regions oldest and most historic settlements: Gashaka village in Taraba and Gumti village in Adamawa state. Gashaka Gumti National Park was created by federal Decree now Act in 1991 by the merging of Gashaka game reserve with Gumti reserve (Dunn, 1998).

Study Design

The study was carried out in two ranges of the park namely Gumti Range and Mayo-Selbe Range. Plot sampling techniques was used. A 100 X 100m plot was established in each range, using measuring tape and ranging poles for proper measurement and alignment and also to pegged out each of the plots. Each of the plots was further divided into two making a total of four plots. Plot 1 and 2 in the Gumti Range and plot 3 and 4 in the Mayo-Selbe Range of the park. The plots were used to assess the extent of plant exploitation by humans, and as well determine the abundance of wild animal/ birds species within the study area.

The project was carried out for a period of three (3) months. January - March. Each site was visited five (5) days in the month. Period of visit was between 6:00am – 9:00am in the morning and 3:00pm – 6:00pm in the evening. The visit was to observe for any new illegal activity in the plots as well as the presence of wild animals in the area.

Plant/ Animal assessment

Each plot in the study site was assessed. The plants species utilized by man identified and recorded and by using a colourful nylon to tag the plant to avoid double counting. The plants counted include lopped/ logged plants, plants parts used, the fruits and seeds that were being harvested excessively. For the animal inventory, within the plots wild animals/birds that utilize the area were also censured and recorded. The researcher and the field assistant aided with binoculars, walked along the stripes at a maximum speed of 1 km/ hour stopping at intervals to observe and count the animals when sighted. The following information were recorded, name of species, number of individuals of the species, sighting distance and species activities when first sighted.

Data Analysis

Data obtained were analyzed using descriptive statistics (tables, chart, and percentages).

Data on the utilized plant density (the expression of species per unit area) was obtained using the formula;

$$\text{Density: } D = \frac{\text{No of individual species}}{\text{Unit area}}$$

$$\text{Relative density} = \frac{\text{No of individual species} \times 100}{\text{No of all species}}$$

The model described by Dunn (1993) was used to calculate the relative abundance of each species from the class of animals it belongs, in each habitat. The model is mathematically stated thus;

$$A = n/N$$

Where A = relative abundance

n = Quantity of each species present

N = Quantity of all species present

Analysis of Variance [ANOVA] was used to test if species diversity indices differed between plots.

RESULTS AND DISCUSSION

The findings from this study as shown in (Table 1) revealed that, the human illegal activities are prevalent in Gashaka-Gumti National Park. The results indicated that, among the various human activities carried out in the area, Logging (30.43%), fire wood collection (15.22%), grazing (19.56%), and farming (15.22%), had the greatest impact on biodiversity conservation, which will result to land degradation in future if nothing is done to mitigate it.

Forest clearance for farming is being carried out by the park surrounding communities. The finding indicates that out of 46 study observations made, 7 different farmers group were sighted clearing the surroundings of the park for their annual farming practices. This agrees with (Gawaise, 1997) report that land clearing for subsistence farming is one of the major problems facing National Parks in Nigeria including Gashaka-Gumti National Park and that the increase in human population in Nigeria and in Gashaka Gumti National Park, over the four decades has resulted in increased demands for farmlands, livestock grazing and forest resources such as wood for timber, building and energy. Farming also leads to the loss of habitat and can lead to habitat fragmentations. For instance clearing of vegetation in flatter areas at lower elevations and on the more-productive soils are likely to retain fewer, smaller fragments of original vegetation (Lunt and Spooner 2005). This has important implications for conservation because sites associated with different soil types typically support different sets of wild animal species (Lunt and Spooner 2005). More so the sparser vegetation cover in any fields provides little opportunities for small mammals to hide, offers less protection from predation and heat as well as less food in terms of plant matter, or insects living on and off the plants (Hoffmann and Zeller, 2005).

Grazing; Herders are widespread throughout the park. Pastoralism occurs in two types; nomadic and secondly settled pastoralist. Hence their presence causes a lot of havoc to wildlife in the park, it is either they distribute tsetse fly throughout the park or causes diseases such as Rinderpest to which will have a devastating effect on the park wildlife (Dunn, (1998). Also overgrazing and annual burning reduces the vegetation cover of an area, leading to further leaching of the top soil thereby causing soil surface erosion (Dunn, (1998). High grazing intensity also alters plant species composition with an increase of annual, geophyte, and unpalatable shrub species, and decrease of perennial, palatable leaf-succulent shrub species (Desmet, 2007). Grazing by domestic stock and altered nutrient levels can facilitate the invasion of exotic species of plants, which markedly alters the vegetation in fragments and habitats for animals (Hobbs and Yates 2003).

The findings indicates that poaching is being carried out in the study area as well as in the whole park, and poaching here is both for subsistence and for commercial purposes (Dunn, 1998). According to Nicholas & Nyanganji, (2002), wildlife in the Gumti enclave is generally more abundant and more visible than it is in the highland enclaves. For instance most species are majorly the target for poachers (Species such as kobs, roan antelopes, bushbucks, red-flanked duikers, warthogs, lions, elephants and patas monkeys). Nicholas & Nyanganji, (2002) reported that in addition to resident hunters within the park enclaves, hunters also come from neighboring country Cameroon to hunt in the park surroundings. Meanwhile there are a number of different footpaths that provide access to the enclaves and it is difficult for rangers to patrol them all. The hunter's supply the animals obtained to the local bush meat markets of Serti, Mayo Selbe and beyond (Nicholas & Nyanganji, 2002). Wildlife is generally hunted in the area for the major reason of its valuable source of protein. Human activity is also affecting bird populations adversely through hunting, or may indirectly have implications for bird survival and reproduction through changes in their habitat (Lawes *et al.* 2006; Manu *et al.* 2007) or through forcing birds to use sub-optimal areas because of disturbance effects (Blumstein 2006).

Illegal fishing is one of the activities carried out in the area for instance 6.52% illegal fishermen were observed catching and roasting fishes in Gumti area at the time of this study. Dunn, (1998) confirmed that fishing is an important activity at Gumti, Sabere, and to a lesser extent, at Filinga areas of the park.

Table 1. Types of illegal activity of humans in Gumti and Mayo-Selbe Range of GGNP.

S/NO	Illegal Activities	Total number of observations	Percentage (%)
1	Logging	14	30.43
2	Poaching	4	8.69
3	Farming	7	15.22
4	Fishing	3	6.52
5	Bush burning	2	4.35
6	Grazing	9	19.56
7	Firewood collection	7	15.22
	Total	46	99.99

Intensity of plant utilization

The number of plant species observed and counted being illegally exploited in Gumti and Mayo-Selbe Range of Gashaka-Gumti National Park as shown in (Table 2) are totaled 123 stumps. The average density is 30.75 stumps/hectare, while a plot represent 0.01 hectare therefore the number of utilized stumps per hectare = 307 stumps/ha. The frequency of plants utilization in the park indicates that species such as is *Anogeisus leiocarpus, Khaya senegalenses, Afzelia africana and Brachystegia eurcoma* are highly exploited having a (9.52%) relative frequency of use. Haruna and Okeyoyin, (1995) has reported that, with the rate in which National Park forest is being cleared through illegal activities, the implication is that it will not be long before the entire National Park is completely cleared of primary vegetation. This will eventually result into wild animal migration, species reduction and finally, extinction of many indigenous wildlife species will occur.

The plants species are exploited through various ways by, logging, seed and firewood collection, as well as uprooting. The plants are used for different purpose which include, using the leaves to feed livestock or to prepare food for man, using the roots or bark and leave to prepared local medicine and also using the pole to build house. In Gashaka-Gumti National Park, the forests constitute a vital source of fuelwood and timber, medicines for consumption both by humans and livestock's, also wild foods such as honey and palm wine, and a variety of other materials are collected from the park by humans (Dunn, 1998). According to Wuver and Attuquayefio (2006), fuelwood provides the main energy source for both rural and urban households throughout the entire West African sub-region, with estimates of about 50% of total energy consumption. Fuelwood plays an important role in human activities like fish smoking and charcoal production and preparation of food.

Table 2. Intensity of plant utilization(%) in Gumti and Mayo-Selbe Range of Gashaka-Gumti National Park

S /no	Plant species used by man	No. of stumps counted	Density	Relative density%	Number of occurrence in a plot	Frequency of utilization	Relative frequency %
1	*Bombax costatum*	5	1.25	4.06	3	75	7.14
2	*Annona senegalensis*	8	2	6.50	3	75	7.14
3	*Anogeisus leiocarpus*	20	5	16.26	4	100	9.52
4	*Afzelia africana*	4	1	3.25	4	100	9.52
5	*Brachystegia eurcoma*	10	2.5	8.13	4	100	9.52
6	*Burkea africana*	7	1.75	5.69	2	50	4.76
7	*Elaesis guineensis*	2	0.5	1.63	2	50	4.76
8	*Detarium microcarpum*	12	3	9.76	3	75	7.14
9	*Lannea schimperi*	6	1.5	4.88	2	50	4.76
10	*Kigelia africana*	2	0.5	1.63	1	25	2.38
11	*Khaya senegalenses*	20	5	16.26	4	100	9.52
12	*Isoberlina tomentosa*	15	3.7	12.19	3	75	7.14
13	*Philiostigma thonnigii*	4	1	3.25	2	50	4.76
14	*Parkia biglobosa*	3	0.8	2.44	2	50	4.76
15	*Prosopis africana*	4	1	3.25	2	50	4.76
16	*Strychnos spinosa*	1	0.25	0.81	1	25	2.38
	Total	123	30.75	99.99	42	1050	99.96

Source: Field survey

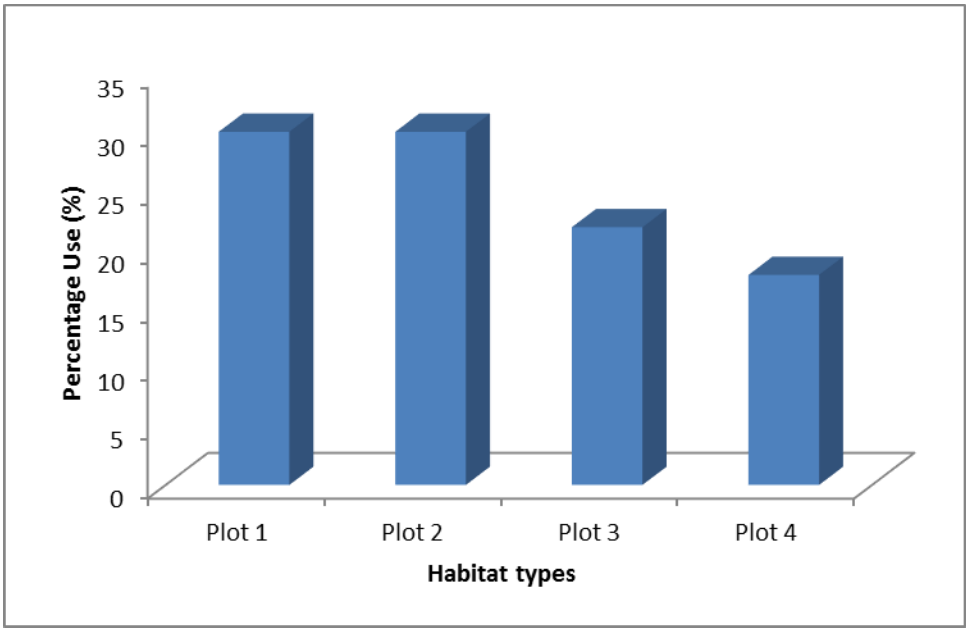

Fig. 1. Rate of plant species utilization (%) in Gumti and Mayo-Selbe Range of Gashaka-Gumti National Park

The rate of plant species utilization indicates that among the various plots as shown in fig. 1. Plot (1) and (2) witness the highest rate of plant species utilization having27.6% effect, while plot (4) have the least 10.9% effect. Hence the entire park requires adequate park protection so as to safeguard the wildlife of the area.

The relative abundance of wild animal's species utilizing the various plots (Table3**)** shows that wild animal species are not quite abundant because a lot of the animals were not easily sighted. Although Warthog had a relative abundance of (15.25%) being the highest, while TortoiseandMonitor Lizard had the least (0.85%) relative abundance respectively. The finding indicates that there is no significant different (P>0.05) between the plots in the abundance of wild animal's species utilizing the area.

Table 3. Relative abundance (%) of wild animal species in Gumti and Mayo-Selbe Range of GGNP.

S/no	Common Name	Scientific Names	Number	Relative abundance (%)
	Bush Buck	*Tragelophus scriptus*	6	5.08
	Colobus Monkey	*Colobus guereza*	4	3.39
	Ground Squirrel	*Xerus erythropus*	7	5.93
	Monitor Lizard	*Varanus niloticus*	1	0.85
	Putty-nose monkey	*Cercopthecus nictans*	15	12.71
	Red Flanked Duiker	*Cephalopus rufilatus*	10	8.47
	Red river hog	*Hylochoers meinertzhageni*	8	6.78
	Tantalus monkey	*Cercopithecus aethiops*	36	30.51
	Tortoise	*Geochelone gigantea*	1	0.85
	Tree Squirrel	*Epixerus ebii*	2	1.69
	Warthog	*Phacochoerus africanus*	18	15.25
	Water Buck	*Kobus defassa*	10	8.47
	Total		118	99.98

Source: Field survey

The relative abundance of bird's species utilizing the various plots (Table4.**).** The tableshows that only few birds' species were observed. Helmeted Guinea fowl had a relative abundance of (34.78%) being the highest. The finding indicates that there is no significant different (P>0.05) between the plots in the abundance of birds species utilizing the area.

Table 4. Relative abundance (%) of birds' species in Gumti and Mayo-Selbe Range of GGNP.

Common Name	**Scientific Names**	**Number**	**Relative Abundance (%)**
Black Francolin	*Francolinus francolinus*	15	32.61
Abyssinian Ground-hornbill	*Bucorvus abyssinicus*	4	8.69
Helmeted Guineafowl	*Numida meleagris*	16	34.78
Little Paradise-kingfisher	*Tanysiptera hydrocharis*	2	4.35
Senegal Coucal	*Centropus senegalensis*	2	4.35
Scarlet-chested Sunbird	*Nectarinia senegalensis*	3	6.52
Vinaceous Dove	*Streptopelia vinacea*	4	8.69

Source: Field survey

CONCLUSION AND RECOMMENDATIONS

From the findings of the study, the major human activities that impact on the wildlife of the study area were logging, poaching, fire wood collection and farming. Wild animal species are not quite abundant because a lot of the animals were not easily sighted. Indiscriminate deforestation, bush burning and farming activities in the area should be minimized so as to allow wildlife to have enough cover and feed for survival. The protection of the park from illegal human activities should be given proper attention by both government and wealthy individuals, to prevent the park wildlife from going into extinction.

Base on the findings the following recommendations are proffered;

- Local communities' leaders should be included in the park decision making so as to help minimize community encroachment into the park as well as cattle grazing, and other illegal activities around the park environs.
- The park authority should intensify on its public education and awareness campaigns communities surrounding the park; this will enhance their knowledge on wildlife conservation.
- The state government and the local government authority should be encouraged to establish community woodlots of indigenous plants this will help to reduce the dependence on the park resources by the people.
- Government should introduce a better alternative form of cooking energy for the people so as to discourage the use of firewood mostly.
- Government should make provision for alternative sources of income for the local population; this will reduce their dependence on forest products for livelihood.
- The park authority should intensify anti-poaching patrol so as to stop humans from entering the park and killing most wild animals

REFERENCES

Akinsoji, A., Adeonipekun, P.A., Adeniyi, T.A., Oyedanji, O.O and Eluwole, T.A. (2016).Evaluation and flora diversity of Gashaka Gumti National Park, Gashaka Sector, Taraba State, Nigeria, Ethiopian Journal of Environmental Studies & Management 9(6): 713 – 737, Submitted: June 17, 2016 Accepted: November 02, 2016

Blumstein, D. T. (2006). Developing an evolutionary ecology of fear: how life history and natural history traits affect disturbance tolerance in birds. *Anim Behav* 71: pp 389– 399.

Chapin, F.S. I, E.S. Zaveleta, V.T. Eviner, R.L. Naylor, P.T. Vitousek, H.L. Reynolds, D.U. Hooper, S. Lavorel, O.E. Sala, S.E. Hobbie, M.C. Mack, and S. Diaz. (2000). Consequences of changing biodiversity. *Nature* 405, pp 234–242.

Desmet, P.G., (2007). Namaqualand a brief overview of the physical and floristic environment. J. Arid Environ. 70, 570- 587.

Dunn, A. (1993). The large mammals of GGNP, Nigeria: line transect surveys of forest to savannah. A report prepared for the FMA,WRRD, NCF, Lagos and WWF-UK.

Dunn, A. (1998). Gashaka Gunti National Park. A management plan for developing the park and its support zone.NPS,NCF,WWF-UK.

Ezealor, A. U. (2002). Critical site for biodiversity conservation in Nigeria. NCF, Lagos, Nigeria. Pp3-9.

Gawaisa S.G (1997). The status of large mammals and the impact of Human Activities on Gashaka Gumti National Park. Unpublished B. Tech, thesis Federal University of Technology, Yola. pp 1-62.

Gawaisa, S.G. (2001) Population Dynamics of Mammals in the Savanna Zone and Management Programmes in GGNP, Nigeria. Unpublished Masters of Technology Thesis, FUTY. Yola. pp 1-62.

Gumnior, M. and Sommer, V. (2012). Multi-Scale, Multi-Temporal Vegetation Mapping and Assessment of Ecosystem Degradation at Gashaka Gumti National Park (Nigeria). *Research Journal of Environmental and Earth Sciences,* 4(4): 397-412.

Haruna, S. Z. and Okeyoyin, O. A. (1995) The threat of human activities and livestock grazing on the conservation of Gashaka Gumti National Park. Nigeria. In Proceedings of the regional training workshop held at FUT. Akure. Nigeria Pp. 24-26.

Hobbs, R. J. and Yates, C. J. (2003). Impacts of ecosystem fragmentation on plant populations: generalising the idiosyncratic. Turner Review No. 7. Australian Journal of Botany, 51, 471–488.

Hoffmann, A., Zeller, U. (2005). Influence of variations in land use intensity on species diversity and abundance of small mammals in the Nama Karoo,Namibia. Belg. J. Zool. 135, 91-96.

Lawes M. J, Fly S, Piper S. E (2006) Game bird vulnerability to forest fragmentation: patch occupancy of the crested guinea fowl (*Guttera edouardi*) in Afro-montane forests. *Anim. Conserv* 9: pp 67–74.

Lichstein, J.W.,T.R. Simons, and K.E. Franzreb. (2002). Landscape effects on breeding song-Mann, S.L., R.J. Steidl, and V.M. Dalton. 2002. Effects of cave tours on breeding cavemyotis. *Journal of Wildlife Management* 66, 618–624.

Lunt, I. D. and Spooner, P. G. (2005). Using historical ecology to understand patterns of biodiversity in fragmented agricultural landscapes. Journal of Biogeography, 32, 1859–1873.

Manu S, Peach W, Cresswell W (2007). The effects of edge, fragmentation size and degreeof isolation on avian species richness in highly fragmented forest in West Africa. *Ibis* 149: pp 287–297.

Nicholas, A. and Nyanganji, G. (2001) A Preliminary Socio-economic Survey of Fishing Activity on the River Kam Outside GGNP. Unpublished report to NCF, WWF and GGNP.

Robert J. S. and Brian F. Powell (2006) Assessing the Effects of Human Activities onWildlife. Visitor Impact Monitoring. Vol. 23. Number 2 pp 50-58.

Steidl, R.J., and R.G. Anthony. (2000). Responses of bald eagles to human activity during the summer in interior Alaska. *Ecological Applications* 6, 482–491.

The Nigerian Environmental study/Action Team-NEST (1991) The threatened Environment. A National profile. NEST publication. , Intec printer limited. Ibadan pp. 182-183.

Wuver A. M. and Attuquayefio D. K. (2006). The Impact of Human Activities on Biodiversity Conservation in a Coastal Wetland in Ghana. West Africa Journal of Applied Ecology (WAJAE). Volume 9. Page. 14 www.wajae.org.

SUSTAINABLE HEALTHY FOOD PRODUCTION THROUGH ECO-FRIENDLY AGRICULTURAL PRACTICES

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Abstract
Needful adjustments have to be made if the ever increasing world population is to properly fed with good doses of nutrients. The current food production practices involve the abuse of environmental safety where various qualities and quantities of fertilizer, pesticides, irrigation techniques, equipment and machineries are being used. The involvement of sustainable food production practices presents an hopefor a future of properly fed population. In the context of this study, sustainable healthy food production is considered as securing the availability and accessibility of nutrient filled foods to all members of the society across different generations, with minimal violation of the environment. The various identifiable consequences of the current cultural agricultural practices include; water quality contamination, soil degradation, greenhouse gas emissions, deforestation, agricultural waste production and extinction of some fish species through over fishing and unintended by-catch. Differences were noted across agricultural enterprise and geographical location in the perception of farmers on the various eco-friendly farm practices.Lack of knowledge, low price of harvested food crops, non-availability of labour and lack of knowledge about bio-agent parasites for the control of particular insect pest were leading constraints to farmers adopting eco-friendly agricultural practices. Adequate publicity and campaign on organic farming, agricultural eco-friendly operations, and conversion of sewages and effluents to manure are eco-friendly solutions.

Keywords: *Agricultural practices, Eco-friendly, Food production, Sustainable*

INTRODUCTION

The current world population is fast growing; ensuring a sustainable food production has therefore become a major challengethat requires a collaborative network of several components in order to enhance social, environmental and economic well - being. As the world's population grows, it is expected that the demand for food, timber, fresh water, fuel and cloths will also increase (Food and Agriculture Organization [FAO], 2011). This was observed to account for the inadequate 2.5-3.0 times increase of global agriculture over the last 50 yearswhen compared to global population increase (FAO, 2011).Agriculture and forestry will need to cater to these increasing demands but at the same time minimise the environmental impacts of production (Econation, 2019). Food production is an important area that require effective action, especially when considering an estimated 9.1 billion world population by year 2050 (Eufic, 2015). There is an urgent need for increased production of healthy food to feed the world's growing population since every part of human development is affected by hunger and malnutrition. Increased healthy food production, however must be based on the sustainable use of the increasingly scarceand degraded resources; ensuring that biodiversity and ecosystem activities are carefully protected while supporting the livelihood of the poor. With focus on “green revolutions”, the future should consider guided natural ways and processes for augmenting agricultural productivity, while discontinuing chemical inputs-based intensive technologies (Mishra, 2013).Eufic (2015) stated that sufficient and nutritious foods will have to be produced through cultivating less and unequally accessible farmland area, while water and energy becomes limiting factors. FAO (2011) noted an urgent need to increase agricultural production by an estimate of 70 per cent globally and 100 per cent in developing countries by 2050; in order to keep pace with the population growth and shifting dietary needs across the world population. Farmers use energy, water and other resources to produce food. Moreover, it is also essential to lessen until completely eliminated the emission of Greenhouse Gas (GHG) and other accompanying negative production wastes fromagriculture and food production. A lot of various types of waste are usually generated in the course of producing food.Sustainable food production aims to minimise the negative impacts of waste generated in food production on the environment, prevent resource degradation, increase agricultural production, especially nutrient rich foods. This study therefore aims at;

i. describing sustainable food production
ii. elucidate specific impact of some agricultural and food production practices
iii. identifying the sustainable eco-friendly agricultural practices

MATERIALS AND METHODS

Sustainable Food Production

Considering a target of providing adequate food supplies for future generations, the concept of “food sustainability” is introduced. “Sustainable” brings in the image of a reliable and renewable abundance that will last forever (Alternative Energy Tutorial, 2019).Eufic (2015) and FAO (2011) describe sustainable food production as cultivation methods using processes and systems that are non-polluting, conserve non-renewable energy and natural resources, are economically efficient, are safe for workers, communities and consumers, and donot compromise the needs of the future generations. sustainable food production means more than expanding the food supply. According to Alternative Energy Tutorial (2019), healthy people basically require a healthy and sustainable food system that can provide a nutritious diet for all peoples, while at the same time protecting the capacity of future generations to feed themselves by efficient food resources use. The consumption of nutrient laden food, usually from a variety of food has a reward of encouraging better food production, noting that food stuffs children eat from an early age becomes part of them till older life. This not only has an impact on the health and wellbeing of everyone, but also on the general health of the planet.It also encompasses social, economic and ecological considerations, such as infrastructure, storage, waste reduction and improving and preserving water quality - all of which are critical to achieving global food security (DuPont, 2019).

The production of healthy food can better be advanced through right campaign on correct food consumption across a levels of growth, especially eating varieties of foods. This will not only have effect on the health and well-being of everyone, but also on the general health of the planet. It also encompasses social, economic and ecological considerations, which are critical in achieving global food security (DuPoint, 2019). Some characteristics of sustainable food production system are outlined below:

i. It benefits the environment by maintaining and improving soil quality, reducing soil degradation and erosion and saving water.
ii. It increases biodiversity of the area by providing a variety of organisms with healthy and natural environment to live in, saving water and conserve or enhance biodiversity and eco-system services (Mishra, 2013).
iii. It focuses on producing long-term crops and livestock while minimizing its effect on the environment (study.com, 2019)
iv. It pursues maintaining water quality and supply through keeping harmful contaminants such as pesticides and nitrates out of the water table. This helps to protect the soil, supports crop growth and ensures the continued arability of the land (Byloo, 2011).
v. It attempts to advance renewable energy production and consumption instead of the rather commonly used non-renewable energy from fossils like coal and petroleum. These fossil energy sources contribute the global climate change – which may have catastrophic consequences for agriculture.
vi. It develop better labour practices and social and economic equity. According to Byloo (2011) and Mishra (2013), working towards sustainable agriculture means addressing the socio-economic ills in rural communities to help them thrive and secure their continued vitality. It must in essence be acceptable to the society.

Specific Impact of some Agricultural Practices and Eco-friendly Solutions

The degree of negative environmental impact of crop cultivation and livestock farming relates to the place, method of food production and the local availability of natural resources, such as water and soil. There are frequent trade-offs between environmental factors, and to date there is no simple set of principles to determine if one food product is more environmentally sustainable than another. Eco-friendly agriculture describes landscapes that support both agricultural production and biodiversity conservation, working in harmony together to improve the livelihoods of rural communities (Scherr and McNeely, 2002). The following are some specific impacts of various cultural agricultural practices and solutions;

Water Quality Contamination

Run-off of agrochemicals (pesticides, herbicides and chemical fertilizers) and sewages into various water bodies (aquifers, streams, rivers and lakes) leading to pollution and contamination of both ground and surface waters.

Solution: Appropriate use of fertilizers and pesticides to avoid pollutionof soils and waterways. Entomological practices which include the use of control termite, American bollworm, sucking pests and other insect can be used instead of the chemical options (Mishra, 2013). Organic farming can be practiced while effluents can be reduced (using less water) and applied to farmland as manures.

Soil degradation

This is the effect of soil pollution, soil erosion and nutrient depletion. Econation (2019) noted that in the past 40 years, nearly a third of the world’s arable land has been abandoned because of erosion.

Agricultural practices that remove soil nutrients such as nitrogen, potassium and phosphorus without replenishing them (sometimes termed nutrient mining) contributes to low crop productivity.

Solution: The use of organic farming is effective in improving soil nutrient content over a longterm period, while over grazing and over cultivation are avoided. Eufic (2015) noted that designing energy and water efficient food manufacturing sites, crops and livestock farms can help in check mating the natural resources use.

Greenhouse gas emissions

Modern agricultural procedures and practices are energy demanding - tractor and transport fuel, producing agri-chemicals and storing and processing food all depend on affordable fossil fuels. So there are growing concerns about the carbon impressions of the food sector. Agriculture contributes around 13.5 per cent of global greenhouse gas emissions as a result of cultivation practices and the expansion of agricultural land into forest areas, releasing stored carbon from above and below ground(Econation, 2019). Other contributors to greenhouse emission across different countries of the world are livestock flatulence and fertilizer production(Econation, 2019).

Solution: Agrochemical use can be reduced using organic farming methods, while animal products consumption can be reduced. Increasing the consumption of local, seasonal fresh (unprocessed) produce. Eufic (2015) identified that reducing use of fossil fuels and optimising water use in production will play a significant role ensuring that air quality is maintained and green-house gas emission is reduced

Deforestation

This entails the change in land use from forests lands to arable farm land, there by affecting biodiversity and the world carbon storage.

Solution: Raising effective publicity and awareness on avoidance of deforestation.

Agricultural waste

This is obvious in the runoff of waste water and nutrient rich effluent.

Solution: Effective conversion of agricultural wastes and effluent to compost which is then applied to farm lands.

Over fishing and unintended by-catch

This is a frequent practice in many places where fish stocks have been decimated to the point that fishing is no longer possible.

Solution: Using target fishing techniques to reduce by catch and setting fishing quotas for each type of commercial fish

Other Eco-friendly Agricultural Practices

Generally, eco-friendly agricultural practices are comparatively convenient to implement and assures of great rewards. There are various methods that can ensure that no damage is caused to the environment. The following are some steps that should be considered when considering practicing an eco-friendly agriculture. They include:

i. **Installing Solar Devices in the Farm**: Machineries, tools and equipment are being used to facilitate various agricultural practices. According to Econation (2019) electricity and fossil fuel energy are needed to power this equipment. The best alternative to use is to engage the use of solar panel as alternative source of farm power for equipment operations. This will in no small ways reduce carbon emissions and curb the use of the traditional energy sources.

ii. **Implementing steps for water management**; Irrigation systems especially like the sprinkle and drip irrigation systems ensure that crops are appropriately watered and moisture while preventing water wastage. Econation (2019) noted that it delivers a precise amount of water at the plant's root zone, and also assists the water contractors have a good measurement on quantity of water used for crop cultivation.

iii. **Using a zero-tillage approach:** This tillage method ensures the retention of trapped nutrients, moisture content, soil quality, and trapped carbon, which are essential considerations in crop farming. No-till or decreased tilling options help to avoid disturbing soil which increases healthy organic material and decrease erosion.

iv. **Practicing mulching**: Efforts to retain trapped nutrients, moisture content and soil quality can also include the practice of mulching. Apart from giving visual appeal to the farm, using crop residues, straws, leaves, grass and twigs to cover the top layer of the soil help to cultivate the soil micro-organism and earthworms. This is of a great benefit to soil crop sustenance. While mulching can effectively prevent erosion, the decomposition of the mulching materials adds to the soil nutrients.

v. **Using cover crop residue**: Cover crop or crop residues help to reduce evaporation, increase soil carbon and reduce water contamination.

1. Constraints to Using Eco-friendly Agricultural Practices

Adopting eco-friendly agricultural practices has often met with leading constraints lack of knowledge about bio-agent parasites for the control of particular insect pest, that lack of knowledge about natural enemies of pests present in the crop fieldnon-availability of labour and low price of harvested food crops (Rane, 2016). Gupta, Sharma and Kakran (2003) identified the untimely availability of production technology, high input cost, lack of irrigation facilities andunavailability of finance in time as other important limitations.

A number of restrictions to effective farming operations and adoption of Integrated Pest Management [IPM] practices were identified by Kumari (2012). These constraints include inadequate of knowledge and skills, the strenuous and multifarious nature of IPM practices and inadequate inputs and equipment of IPM were the major constraints reported by the farmers. Fragmented farm size and inadequate of information about recent pest management strategies, extension services, involvement of IPM experts, community participation were also reported by farmers as major limitations. Basanayak, Rajashekhar , Ravindra, Nagesha, Chitannya. and Maheshwar(2013)'s study mentioned lack of knowledge about modern adoption strategies, access to water for irrigation, capital and awareness about climate change scenario as the limitations to the adoption of modern techniques of confronting climate variabilities in the area.

Sound governance of agricultural programmes coupled with proper awareness of soil and water conservation by enhancing the institutional involvement and further crop improvement research could provide a better way forward in agricultural development (Das, 2010).

Pathak, Aggarwal and Singh (2012) noted that there is a need to develop and apply a standard methodology across the board for various studies related to climate change and agriculture. Shashidahra (2012) found that inadequate access to credit was mentioned by respondents as the major constraint to IPM adaptation.Basanayak *et al.* (2013) noted that there isa need to motivate farmers to follow more adaptive strategies based on their experience and also to organize training programs for the farmers about climate resilient technologies that will help them overcome climate change more effectively. Patidar and Singh (2014) suggested that enhanced access to credit, information on climatic and agronomic related issues as well as to markets (input and output) can significantly increase farm-level adaptation.

2. Farmers' Perception Regarding Eco-friendly Farming Practices

Assis and Mohd Ismail (2011) observed that that farmers' attitude is still very undesirable towards organic farming and they are still dependent on conventional practices (i.e. the use of various chemicals) pests and diseases control on farms. Bhadoriya *et al.,* (2011) conducted a study on impact of training programs on adoption of organic farming practices in Morar block of Gwalior district of Madhya Pradesh and reported that only 7.5 per cent of the respondents had high perception in organic farming. This shows a low adoption or organic farming among farmers. Lami and Ali (2013) conducted a study on perception of agro-chemical use and organic farming in Markurdi, Nigeria and concluded that the 56 per cent of the respondents had a positive perception towards organic farming while 38 per cent had a negative perception and 6 per cent were undecided. Even through 58.7 per cent agree that fertilizers and pesticides are effective, with 40 per cent disagreeing and 1.3 per cent undecided, 90.66 per cent agreed that these agrochemicals can damage the environment, 7.3 per cent disagreed and 2 per cent were undecided. Singha and Devi (2013) conducted a study on analysis of factors influencing farmers' knowledge on resource conservation technologies in rice revealed that over half of the respondents had medium level of knowledge about resource conservation practices in rice cultivation followed by low and high levels. Except the practices like seed selection, sowing and transplanting, soil fertility and nutrient management and water management, majority of the respondents had no knowledge on the various recommendations of the remaining five practices related to resource conservation in rice cultivation. Dhenge, Mankar. and Wakle (2014) revealed that over three fourth of the respondents (82.5%) medium level of knowledge, majority of the respondents had 86.7 per cent knowledge about name of the diseases like blast of paddy (Blast of paddy and Bacterial blight) followed by knowledge about names of the two important insect like gall fly and stem borer (85.0%). Indeche and Ondieki-Mwaura (2015) conduct a study to determine level of knowledge on application of sustainable agriculture practices among rice farmers. The results of this study revealed that the knowledge level on sustainable agriculture practices among rice farmers is moderate. Patidar and Patidar (2015) found from their study on perception of farmers towards organic farming that 67% of respondents have positive perception towards organic farming.

CONCLUSION AND RECOMMENDATIONS

The conclusion from this review are as follows:

1. Sustainable healthy food production entails securing the availability and accessibility of foods to all members of the society across different generations.
2. The specific impacts of various cultural agricultural practices are: water quality contamination, soil degradation, greenhouse gas emissions, deforestation, agricultural waste production and extinction of some fish species through over fishing and unintended by-catch.

3. Adequate publicity and awareness creation on organic farming and other agricultural eco-friendly operations, and conversion of sewages and effluents to manure are eco-friendly solutions.
4. Lack of knowledge, low price of harvested food crops, non-availability of labour and lack of knowledge about bio-agent parasites for the control of particular insect pest were leading constraints to farmers adopting eco-friendly agricultural practices.
5. Differences were noted across agricultural enterprise and geographical location in the perception of farmers on the various eco-friendly farm practices.

It is hereby recommended

1. There is an urgent need for developing an robust unconventional agricultural approach that is sustainable, productive and environment-friendly which can be easily adopted by farmers.
2. Adequate financing facility should be made available to farmer cooperatives for practicing eco-friendly farming, and assist them in marketing their organic produce.
3. Adequate and strategic training should be offered to farmers on the various practices of eco-friendly farming by governmental and non-governmental extension agencies.
4. Not expensive consumer friendly technology should be demonstrated to farmers within their communities to give farmers correct positive perception and assist them in adopting these practices.

REFERENCES

Alternative Energy Tutorial. (2019). Sustainable Food Production. Energy Articles. http://www.alternative-energy-tutorials.com/energy-articles/sustainable-food-production.htmlAccessed on Feb 16, 2018

Assis K. and Mohd Ismail H.A. (2011). Knowledge, attitude and practices of farmers towards organic farming. International Journal of Economics Research 2(3): 1-6.

Basanayak, Rajashekhar T., Ravindra S.P., Nagesha L., Chitannya H.S. and Maheshwar K.J. (2013). An analysis of farmer's opinion and their adaptation behavior to climate change in Bidar district. Environment and Ecology 31(3):1300-1302.

Bhadoriya S.K., Yadav M.K., Daipuria O.P. and Chouhan S.V.S. (2011). Impact of training programs on adoption of organic farming practices. Indian Research Journal of Extension Education 11(2): 42-45.

Byloos M. (2011). Planet Matters and More. 5 Important Elements of Sustainable Agriculture. http://planetmattersandmore.com/sustainable-agriculture-2/five-important-elements-of-sustainable-agriculture/Accessed on Feb 16, 2018

Dhenge S.A., Mankar D.M. and Wakle P.K. (2014). knowledge level of farmers about integrated pest management practices of paddy. An International Quaterly Journal on Environmental Sciences 6: 27-33.

DuPont, (2019). http://www.dupont.com/corporate-functions/our-approach/global-challenges/food/articles/solutions- sustainability.html. Accessed on Feb 16, 2018

Econation (2019). Econation for people and planet. Sustainable food production. https://econation.co.nz/sustainable-food-production Accessed on Feb 16, 2018

Eufic (2015). Food production 3/3: A sustainable food supply. https://www.eufic.org/en/food-production/article/food-production-3-3-a-sustainable-food-supplyAccessed on Feb 16, 2018

Food and Agricultural Organization of the United Nation [FAO] (2011) The Future of Food and Farming: Challenges and Choices for Global Sustainability. Final Project Report. London: Government Office for Science.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdfAccessed on Feb 16, 2018

Food and Agriculture Organization [FAO] (2011). *The State of the World's Land and Water Resources For Food and Agriculture: managing systems at risk*. (FAO, Rome and Earthscan, London. 2011)

Gupta D., Sharma S.K. and Kakran M.S. (2003). Constraints in adoption of watershed management technology. Maharashtra Journal of Extension Education 22(2): 86- 89.

Indeche A. and Ondieki-Mwaura F. (2015). Level of knowledge on application of sustainable agriculture practices among rice farmers in Mwea, Kirinyaga county, Kenya. International Journal of Education and Research 3: 313 – 330

Kumari G. (2012). Constraints in Adoption of Integrated Pest Management (IPM) Practices by Rice Growing Farmers of Jammu Division. Indian Research Journal of Extension Education, Special Issue (Volume II).15-17

Lami A Namonu and Abraham E A. (2013). Study on perception of agrochemicals use and organic farming in Makurdi, Benue state, Nigeria. International Journal of Environmental Protection 3(8): 48-52.

Mishra M. (2013). Role of Eco-friendly Agricultural Practices in Indian Agriculture Development. International Journal of Agriculture and Food Science Technology (IJAFST). Vol 4 (2). p5

Pathak H., Aggarwal P.K. and Singh S.D. (2012). Climate change impact, adaptation and mitigation in agriculture: methodology for assessment and applications. Indian Agricultural Research Institute, New Delhi. pp xix + 302.

Patidar, S. and Patidar H. (2015). A study of perception of farmers towards organic farming. International Journal of Application in Engineering and Management 4(3): 269-277.

Patidar S and Singh S. (2014). Analysis of perception and adaptability strategies of the farmers to climate change. Challenge and opportunities for agriculture crop productivity under climate change 21-22 September. JNKVV College of Agriculture Rewa, Madhya Pradesh, India. P171 (182).

Rane S. (2016). A Study on Adoption of Eco-Friendly Farming Practices among Rice Growers of Hanumana Block of Rewa District (M.P). Master's Thesis in Agricultural Extension. Department of Extension Education, College of Agriculture, Rewa 486001, Jawaharlal Nehru Krishi vishwa vidyalaya Jabalpur (M.) Pp

Scherr, S.J. and McNeely J.A. (2002). Reconciling Agriculture and Biodiversity: Policy and Research Challenges of Eco-agriculture. UNDP World Summit on Sustainable Development, Equator Initiative. Pp. 2-3

Shashidhara K.K. (2012). Adoption of Eco-Friendly Technologies by Cotton Growers. Indian Research Journal of Extension Education Special Issue (Volume I).217- 221.

Singha A.K. and Devi Sony. (2013). Analysis of Factors Influencing Farmers' Knowledge on Resource Conservation Technologies (RCTs) in Rice *(Oryza sativa L.*). Cultivation. Journal of Agriculture Science 4(1): 13- 19.

Study.com (2019). http://study.com/academy/lesson/what-is-sustainable-agriculture-definition-benefits-and-issues.htmlAccessed on Feb 16, 2018

Wilson C. (2019). The Swamp. Which Agricultural Practice is Eco-friendly? http://theswamp.media/which-agriculture-practice-is-eco-friendlyAccessed on Feb 16, 2018

PERCEIVED EFFECTS OF CLIMATE CHANGE ON PRODUCTION ACTIVITIES OF ARABLE CROP FARMERS IN OSUN STATE.

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Abstract
The research focuses on the perceived effect of climate change on production activities of arable crop farmers in Osun State. The study described the socio economic characteristics of arable farmers in Osun State, examined the perceived effects of climate change on income generating activities of arable crop farmers, and identified the coping strategies adopted by arable crop farmers in the study area. Multi stage random sampling was used to select 135 arable crop farmers from three purposively selected Local Government in Osun State. Data obtained from respondents through interview schedule was subjected to descriptive and inferential statistics. The result revealed that majority (51.9%) of the respondents were above 50 years, 66.7% were male, 58.8% of the respondents were educated, 52.7% had above 20 years of farming experience while majority (68.9%) had less than 2.5ha of land. 64.4% of the respondents disagreed that their knowledge about climate change affects their farm negatively, 67.4% disagreed that climate change affects their standard of living and farm management while 37.8% of the respondents indicated that their participation in cooperative society and exposure to mass media (36.3%) made them aware of the effects of climate change on Agriculture. Grand mean for the perception statement given as 3.2 shows that respondent's have poor perception of the effects of climate change on their agricultural activities. Reforestation and afforestation ranked 1st (20.7%) among the general coping strategies while multiple cropping (31.2%) was the best indigenous adaptive strategy used by respondents. The study concluded that respondents have poor perception of the effects of climate change on agricultural activities. It was recommended that enlightenment programmes should be organized for farmers on the concept of climate change and various coping and adaptation strategies that can be used by arable crop farmers.

Keywords: *climate change, perceived effect, coping strategies, adaptation strategies, production activities.*

INTRODUCTION

Climate change is perhaps the most serious environmental threat facing mankind worldwide. It affects agriculture for instance in several ways, one of which is its direct effect on food production. Climatic change, which is attributable to natural climate cycle and human activities, has adversely affected agricultural productivity in Africa (Ziervogel *et al*. 2006). As the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent (Zoellick 2009). This results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (UNFCCC, 2007). Farmers in Osun, face prospects of tragic crop failures, reduced agricultural productivity, increased hunger, malnutrition and diseases as a result of their dependant on rainfed agriculture. It is projected that crop yield in Nigeria may fall by 10-20% by 2050 or even up to 50% due to climate change (Jones and Thornton, 2003),

The pattern of the general circulation of the atmosphere which determines the characteristics of global and regional climate will be different from what it is currently. If the current global warming persists unchecked, it may lead to significant changes in global and regional climates (Ayoade, 2010). The anticipated changes include substantial increase in the length of the growing season in the middle and high altitudes, increase in precipitation extremes, giving rise to increase in the occurrences of floods and droughts, as well as loss of biodiversity and rare/valued ecosystems. These will affect agricultural production and land use, with crop pests and diseases being greatly influenced in their incidence, spread and distribution (Mirza, 2002).

It has been well documented that climate change is expected to have a significant impact on the livelihoods of the rural poor in developing countries such as Nigeria (Ndambiri *et. al.*, 2010). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicts that climate change is likely to have a significant effect on agricultural production in many African countries, most especially Nigeria in which Osun State is one of the states where Agriculture is part of their income. Climate variability will increase almost everywhere and its effects will continue to challenge vulnerable people.

Awareness and Coping Strategies on Climate Change

Coping capacity and degree of exposure is related to environmental changes, they are both also related to changes in societal aspects such as land use and cultural practices. This could be at the root of the much talked about poverty alleviation and food security for the vulnerable groups in Osun, who are most at risk when agriculture is stressed by climate change, Leonora *et al* (2013) enumerated that seventeen adaptive strategies were discovered to have been prominent in combating change by rural farmers in Northern Luzon, Philippines but there were only three adaptive strategies which were found to be sometimes adopted. These include rainwater harvesting, the use of drip irrigation water to minimize water loss, and livestock management. Universities and Research Institutes have been involved in the development of a multi-pronged capacity to tackle this imminent danger of climate change, which is slowly eroding the gains of the fight against starvation, hunger and poverty among farming communities in Osun State. Daudu *et al.*, (2014) found that crop rotation practices, planting of early maturing seed, reduced use of chemical fertilizers and changing of crop varieties were the indigenous coping strategies commonly used among women crop farmers in Kogi state, Nigeria. Amongst the coping strategies identified by Codjoe *et al.*, (2013) include the soil fertility strategy, shade management strategy, land preparation strategy, farm size strategy and lining and pegging strategy. Codjoe (2013) also found that cocoa farmers in all the cocoa growing regions in Ghana are much aware of climate change and its impact on their farming activities ranging from the time of planting cocoa to the time of harvesting and drying cocoa beans.

Adaptation strategies are those methods that enable the individual or the community to cope with or adjust to the impacts of the climate in the local areas. Such strategies will include, among others, the adoption of efficient environmental resources management practices such as the planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall declined. They also include the use of technological products that enable the individual to function in the prevailing situation (Nyong *etal*., 2007). Ability of the people to cope with climate change determines their level of food security and livelihood generally.

Some of the coping strategies used by Nigerian farmers against climate change include irrigation, farm enterprise diversification, improved technologies and practices and water harvesting (Awotodunbo, 2012). Indigenous adaptive measures being used by farmers to cushion the harmful effects of climate change include: changes in planting dates, changes in harvesting dates, multiple cropping, intensive manure application, intercropping, expansion of cultivated land area, movement to different site, mixed farming and use of wetland/river valley (e.g. Fadama) (Farauta *et al.*, 2012). Furthermore, in separate studies, the Canada-Nigeria Climate Change Capacity Development project reports (2004) and Farauta *et al.* (2012) put forward the emerging (modern) coping measures being used by farmers including planting of early maturing crops, use of chemicals (herbicides and pesticides) increased use of fertilizers, use of resistant varieties, processing to minimize post-harvest losses, and afforestation. Another study by Adesiji and Obaniyi (2012), showed that farmers use organic fertilizers, use of some plants to control pests, traditional erosion control, changing crop cycle, use of inorganic fertilizer, use of flood resistant rice. Planting maize, fruits and vegetables in mountain region have changed their cropping patterns to suit the climate as well as keep up with demand. Farmers have avoided planting crops that are easily damaged by water in areas prone to flooding. On the other hand, farmers in the mountain region are taking advantage of higher temperature and are trying crops like corn and vegetables. Farmers replaced rice crops with sugarcane so as to cope with uncertain rainfall. Indigenous methods to ensure protection of the environment ranges from offering prayers for good harvest to use of organic fertilizer and pesticides. In Sierra Leone, important indigenous climate change adaptation technologies/strategies include clearing around farm lands, manual fencing of farm and setting of rodent traps, green manure application, mulching, hunting, irrigation, change of farming dates and performance of ancestral ceremony/spiritual invocation among the numerous practices that were adopted by farmers (Morlai *et al*, 2011).
The study of climate change and its effects on income generating activities is necessitated in order to create more awareness among arable crop farmers and to avert losses that are likely to be incurred by these farmers. It also establishes challenges arable farmers face and the strategies they use to cope with them. This helps to establish what the government could do in terms of adaptation strategies and policies to assist arable farmers in this regard. It is against this background that the study is proposed to analyze the effect of climate change on income generating activities of arable farmers and the mitigating strategies used in combating climate

The agriculture sector, especially in Africa countries, has been worst affected by climate change. Hope (2009) indicated that majority of the African population derive their livelihood from agriculture which is the largest economic activity in the continent. Hope (2009) further observed that, in Africa small scale agriculture, which is practiced by many farmers, relies heavily on rainfall for the provision of water for crops and climate change creates havoc for African farmers.

The first theory of climate change contends that human emissions of greenhouse gases, principally carbon dioxide (CO_2), methane, and nitrous oxide, are causing a catastrophic rise in global temperatures (Forster, *et al*., 2007). The mechanism whereby this happens which is the first theory of climate change and is called the enhanced greenhouse effect also known as “Anthropogenic Global Warming (AGW). Energy from the sun travels through space and reaches earth, the earth’s atmosphere is mostly transparent to the incoming sunlight, allowing it to reach the planet’s surface where some of it is absorbed and some is reflected back as heat out into the atmosphere (Ramachandra, 2006). Certain gases in the atmosphere, called "Greenhouse Gases," absorb the outgoing reflected or internal thermal radiation, resulting in Earth's atmosphere becoming warmer.

The second theory of climate change holds that negative feedbacks from biological and chemical processes entirely or almost entirely offset whatever positive feedbacks might be caused by rising CO_2. These processes act as a "global bio-thermostat" keeping temperatures in equilibrium. The scientific literature contains evidence of at least eight such feedbacks, not counting cloud formation (Bast, 2010).

A third theory of climate change postulates that changes in the formation and albedo of clouds create negative feedbacks that cancel out all or nearly all of the warming effect of higher levels of CO_2. This theory is based largely on observational data reported by a series of researchers, rather than computer models as in the case of the AGW theory (Bast, 2010).

The study is therefore targeted at describing the socio economic characteristics of arable farmers in Osun State, examine the perceived effects of climate change on income generating activities of arable crop farmers and identify the coping strategies adopted by arable crop farmers in the study area.

MATERIALS AND METHODS

Multi stage random sampling was used for this study. Three out of the 30 Local Government Areas (LGAs) in Osun State were purposively selected. These Local Governments Areas are Odootin, Ifedayo, and Boluwaduro. Three villages were selected randomly from each Local Government from which fifteen farmers (15) were selected from each village giving a sample size of One hundred and thirty five respondents (135).

The primary data was sourced from the use of interview schedule. Data collected include socio economic characteristics of farmers, status of awareness of climate change and its link among farmers with agriculture, land use practices that could exacerbate climate change, Farmers' coping strategies, and problems encountered in coping with climate change, etc

Primary data obtained from respondents was subjected to descriptive and inferential statistics. The socio-economic characteristics of the respondents were analyzed using descriptive statistics such as frequency counts, mean, charts and graphs percentage.

RESULTS AND DISCUSSION

The result of the analysis of data collected revealed information on the age of the respondents with the majority (51.9%) above 50 years, while 66.7% were male(table 1). This implies that, there is a dominance of the male gender than female in agricultural work. This is corroborated by Akinbile (2010) who noted that 93.8 percent of the farmers were male in a climate change related study in Osun State. The table further reveals that 58.8% of the respondents were educated, 52.7% had above 20years farming experience while majority (68.9%) had less than 2.5ha of land. This assertion corroborates the findings of Ike and Ezeafulukwe (2015) who reported that more than 71% of the farmers had farms ranging from 0.1-2.0 hectares while a small fraction of 28.9% owns farmlands ranging from 2.1 -4.0 hectares.

Table 1: Socio economic characteristics of respondents.

Variables	Frequency	Percentage (%)
Age		
21-30	7	5.2
31-40	20	14.8
41-50	38	28.1
Above 50	50	51.9
Total	135	100.0
Sex		
Male	90	66.7
Female	45	33.3
Total	135	100
Educational level		
No formal Education	56	41.2
Adult Education	4	3.0
Attempted Primary School	2	1.5
Completed Primary School	2	1.5
Attempted Secondary School	16	12.1
Completed Secondary School	22	16.3
Attempted Tertiary	8	5.5
Completed tertiary education	25	18.9
Total	135	100.0
Farming Experience (Year)		
1-5	8	5.9
6-10	11	8.1
11-15	17	12.6
16-20	28	20.7
Above 20	71	52.7
Total	135	100.0
Farm Size (Ha)		
Less than 2.5ha	93	68.9
Between 2.51-5.0ha	36	26.7
Above 5.1ha	6	4.4
Total	135	100.0

Result in table 2 shows that majority (64.4%) of the respondents disagreed that their knowledge about climate change affect their farm negatively, 67.4% disagreed that climate change reduces their farm yield and 57.8% disagreed that climate change affects their income directly while 62.2% disagreed that climate change affects their standard of living, and management of their farms.This suggests that respondents in the study area have low knowledge of the effect of climate change on their agricultural activities. However some of the respondents indicated that their participation in cooperative society(37.8%),exposure to mass media(36.3%), participation in agricultural programs(28.1), frequent contact with extension agents(45.9%) made them aware of the effects of climate change . The grand mean for all the perception statement was 3.2 which concludes that arable farmers are still undergoing some psychological trend of thought about climate change and have not come into a logical conclusion about the real effect of climate change in their income generating activities. This is in conflict with the position of Ayoade (2010) who discovered that climate change has undesirable effects on farming activities and may be a threat to the farming profession if mitigation strategies are not observed.

Table 2: Distribution of respondents according to perceived effect of climate change on income generating activities of arable farmers

SN	Perception Statement	SA F (%)	A F (%)	U F (%)	D F (%)	SD F (%)	Mean Score	Decision
1.	Climate change affects my farm negatively	3(2.2)	1(0.7)	1(0.7)	43(31.9)	87(64.4)	1.4	Disagreed
2.	Effect of climate change has reduced my yield	2(1.5)	1(0.7)	5(3.7)	91(67.4)	36(26.7)	1.8	Disagreed
3	Climate change affect my income directly	3(2.2)	7(5.2)	3(2.2)	78(57.8)	44(32.6)	1.9	Disagreed
4	Climate change affect my standard of living	2(1.5)	9(6.7)	4(3.0)	84(62.2)	36(26.7)	1.9	Disagreed
5	Knowledge of climate change help me to manage my farm	2(1.5)	48(35.6)	14(10.4)	8(59)	63(46.7)	4.2	Disagreed
6	My participation in cooperative society exposed me to climate change	36(26.7)	51(37.8)	16(11.9)	11(8.1)	21(15.6)	3.5	Agreed
7.	My exposure to mass media has made me to have knowledge of climate change which has improved the income from my farm.	49(36.3)	44(32.6)	12(8.9)	22(16.3)	8(5.9)	3.7	Agreed
8.	Participation in agricultural programs made me to be a aware of climate change and has increased my income.	38(28.1)	63(46.7)	21(15.6)	8(5.9)	5(3.7)	3.7	Agreed
9.	Participation in agricultural program has changed my attitude towards climate change and has increased my income.	76(56.8)	33(24.4)	2(1.5)	15(11.1)	9(6.7)	4.1	Agreed
10.	My frequency of contact with extension agent has exposed me to the effects of climate change	55(40.7)	62(45.9)	2(1.5)	2(1.5)	14(10.4)	4.0	Agreed
11.	My level of awareness of climate change has helped me improve on my annual income..	41(30.4)	80.(59.3)	2(1.5)	3(2.2)	9(6.7)	4.0	Agreed
12.	The knowledge of climate change has changed my income for good	64(47.7)	62(45.9)	3(2.29)	3(2.2)	3(2.2)	4.5	Agreed

Source: Field Survey; 2015 Grand Mean: 3.2

Key: 1 = Strongly Agreed, 2 = Agreed 3=Undecided 4 = Disagreed 5 = Strongly Disagreed F= Frequency and Percentages in Parenthesis.

Decision Rule: When GM ≤ 1.5- Strongly Disagreed (SD), When GM is between 3.6-4.5-Agreed, When GM is between 1.6-2.5-Disagreed (D), When GM is between 2.6-3.5-Undecided and When GM >4.5-Strongly Agreed

Table 3 reveals the various coping and adaptive strategies used by the respondents' in order to deal with the issue of climate change. The coping and adaptation strategies are ranked according to the ones that are mostly used in coping with climate change. Reforestation and Afforestation technique ranked 1st with 20.7%, aadjusting/timing of farm operations (Planting Date/Calendar) ranked 2nd with 18.5%, Rainwater Harvest ranked 3rd with 15.6%, while the use of Drip Irrigation ranked 7th with 7.4%.
The table further revealed that 31.1% of the respondents identified multiple cropping as their indigenous adaptive measure to combat climate change which is ranked 1st while 7.4%, ranked 5th identified inter cropping as their indigenous adaptive strategies to combat climate change. This implies that majority of the respondents believed that practicing multiple cropping will be of great advantage.

The study showed that majority of the farmers in the study area perceived that there is an unfavorable effect of climate change on their agricultural production. The study concluded that the effects of climate change is evident in the study area, therefore there is a need to improve on the coping and adaptation strategies of arable farmers, so that their income from farming activities is not jeopardized and their source of livelihood threatened.

Table 3: Distribution of Respondents According to Coping and Adaptive Strategies of Climate Change for Arable Crop Farming

General Adaptive Strategies	Frequency	Percentage (%)	Rank
Rainwater Harvest	21	15.6	3rd
Use of Drip Irrigation	10	7.4	7th
Use of soil moisture conservation measures (e.g. Mulching)	18	13.3	4th
Adjusting/timing of farm operations (Planting Date/Calendar).	25	18.5	2nd
Improved Cultivation techniques and livestock and manure management	15	11.2	6th
Develop Simple Measures for Rapid Harvesting and Post Harvesting.	18	13.3	4th
Reforestation and Afforestation	28	20.7	1st
Total	**135**	**100**	

Table 4: Indigenous Adaptive startegies of climate change

Indigenous Adaptive Strategies of Climate Change			
Change in Planting Dates	31	22.9	3rd
Multiple Cropping	42	31.2	1st
Changes in Harvesting Dates	18	13.3	4th
Intensive Manure Application	34	25.2	2nd
Inter Cropping	10	7.4	5th
Total	**135**	**100.0**	

CONCLUSION AND RECOMMENDATIONS

The study concluded that the effects of climate change is evident in the study area however majority of the farmers in the study area have poor perception of effect of climate change on their agricultural activities therefore there is a need to improve on the coping and adaptation strategies of arable farmers by enlightening farmers on the concept of climate change in order for their income from farming activities not to be jeopardized and their source of livelihood threatened.

It is recommended that Government should provide funds and modern equipment for farmers to improve on the adaptation strategies so as to forestall future events of the effects of climate change on the income generating activities in the study area. Seminars and workshop on climate change should be organized for farmers in order to educate the uneducated ones.

REFERENCES

Adesiji, G. B. and Obaniyi, K. S. (2012). Indigenous knowledge in climate change adaptation strategies among farmers in Kwara State, Nigeria. In *Proceedings of the 17th Annual National Conference AESON*.11 – 14th March, 78-85.

Araya, B. and J.A. Adjaye. (2001):. Adoption for farm level soil conservation practices in Eritrea. Indian Journal of Agricultural Economics, Vol. 56 pp. 239-252.

Awotodunbo, A.A. (2012). Improving climate change coping strategies among crop farmers in Nigeria.In *Proceedings of the 17th Annual National Conference of AESON*.11- 14th March pp61-69.

Ayoade, J. O (2010): Climate Change: Causes, Effects and Solution. Impact of climate change on food security in sub-Saharan Africa.Proceedings of the 14th Annual Symposium of the International Association of Research Scholars and Fellows, IITA, Ibadan pp.7-11.

Bast, J. L. (2010). Seven theories of climate change. Heartland Institute.

Codjoe F. N. Y, C. K. Ocansey, D. O. Boateng , J. Ofori (2013). Climate Change Awareness and Coping Strategies of Cocoa Farmers in Rural Ghana.*Journal of Biology, Agriculture and Healthcare*. Accessed Online on August 03, 2015 from www.iiste.org. Vol.3, No.11,

Daudu, A.K., G.B. Adesiji, B. M. Matanmi, O.D. Olorunfemi and O. Agbana (2014): Awareness of climate change and indigenous coping strategies of women crop farmers in Kogi State, Nigeria. *African Journal On-line*. Vol 13, No 1.

Farauta, B. K., Egbule, C. L., Agwu, A. E., Idrisa, Y. L ., Onyekuru, N. A (2012). FarmersAdaptation Initiatives to the Impact of Climate Change on Agriculture in Northern Nigeria. *Journal of Agricultural Extension*. 16 (1):132-144.

Forster, P., Ramaswamy, V., Artaxo, P., Bernsten, T., Betts, R., Fahey, D. W., and Nganga, J.(2007). Changes in atmospheric constituents and in radiative forcing. Chapter 2, In Climate Change 2007. *The Physical Science Basis.*

Hope, K. R. (2009): Climate Change and Poverty in Africa. *International Journal of Sustainable Development and World Ecology*.Vol. 16 No6 pp 451-461.

IFAD (2000): Annual Report for2000 (www.ifad.org)Intergovernmental Panel on Climate. Change, *Climate Change 2007: The Physical Science Basis* (Cambridge University Press, 2007). http://www.ipcc.ch

Jones, P.G. and Thornton, P.K. (2003). Croppers to livestock keepers: Livelihood transition to 2010 in Africa due to climate change. Global Environmental Change, World Health Organization, Geneva, Switzerland.

Leonora, E. Ngilangil, Samuel O. Olivar and Ma. Liezel A. Ballesil (2013). Farmers' awareness and knowledge on climate change adaptation strategies in Northern Luzon, Philippines. *InternationalScientific Research Journal*, Volume – V, Issue – 3, 2013, ISSN 2094 – 1749.

Maddison, D. (2006) The Perception of an Adaptation to Climate Change in Africa (EEPA): A Discussion paper No. 10. Centre for Environmental Economics and Policy in Africa University of Pretoria, South Africa p 9.

Mirza, M.M. Q. (2002). Global warming and changes in the probability of occurrence of floods in Bangladesh and implications. Global environmental change, 12(2), 127-138.

Morlai, T.A., Mansaray, K., and Vandy, G. (2011).Enhancing agricultural yields by smallholder farmers through integrated climate change adaptation programme inSierra Leone.*Research Paper*, African Technology Policy Studies Network (ATPS), Nairobi, Kenya.

Ndambiri H. K., Ritho C., Mbogoh S.G., Ng'ang'a S. I., Muiruri E. J., Nyangweso P.M., KipsatM. J., Omboto P. I., Ogada J.O, Kefa C., Kubowon P. C. and Cherotwo F. H. (2010): Analysis of Farmers' Perceptions of the Effects of Climate Change in Kenya: the Case of Kyuso District *Journal of Environment and Earth Science*. Vol. 2, No.10, pp 74-83.

Nyong, A., Adesina, F., and Elasha, B.O. (2007). The value of Indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Journal of Mitigation and Adaptation Strategies for Global Change* 12:787-797. Retrieved September 02, 2015, from http//www.springerlink.com.

Ramachandra, T.V. (2006). Solar energy potential assessment using GIS. Energy Education Science and Technology, 18(1/2),101.

Ziervogel G., A. Nyong, B. Osman, C. Conde, S. Cortes, and T. Dowing (2006): Climate variability and change: implications for household food security. Assessments of Impacts and Adaptations to Climate Change (AIACC) Working Paper No. 20, January 2006. The AIACC Project Office, International START Secretariat, Washington DC, USA.

Zoellick, Robert B. A (2008): Climate Smart Future. The Nation Newspapers.Vintage Press Limited, Lagos, Nigeria. p 18.

CLIMATE CHANGE REALITIES IN CERTAIN AREAS OF IBADAN

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Abstract

It is obvious that the heat of climate change is felt everywhere in the world, but more in local communities where little or nothing is known about it and where infrastructure that could aid adaptation might not be sufficiently available, this project therefore investigated the realities of climate change by assessing its indicators (irregular rainfall, drought, heat waves and flooding) in Ido and Northeast local government area of Ibadan in order to create awareness on the need for every individual to be involved in climate change mitigation and adaptation processes. Using a concisely well prepared questionnaire, interviews and personal observations, data were collected, then analyzed through a descriptive statistics and results showed that in Ido local government area, 50%, 35% and 15% of the respondents strongly agree, partially agree and disagree respectively with irregularities in rainfall, 75% strongly agree, 20% partially agree while just 5% disagree with heat waves. On drought, 45%, 35%, and 20% strong agree, partially agree and disagree respectively, while on flooding 20%, 25%, and 55% strongly agree, partially agree and disagree respectively. In the Northeast 90%, 10% and 0% strongly agree, partially agree and disagree respectively with rainfall irregularities, heat waves, 45% strongly agree, 50% partially agree, and 5% disagree, 40%, 55%, 5% strongly agree, partially agree, and disagree respectively with the occurrence of drought, and on flooding, 40% strongly agree, 55% partially agree and 5% disagree, based on this information climate change can be said to be real and its impact becoming more felt, not limited to the study area, this study therefore seeks to encourage the involvement of every individual, stakeholders, academics and relevant government bodies in Climate- smart activities (greening the landscape) for better adaptation in this climate change era.

Keywords: *Climate change, irregular Rain, heat waves, flooding, drought*

INTRODUCTION

Humans from the dawn of time have always been making their living out of the environment, man's activities have been proven deleterious directly or indirectly to the environment, (Mike, 2009) such activities can include farming, timber exploitation, burning of fossil fuels, waste disposal, amongst others, all of which have contributed to environmental menace and challenge of this centuryDole,*et al.*,2011. As human population is rapidly on the increase especially in Africa more impacts of these anthropogenic environmental interferences are being felt in terms of extreme climate events such as heat waves, irregularities in precipitation, drought, flood etc as a result of climate change which is now a global challenge.

Climate change according to Mike 2009, can also be referred to as global warming and it's a situation where the average temperature of the earth's surface is on the rise primarily due to human use of fossil fuels through which carbon dioxide and other green house gases are released into the atmosphere,this heat trapping gases can have a lot of effect such as sea level rise, drought amongst others on the environment. IPCC, 2014 reported that, although certain amounts of these gases are naturally available in the atmosphere yet the atmospheric concentration of C02 did not go beyond 300 parts per million between the onset of human civilization of about 1000 years ago but today is at about 400ppm a height not attained in more than 400,000 years.

This unprecedented change in the Earth's climate has caused a lot of unwantedclimatic events around the globe such as the warming of ocean temperature which is closely associated with stronger and more storms, additional rainfall leading to frequent flooding that exceeds previous bounds for extreme weather events. At the same time, dry spells in between such events also increase and in places where it is not raining, the extra heat dries things out, hence, droughts set in quicker and become more intenseWesterling *et al.,* 2006. Heat waves episode which has contributed to the death of humans and other consequences are becoming unprecedented and diseases such as heat stroke are on the rise Bobb *et al.,* 2014.

More dangerous than heat, are the effects of a warming planet on thewater cycle in which the oceans play an important role as the atmosphere holds about 4% more moisture per 1°F (or7% per 1°C), rise in temperature which leads to increased water vapour (a powerful greenhouse gas) in the atmosphere, influences the rate of precipitation and also intensifies the original warming significantly Trenberth, 2007.

Impact of climate change was reportedly more pronounced in developing nations majorly for lack of proper infrastructures that could have cushioned the effect(IPCC, 2014) and so this study considers it reasonable to assess the occurrence of heatwaves, rainfall irregularities, drought, flooding as indicators of climate change in Ido and northeast local government areas of Ibadan. This study therefore becomes necessary and urgent as the heat of climate change is becoming more felt not just in Africa but also around the wilder world.

MATERIALS AND METHODS

This study was carried out in Ido and Ibadan North-East local government areas, Ido local government headquarters is located in Ido town and it lies between latitude 6′ 45 ′and 9 ′ 45 ′ North of the Equator and longitude 2′ 30′ and 9′ 45 ′ East of Greenwich Meridian while Ibadan Northeast whose headquarters is at Iwo Road lies between latitude 7^o 38′ N to 7^o 44′ N and longitude 3^o 88′E and 3^o 95 E. The study area has tropical wet and dry climate(koppen climate classification) with wet season that extends from March through October and the dry season is within November to February during which a typical west African harmattan is experienced, mean annual rainfall is 1420.06mm, mean maximum and minimum temperature is 26.46C and 21.42C respectively, relative humidity is 74.55%. Ido local government has a population of 103,261 and landmass of 986km^2, northeast has population of 330,399 and 18km^2 landmass. Data were collected through a carefully prepared questionnaire, interview and personal observation and were subjected to analysis using a descriptive statistics.

RESULTS AND DISCUSSION

Rainfall Irregularities

The figures (1 for Ido local government and 2 for Northeast) below showed that climate change realities and indicators were actually in existence in the study area as majority of the respondents agreed that rainfall was indeed untimely, grossly irregular and mostly heavy. Possible reasons according to global analysis is that the amount of water vapor in the atmosphere has increased due to human induced warming and this extra moisture is now readily available to the storm systems thus resulting in heavier rainfall and as the intensity of downpours increases due to this unprecedented warming, the risk of floods is also becoming more pronounced in most places around the world Doocy, S.A. et al 2013 and Duffy *et.al*. 2012. IPCC's 2007 Report also revealed that the higher rate of evaporation has led to occurrences of extreme rain and flooding events in West Africa.

Findings by Intergovernmental Panel on Climate Change (2014) also showed that while heavy precipitation might be experienced in some places others might have reduced rainfall, hence irregularity becomes more pronounced.

Heat waves and Drought

Majority of the respondents also felt the heat and drought and it was observed that people were water stressed even at the onset of dry period. Heat waves are periods of hot weather lasting days to week but in recent years the number of heat waves has been increasing, this according to Ashley *et al.,* 2008 and Bell *et al.,* 2012 was attributed to human induced climate change which has also shifted prolonged multi month extreme heat to the unprecedented extent. It was projected by IPCC, 2013 that summer temperature will continue to rise and thus reduction of soil moisture and extreme heat days was also projected to occur over most of the nations.

Carmago *et al.*,2013 and Christidis *et al.*,2011 also reported in their work that higher temperature has led to increased evaporation rates and this in turn has led to increased loss of moisture through plant leaves and they also found out that even in areas where precipitation does not reduce, increased surface evaporation as well as rapid loss of water from plants has led to more speedy drying of soils.

Flooding

In Ido local government area(figure1) 20%, 25%, and 55% respectively strongly agree, partially agree and disagree and in the Northeast(figure 2) 40% strongly agree, 55% partially agree and 5% disagree. Although it was reported by IPCC, 2013 that global sea levels has risen and it is projected to rise more and that in the next several decades, storm surges and high tides could combine with sea's level rise and land subsistence to further increase flooding for many regions button the contrary larger percentage of respondents in Ido Local Government (figure 1) disagreed and very little disagreed in Northeast(figure2) with occurrence of flooding, possibly because urban flooding might not be totally attributed to climate change but sometimes to poor maintenance of engineering structures (drainage system). Although, NOAA, 2013 and Hoerling *et al.,* 2013 confirmed that urban flooding can be caused by heavy downpour yet the major possible reason was that urbanization creates large area of unreceptive surfaces that might hinder the free flow of runoff which can exceed the capacity of storm drains, thus where drains or drainage systems are very poor, flooding risk might be higher.

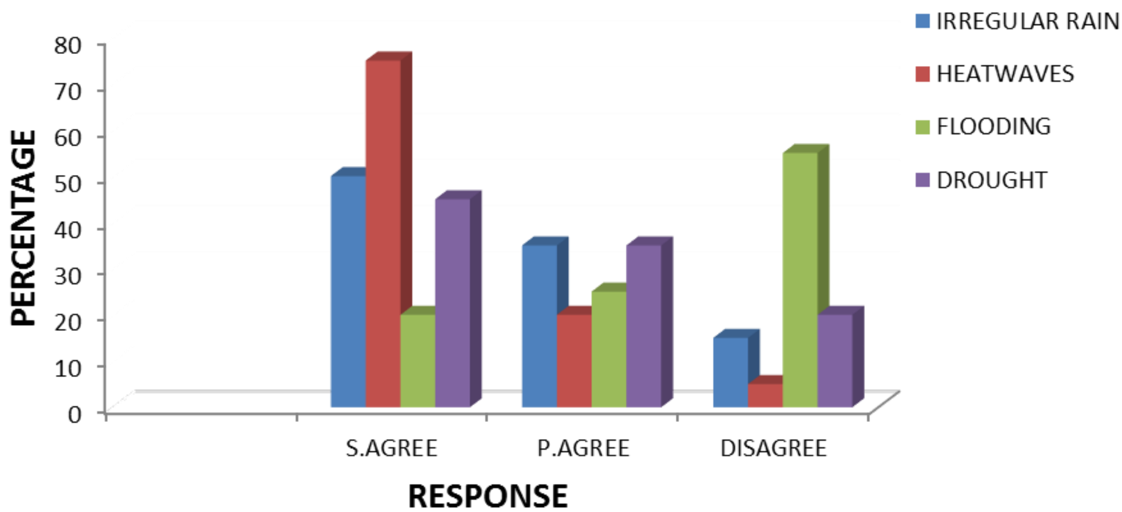

Figure 1: AChart Showing Respondents' Views on Climate Change Indicators inIdo Local Government

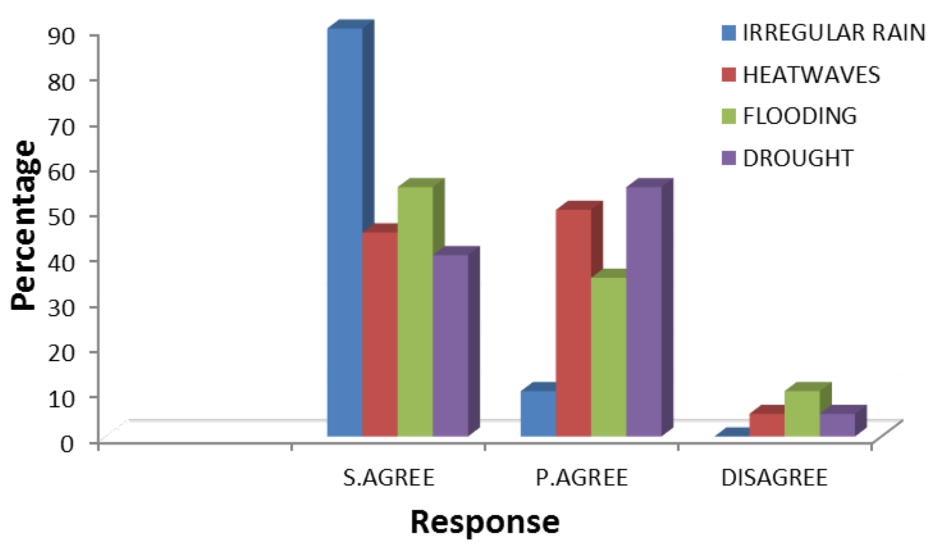

Figure 2: A Chart Showing Respondents' Views on Climate Change Indicators in North East Local Government

CONCLUSION

This study has shown evidence of increasing extreme climate events in the study area as a result of climate change which has caused the warming of our world. There is a need to look into areas of mitigation and adaptation in this era. There is also an urgent need for individuals ,government institutions to be fully engaged in climate -mart practices especially climate-smart Agriculture(a practice that seeks to transform Agriculture under the new realities of climate change i.e. Agriculture that sustainably increases productivity, enhances resilience, reduces or removes GHGS where possible and enhances attainment of national food security and development goals. Indiscriminate dumping of waste should be discouraged in order to avoid blockage of drainage systems that may lead to flooding and there is also a need for rapid reforestation while condemning overexploitation of forest resources.

REFERENCES

Ashley, S. T. and W.S. Ashley, (2008): Flood Fatalities in the United States. Journal of Applied Atlantic Tropical Cyclone Potential Intensity. Climate Dynamics, 40 pp 1515-1529, doi 10.1007/500382-012-1536-4

Bell, G.D.E.S. Blake,C.W. Landesea, T.B., Kimberlin, S.B., Goldenberg,J. Schemm, and R.J. Pasch, (2012): (Tropical Cyclones) Atlantic Basin(in state of the climate in 2011). Bulletin of the American Meteorology Society, 93, S99-S105, doi: 10.1175/2012 BAMS State of the climate .1.

Bobb, J. F., R. D. Peng, M. L. Bell and F. Dominici, (2014): Heat-related mortality and adaptation to heat in the

Carmago, S.J.M. Ting, and Y. Kushnir, (2013): Influence of local and remote SST on North change impacts in United State, Cambridge, University press, 2009.

Christidis, N., P. A. Stott, and S.J. Brown, (2011). The role of human activity in the recent warming of extremely warm daytime temperatures. Journal of climate, 24,1922-1930, doi 10.1175/2011 JCL 14150.1.

Dole , R. *et al.* (2011): Was there a basis for anticipating the 2010 Russian heat wave? *Geophys. Res. Lett*., 38.

Doocy, S.A., Daniel, S. Murray, and T.D. K Irsch, (2013): The human impact of floods; A historical review of events 1980-2009 and systematic literature review. PLOS currents Disasters, doi: 10.1371/.

Duffy P.B. and C. Telbaldi, (2012): Increasing Prevalence of extreme summer temperature in the U.S. climatic change, 111,487-495, doi; 10.1007/510584-012-0396-6.

Hoerling. M.M, Chen, R. Dole, J. Eischeids,A, Kumar, J.W. Nielson-Gammon, P. Pegion,J. Perwitz, X-W. Quan, and T. Zhang, (2013): Anatomy of an Extreme events. Journal of Climate. 26,2811-2832, doi 10:1175/JCLI-D-12-00270.1.increase Western U.S. forest wildfire activity. *Science*, **313**, 940–943.

Intergovernmental Panel on Climate Change 2007a. Climate Change 2007: The physical Science Basis. Working Group iii to the Fourth Assessment Report: 994. Cambridge, UK and New York, USA Cambridge University press.

IPCC Fifth assessment Report, 2014 United States Global Change Research program, global

IPCC, 2013; Summary for policymakers in climate change 2013; The physical Science Basis. Contribution of working Group1 to the fifth Assessment Report of Intergovernmental panel on climate change (Stocker. TFD. Qin, G.K Plattner, M. Tignor,S.K. Allen, J. Boschung, A. Nauels, Y Xia,V.Bex and P.M. Midgley(eds.). Cambridge University Press, Cambridge ,United Kingdom and New York, NY, USA.

Meteorology and Climatology, 47,805-818, doi 10.1175/2007 JAMX1611.1. Bartlett S. 2008, Climate Change and Urban Children. Implications for adaptation in low and middle income countries. Environ. Urban:20, 501-520 (doi: 101177/0956247808096125).

Mike Lockwood, Solar Change and Climate an update in the light of the current exceptional solar minimum. Proceedings of the Royal Society A, 2 December, 2009. Doi 10.1098/rspa.2009.0519

NOAA, (2013): Billion Dollar Weather/Climate Disasters. National Oceanic and Atmospheric Administration.

Trenberth, K. E.(2007): Warmer oceans, stronger hurricanes. *Scientific American*, July, 2007, 45-51.United States. *Environmental Health Perspectives (Online)* **122,** 811.

Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam, (2006): Warming and earlier spring.

THE HEALTH IMPLICATIONS OF WATER, AIR AND SOIL POLLUTION IN NIGERIA.

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Abstract
The presences of significant or abnormally high concentration of natural or artificial constituents at a level that causes undesirable health effects on man has been a national and global issue, humans and all living species in the world are facing. This study considered the history of pollution, water pollution, categories and causes of water pollution, health effects of water pollution. Using secondary literature, different forms of pollutant and their health effects are reviewed.Other aspects this study extensively covered includes air, waterpollution, causes and remediation. The study suggests public enlightenment campaign on the hazards on the different areas of pollution, health educators be employed in all levels of educational institute to teach students on the effects of pollution on healthful living. It recommended that manufacturing companies with harmful pollutant materials and chemicals should not be permitted to establish in residential areas.Further research in this area is advised, particularly in other areas of pollution not covered in this research.

Keywords: *Pollution, Water Pollution, Air Pollution, Soil Pollution, pollutant inventory and Health Effects*

INTRODUCTION

Pollution is the introduction of contaminants into the natural environment that cause adverse change, it can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances, energies or naturally occurring contaminants. Major forms of pollution include water, air, soil contamination, light pollution, littering, noise pollution, plastic pollution, radioactive contamination, thermal pollution and visual pollution. Most people fall sick or even die because of lack of information. While some have the information, nothing is done with the information they have. This paper however focuses on water, air and soil pollution. Water pollution therefore, is the contamination of water bodies, usually as a result of human activities. It include for example lakes, rivers, oceans, aquifers and groundwater, this results when contaminants are introduced into the natural environment. Air pollution occurs when harmful or excessive quantities of substances including gases, particles, and biological molecules are introduced into earth's atmosphere. While Soil contamination or soil pollution as part of land degradation is caused by the presence of xenobiotic chemicals or other alteration in the natural soil environment. This is typically caused by industrial activity, agricultural chemicals, or improper disposal of waste (Gasthoresky, 2018).

MATERIALS AND METHODS

History

Water, air and soil pollution has always accompanied civilisation. Pollution issues escalated as population growth far exceeded viability of neighborhoods to handle the waste problem. Reformers began to demand sewer systems and clean water.Waste water from houses collected in the gutters running alongside the curbs and emitted a truly fearsome smell. There were no public toilets in the streets. Visitors, especially women, often became desperate when nature called, in public buildings the sanitary facilities were unbelievably primitive in countries like Brazil, India, Scotland, and China. The primitive conditions became intolerable and the government brought in its scientists, engineers, and urban planners to not only solve the deficiencies, but to establish a better healthy environment (Bennes, 2015).

Pollution started from prehistoric times,when man created the first fires. On ceilings of prehistoric caves were proofs and ample evidence of the high levels of pollution that was associated with inadequate ventilation of open fires. The burning of coal and wood, and the presence of many horses in concentrated areas made the cities the primary sources of pollution. The Industrial Revolution in 1900 in Berlin brought an infusion of untreated chemicals and wastes into local streams that served as the water supply. It was the industrial revolution that gave birth to environmental pollution as we know it today. The emergence of great factories and consumption of immense quantities of coal gave rise to unprecedented air pollution and the large volume of industrial chemical discharges added to the growing load of untreated human waste. Chicago and Cincinnati were the first two American cities to enact laws ensuring cleaner air in 1881. Pollution became a major issue in the United States in the early twentieth century, as progressive reformers took issue with water pollution caused by bad sanitation, air pollution caused by coal burning, and soil pollution caused by the over 3 million horses who worked in American cities in 1900, generating large quantities of urine and manure. The generation that first saw automobiles replacing the horses saw cars as miracles of cleanliness. By the 1940s, however, smog caused by automobiles became a major issue in Los Angeles and other cities (Martin-Melosi, 1999). Pollution issues have occupied a pride of place in the advanced countries of the world for quite some time. However, Nigeria has only started devoting the required attention to this very important area within the last two decades. Prior to this time, concern for the environment did not go beyond local municipal sanitation matters.

The lack of environmental pollution awareness in Nigeria for so long could be ascribed principally to ignorance on the part of policy makers as well as the general citizenry in whose perceptions, pollution was thought to arise from manufacturing industries alone. Nigeria in the last few years has experienced accelerated development in form of economic growth. One of the major consequences of such growth has been relative shift in favour of urban and rural based environment. In the past, development planning in Nigeria has not given adequate attention to environmental pollution and its management. Many Nigerians still consider the cry to solve environmental problems especially water, air and soil pollution as a voice in the wilderness. The key environmental issues in the Niger Delta of Nigeria relate to its petroleum and industry that witnessed slow poisoning of the waters and the destruction of vegetation and agricultural land by oil spills which occur during petroleum operations. But since the inception of the oil industry in Nigeria, more than twenty-five years ago, there has been no concerned and effective effort on the part of the government, let alone the oil operators, to control environmental problems associated with the industry (Ogundele, 2004).

Water pollution

In the view of Walter and Wallke (2010), water pollution occurs when harmful substances often chemicals or microorganisms contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment. Water, a universal solvent, is uniquely vulnerable to pollution, water is able to dissolve more substances than any other liquid on earth. Toxic substances from farms, towns, and factories readily dissolve into and mix with it, causing water pollution.

Categories of Water Pollution

- **Groundwater**

When rain falls and seeps deep into the earth, filling the cracks, crevices, and porous spaces of an aquifer basically an underground storehouse of water, it becomes groundwater, one of the least visible but most important natural resources. Groundwater gets polluted when contaminants from pesticides and fertilisers from landfills and septic systems make way into an aquifer, rendering it unsafe for human use. Groundwater can also spread contamination far from the original polluting source as it seeps into streams, lakes, and oceans Walter and Wallke (2010).

- **Surface water**

Surface water covers about 70% of the earth, surface water is what fills the oceans, lakes, rivers. According to the most recent surveys on national water quality from the U.S. Environmental Protection Agency (EPA) (2018), nearly half of the rivers and streams and more than 1/3 of the lakes are polluted and unfit for swimming, fishing, and drinking. Nutrient pollution, which includes nitrates and phosphates, is the leading type of contamination in these freshwater sources. While plants and animals need these nutrients to grow, they have become a major pollutant due to farm waste and fertilizer runoff. Municipal and industrial waste discharges contribute their fair share of toxins as well. There is also all the random junk that industry and individuals dump directly into waterways.

- **Ocean water**

About 80% of ocean pollution also called marine pollution originates on land whether along the coast or far inland. Contaminants such as chemicals, nutrients, and heavy metals are carried from farms, factories, and cities by streams and rivers into the bays and estuaries, from there to the sea. Meanwhile, marine debris particularly plastic is blown in by the wind or washed in via storm drains and sewers. The seas are also sometimes spoiled by oil spills and leaks big and are consistently soaking up carbon pollution from the air. The ocean absorbs as much as a quarter of man-made carbon emissionsWalter and Wallke (2010). The most common type of water contamination include agriculture, sewage and waste water, oil pollution and radioactive substances.

Health Effects of Water Pollution

According to WHO (2016), Water pollution is a treat to life, in fact, it caused over 1.8 million deaths in 2015. Contaminated water causes illness. Every year, unsafe water sickens about 1 billion people and low income communities are disproportionately at risk because such homes are often closest to the most polluting industries. Waterborne pathogens, in the form of disease causing bacteria and viruses from human and animal waste, are a major cause of illness from contaminated drinking water. Diseases spread by unsafe water include cholera, giardia, and typhoid. Even in wealthy nations, accidental or illegal releases from sewage treatment facilities, as well as runoff from farms and urban areas, contribute harmful pathogens to waterways.

Air Pollution

Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole. It could also be the presence of one or more contaminants such as moisture, odour, smoke, dust, fumes and gas in quantities and of duration that can be injurious to the health of man, plant and animal. Most air pollution comes from energy use and production. Burning fossil fuels releases gases and chemicals into the air and in an especially destructive feedback loop, air pollution not only contributes to climate change but is also exacerbated by it. Air pollution in the form of carbon dioxide and methane raises the temperature of the earth. Another type of air pollution is then worsened by that increased heat: Smog forms when the weather is warmer and there is more ultraviolet radiation. Climate change also increases the production of allergenic air pollutants including and pollen due to a longer pollen season and more pollen production. Any process that produces substances that are small and light enough to be carried in air, or are gases themselves, can contribute to air pollution. These sources can be natural or man-made and occur all at once or slowly over time. Sources can be localized, such as industrial complexes, or come from multiple producers, such as cars. They can be indoor or outdoor, and even if pollutants are present, this does not mean that they are dangerous to health, such as combustion from industries, transportation emissions, volcano eruptions, forest fire, tobacco smoking and metal smelting as long as they do not exceed safe limits set by organizations such as the U.S. Environmental Protection Agency (Boltken and Keller, 2016).

- **Pollen and mold**

Mold and allergens from trees, weeds, and grass are also carried in the air, are made sever by climate change, and can be hazardous to health. They are not regulated by the government and are less directly connected to human actions, but they can be considered air pollution. When homes, schools, or businesses get water damage, mold can grow and can produce allergenic airborne pollutants. Mold exposure can precipitate asthma attacks or an allergic response, and some molds can even produce toxins that would be dangerous for anyone to inhale. Pollen allergies are worsening because of climate change causing health conditions such as runny noses, fevers, itchy eyes, and other symptoms (Knowlton, 2014).

Health effects of Air Pollution

Smog and soot are the two most prevalent types of air pollution. Smog, or ground level ozone, occurs when emissions from combusting fossil fuels react with sunlight. Soot, or particulate matter, is made up of tiny particles of chemicals, soil, smoke, dust, or allergens, in the form of gas or solids that are carried in the air. This has reduced the distance and clarity of vision by 70%. The sources of smog and soot are similar both come from cars and trucks, factories, power plants, incinerators, engines anything that combusts fossil fuels such as coal, gas, or natural gas. Smog can irritate the eyes and throat and also damage the lungs especially of people who work or exercise outside. It is even worse for people who have asthma or allergies. These extra pollutants only intensify the symptoms and can trigger asthma attacks. The tiniest airborne particles in soot whether in the form of gas or solids are dangerous because they can penetrate the lungs and bloodstream and worsen bronchitis, lead to heart attacks, and death. (WHO, 2017).

There are other hazardous air pollutants that are deadly or have more severe health risks even in small amounts. Some of the most common are mercury, lead, dioxins, and benzene. “These are also most often emitted during gas or coal combustion, incineration. Benzene is found in gasoline and classified as a carcinogen which can cause eye, skin, and lung irritation in the short term and blood disorders in the long term. Dioxins, more typically found in food but also present in small amounts in the air, can affect the liver in the short term and harm the immune, nervous, and endocrine systems, as well as reproductive functions. Lead in large amounts can damage children brains and kidneys, and even in small amounts it can affect Intelligent Quotients of children and ability to learn. Mercury affects the central nervous system (Bennes, 2015).

Land Pollution

In the opinion of Swartz (2016), land pollution is a serious problem that have great impacts on humans, animals and the earth. Without taking measures to reduce pollution levels, permanent changes to the land can occur. The adverse changes to the environment due to land pollution are subtle, however, the problem is much bigger than it appears. Though most people have a general understanding of pollution, the significance of land pollution may not be properly understood. The basic definition of land pollution is the destruction and contamination of the land through the direct and indirect actions of humans. The pollution results in changes to the land, such as soil erosion. Some of the changes are irreversible, while others are not. The effects of land pollution do not necessarily appear overnight. It is the result of long term destruction from human activities. For instance, the damage from chemicals from an oil spill can take months or even years to be fully realised. In the view of Swartz (2016), there are several known causes of land pollution. Of which, there are six factors that contribute more than others which includes:

- **Deforestation and soil erosion**

When forests are cleared for development and to meet the demand for wood supply, the soil is loosened in the process. Without the protection of the trees, the land becomes barren over time and starts to erode.

- **Agricultural chemicals**

Part of the farming process often involves the use of harmful pesticides and insecticides to protect crops. However, the chemicals can cause the land to become barren. The once fertile soil is then more susceptible to environmental elements, such as the wind.

- **Industrialisation**

The Industrial Revolution may have resulted in significant positive changes to the economy and society, but it also led to significant pollution of the land. Through unsafe disposal practices for chemicals used in manufacturing, poor regulation, and the overwhelming number of industries and factories that are polluting the land daily, industrialisation has become one of the main contributors to the pollution problem.

- **Mining**

The mining process can lead to the creation of large open spaces beneath the surface of the earth. This can result in the land caving in, which compromises the integrity of the land. Mining also results in harmful chemicals, such as uranium, being disturbed and released into the environment.

- **Landfills**

The garbage found at landfills is filled with toxins that eventually seep into the earth. During rains, the toxins are washed into other areas and the pollution is spread. As the population grows, the amount of garbage filling landfills also grows.

- **Human sewage**

Untreated human waste can produce toxic gases that can seep into the ground. As with air pollution, the soil quality is negatively impacted, and land nearby can be contaminated. In addition to this, the probability of human illnesses occurring increases.

Health effects of Land Pollution

The contamination of the land has far reaching consequences that can be catastrophic for water, soil and animals. In agreement to Swartz (2016), Campbell and Lemmane (2018) discovered that humans can also experience negative consequences that can influence quality of life and health. There are several possible consequences of land pollution which includes:

- **Ground water poisoning:** Depending on the soil and whether the chemicals were improperly disposed of on the land, the chemicals could end up in the ground water thereby affecting human health. The process is known as leaching. It can occur on farms, industrial sites, and landfills.
- **Water nutrient enrichment:** Chemicals, such as nitrogen, are used frequently on farms. Only a small portion of the nutrients end up benefitting the crops. The remainder usually ends up in water that is populated by fish, algae, and other life forms. The nutrient heavy water saps up most of the oxygen in the water, which leaves little for fish and other life. When this happens, the water is unable to support most life forms.
- **Loss of topsoil:** As chemical fertilizers and pesticides are used to maintain crops, the topsoil composition becomes altered. The soil becomes more susceptible to harmful fungus species dangerous to health and begins to erode. It is important to conserve the soil to maximise land productivity.
- **Shifting habitat:** As deforestation and soil erosion progress, animals are forced to move to find shelter and food. For some animals, the change is too traumatic, and this has led to some dying. As a result, some species are at a greater risk of extinction.
- **Increased risk of wildfires:** The dry conditions created by pollutants in the soil help to create the perfect environment for wildfires. The fires can grow quickly because of the dry conditions and widening area of polluted land.

Some other potential consequences on the health of humans include birth defects, the development of breathing disorders, skin diseases, and cancer. Most of these develop after exposure to waste from water poisoning and soil contamination. Land pollution has also been linked to developmental deficits in children. Chemicals that are commonly found in contaminated soil and water, such as lead, can have impact the cognitive development of children even if the exposure is very low.

Reducing the harmful effect of pollution

There are many things that can be done to reduce the impact of pollution on the environment. If the use of energy, transport and other goods and services are done more carefully, the harmful emissions in the air, land and water will be reduced. Everyday choices have the power to make a difference, and help protect our environment for a clean and sustainable future. The United Nations, Department of Economic and Social Affairs (2014), advised that individuals, industries and the government take the following measures to ameliorate the harmful effect of pollution: **Personal efforts**

Be a part of the solution to pollution. The choices that we make every day can help to make a difference. Here are some simple steps that can be taken:

- Make yourself less vulnerable, reduce personal exposure to ambient air pollution and stay indoors as much as possible.
- Avoid smoking, reduce fireplace use, maintain a hygienic environment and reduce the effective inhaled dose of air pollution.
- Avoid outdoor activity when and where air pollutant levels are higher, reduce exposure in microenvironments near sources such as traffic and walk around with a personal protective equipment-respirators
- Commute smart by walking or riding to work or the shops instead of driving. Motor vehicle emissions remain the most significant source of most common air pollutants. Choose a fuel-efficient vehicle next time you are replacing your car.
- Save energy, by turning off the television and make sure you flick the light switch when you leave the room. Not only will you save money on your electricity bill, you will be reducing emissions from coal-fired electricity plants.
- Buy energy-efficient appliances. Check the energy rating label when buying new or second hand electrical appliances. More stars mean less emissions.
- Use environmentally friendly cleaning products. Phosphorus in detergents increases nutrient loads in rivers and can cause excessive algal growth. Never pour chemicals or fertilisers down the drain as they get washed into storm water drains and into rivers or the ocean.
- These are just a few small changes you can make to reduce your household's impact on the environment.

Efforts of the Industry

Industry can use National Pollutant Inventory NPI data to improve manufacturing processes, and can benchmark their emissions against similar facilities. Annual reporting also assists industry in documenting progress in reducing emissions and provides a measure of current environmental performance. One of the main goals of the NPI is to encourage facilities to use cleaner production techniques to reduce substance emissions and decrease waste. Reporting facilities have the option of reporting on cleaner production activities and pollution control developments that they have undertaken during the reporting year.

Efforts of the Government

Governments can use NPI data to assist with environmental planning and management. NPI data is often used in the preparation of State of the Environment reports, and to support initiatives which help protect the environment. Pollution control is the responsibility of state and territory environment agencies.

CONCLUSION AND RECOMMENDATIONS

The negative consequences of water, air and land pollution can be greatly reduced with the cooperation of every stakeholder, by making conscious effort to contribute to a safer environment, the health and wellbeing of all.

Recommendations

- Public enlightenment campaign on the hazards on the different areas of pollution Should be a priority to all stake holders.
- Health educators should be employed in all levels of educational institute to teach students on the health effects of pollution.
- Manufacturing companies with harmful pollutant materials and chemicals should not be permitted to establish in residential areas.
- Further research in this area is advised, particularly in other areas of pollution not covered in this research.

REFERENCES

Bennes, R.O. (2015). Environmental impacts of uranium mining and milling methods of chemical separation techniques on contaminants.https://www.environmental/pollution/sites/default/files/uraniunmining_chemicals.pdf.002130645 Retrieved, February, 2019.

Boltken, J. and Keller, F. (2018). Environmental science studies. Bell and Howell publishing company. Pp 213-290.

Campbell, R.S and Lemmane, P.P. (2018). Effects of fungicide residues on the physic chemical characteristics of soils of plastic and garbage dump site in Philadelphia. https://www.fungistudy.org/sites/default/files/plastic_garbage/Philadelphia. Retrieved, February, 2019.

Environmental Protection Agency (2018). Artificial pollution and health implications: millennium development goal 2000.

Gasthoresky, L.L. (2018). Economic and health challenges of pollution in North America. https://www.economic/health/pollution/america/books.pdf.221700h56_research. Retrieved, February, 2019. https://www.environmental/science/technology/sites/files/books.pdf.2221700h56 _research. Retrieved, February, 2019. https://www.millenium.goals/2000.org/sites/default/files.pdf0076v55j11111.

Knowlton, G. (2014). Water and air pollution: A treat to human and existence. Van-Noost and Reinhold company New York. Pp 301-365.

Martin-melosi, T. (1999). Environmental science technology. John Willey and Sons publishing house New York. 2nd ed.

Ogundele, B. O. (2004) Problems in health education. Codat publication Ibadan. Pp 9-40. Retrieved, December, 2018.

Retrieved, February, 2019.
Stewart, W. H. (2016). Diarrhoea diseases control and treatment. Environmental health related issues. *America Journal of Tropical medicine and hygiene*. *2(2), 25-40.*
United Nations Department of Economic and Social Affairs. (2014). World Urbanization Prospects: The role of stakeholders in fighting the menace of pollution in the affairs of men.*https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4311076*. *Retrieved 9th April, 2019.*
Walter, K.B. and Wallke, S. (2010). Elemental composition of air pollution and waste water management in a contemporary society. *America Journal of environmental research and health*. *5(3), 76-120.*
World Health Organisation (2016). Drinking clean healthy water: is water life? Geneva. https://www.who/environmental/sci/tech/H20-water/life/pdf.39911700zo.

CLIMATE CHANGE PERCEPTION, MITIGATION AND ADAPTATION STRATEGIES OF FARMERS IN OBAFEMI OWODE LOCAL GOVERNMENT AREA OF OGUN STATE, WESTERN NIGERIA.

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Abstract
This study was conducted to examine the perception of climate change by rural farmers in Obafemi Owode, area of Ogun State and identify the climate change mitigation and adaption strategies they have adopted as responses to climate change effects. A combination of purposive and random sampling techniques was employed in the selection of 180 farmers for questionnaire administration. Primary data on the farmers' socioeconomic characteristics, perception, mitigation and adaptation strategies to climate change were obtained. Data were analyzed using descriptive statistics, frequency tables and a 3-point Likert type scale operation. Results reveal that average farm household size was 8.3 and that the households were mostly headed by males (85%) who were moderately educated (14.8yrs of formal education). Also, an average daily income of 0.6 USD was recorded. Furthermore, although farmers in the area were not aware of the term "climate change", they have a perception of its occurrence and consequences. Majority (61.1%) feel that climate change consequences are a result of normal natural course of events. Results on mitigation and adaptation strategies indicate that farmers are more interested in coping with the situation than reversing or preventing further occurrence. Education is canvassed to assist the farmers in adopting more proactive strategies against climate change. Investments to increase the uptake of more profitable adaptation strategies like improved crop varieties and weather advisory services are canvassed.

Keywords*: Climate Change Perception Mitigation Adaptation Farmers*

INTRODUCTION

Agriculture remains the leading non – oil sector of Nigeria's economy, supporting about 60% of the population directly, hence it was the main – stay of the Nigerian economy (Inusa *et al*., 2016). In the pre-independence era, the contribution of theagricultural sector to the Gross Domestic product (GDP) surpassed every other sector in the economy(Sekumade, 2009). Despiteseveral bottlenecks; it remains a resilient sustainer of the populace since the 1960s. Furthermore, Nigeria was theworld's largest exporter of groundnut, the second largest exporter of cocoa and palm produceand an important exporter of rubber, cotton. More recently, agricultureemploys about two-thirds of Nigeria‟s labour force (Odetola and Etumnu, 2013).Realizing that the best sector to target in poverty eradication measures is the agricultural sector, successive government have been applying measures to help the sector grow (Onuche *et al.*, 2014). Unfortunately, government is handicapped in the face of factors not within the control of humans, the climate for example is unpredictable.

Agriculture in Africa is mostly weather dependent and is highly vulnerable to climate change, most especially during the rainy seasons (Tunde, 2011). The effects of climate change on agricultural production poses great challenges to food security (Elum *et al*, 2017). These effects permeate all activities in agriculture, including fisheries, aquaculture forestry, animal production and crop production. Invariably, climate change poses serious environmental and socioeconomic consequences in Nigeria. Although, the net effects of climate change are mixed depending on the location **(**Tripathi and Mishra, 2017), evidence of climate change in Nigeria is observed to be majorly on the negative side, resulting in environmental refugees, disappearance of some species of flora and fauna, flooding, period, low crop yield and increases in farmer-herder clashes (Sambo, 2010, Ayanlade *et al*., 2017). IFAD (2009) has also alluded to other negative consequences of climate change on livelihood in poor countries. Other climate change consequences include increased rate of ill health, reduction in family income (Tolongbose *et al*, 2010) as well as food insecurity, increased incidence of pest and diseases on plants and animals and men, increased frequency and intensity of heat waves. Environmental disasters such as varying rainfall, hurricanes, rising temperature are evident fall outs of climate change (Tripathi and Mishra, 2017), but global consensus have not been adopted on how to tackle the menace (Sharma, 2015). Locally however, mitigation and adaptation strategies of climate change exist such asland-use planning (ensuring adequate regeneration after harvesting and vigorous growing of trees); volcano monitoring and education of the public, media, decision makers on hazard warning and disaster preparedness. We have been experiencing changes in climate variability such as rising temperatures, variable rainfall, unfavorable harmattan, hurricanes and typhoons, and has almost failed to reach a global consensus on the mitigation of Green House Gas (GHG) emissions (A. Tripathi and A. K. Mishra, 2017).

Agriculture is the sector most affected by climate change because it is estimated that higher temperature could reduce crop yield by 10 - 20% in the sub-Saharan Africa by 2050 (Zenebe, 2018). However, Agriculture is one of the contributors of greenhouse gases to climate change and climate change affects agriculture in return (Tunde, 2011, Zenebe, 2018).Hencethere is need to neutralize adverse effect of climate change in order to avert the socioeconomic disaster waiting to happen (Asrat and Simane, 2018). As such, attempts at various levels have been made to address the challenge. Two broad approaches have been used in response to climate change;mitigation and adaption. While mitigation relates with long term solution to address the scourge by reducing emissions or enhancing the sinks of greenhouse gases, adaptation is concerned with the adjustments in humans or ecosystem elicited in responses to the phenomenon (Elum, 2017, Kongsager *et al*., 2015). Mitigation tackles the causes of climate change while adaptation includes responses to actual stimuli of climate change (Kabani, 2012). Successful adaption reduces vulnerability by building on and strengthening existing coping strategies. Adaptation strategies include minimizing the adverse effect of climate change on livelihood, the economy, health and environment.

In reducing the menace of climate change on agriculture, mitigation and adaptation have to be complimentary (FAO, 2009 Umar, 2014) in order to have a sustained minimization of the impact of climate change. As noted by Musa and Omokore (2011), local populations have developed and implemented indigenous knowledge systems (IKS) to reduce their vulnerability to adverse effect of climate change. This has been based on their perception of the problems. Perception determines the success of adaptation and mitigation strategies. Incorrect perception will lead to wrong steps towards

resolving an issue (Tripathi and Mishra, 2017). The perception of individuals affect climate change believes and invariably, the adoption of mitigation and adaptations strategies (Niles and Muller, 2016).
There is however no information on the way the rural farmers in Obafemi Owode LGA of Ogun State perceive and react to the scourge of climate change. Hence, it was imperative for us to embark on this study. To this end, we raised the following questions: How do the rural farmers in Obafemi Owode local government area of Ogun State perceive climate change? What do they understand to be the cause of observed deviations of weather elements? And what measures do they employ to mitigate and adapt to it? Hence, the following objectives were set in other to achieve the goal of the research; to examine the perception of climate change by farmers as well as to identify the climate mitigation and adaptation strategies in the study area.

MATERIALS AND METHODS

Study Area and Selection of the Study Site

The study was undertaken in the farming communities of Obafemi Owode Local Government Area of Ogun State, South western Nigeria. It has an area of 1, 410 km^2 and a population of 185, 989,640 (National Population Commission, census, 2016). The people are predominantly farmers, most of who engage in the production of arable crops. Obafemi Owode LGA is made up of people residing in Adigbe, Kobape, Ogunmakin, Ajebo, Owode, Oba Erin, Eriti and Ibafo respectively. The average temperature during the dry season and rainy season is 24^0C and 30^0C respectively (Odine *et al*, 2015). The study area is rich in alluvial floodplains, making it suitable for dry season crop production and supports fish farming (Badiru and Olaoye, 2015). Purposive sampling technique was employed in the selection of the local government area owing to the high level of agricultural activities there. Random sampling technique was applied in the selection of three (3) communities- Erin, Eriti and Ibafo, in which 60 farmers (each) were then selected using random sampling technique on a sampling frame obtained from the local government agriculture department. Thus, 180 farmers were selected for questionnaire administration.

Data Collection and Analysis

Primary data on the farmers' socioeconomic characteristics, perception, mitigation and adaptation to climate change were obtained. These data were analyzed using descriptive statistics, frequency tables and a 3- point Likert type scale operation. Adaptation and mitigation strategies listed in the questionnaire were adopted from the IPCC identified measures (2014) for the agricultural sector. Farmers were asked to indicate the extent to which they employ a particular strategy. They were asked to indicate "3" if they were serious with application of a particular strategy; "2" if the application of the strategy is in an "unserious" manner and "1" if they do not apply a strategy at all. Thereafter the total scores were calculated. The means score was arrived at thus:

Mean score ($\ddot{X}$)= $\sum Fx/n$

Where F is the frequency of responses for each degree of seriousness of application of a strategy, x is the scale point of that degree (3, 2 or 1) and n is the sum of frequencies (i.e. total number of respondents, 180 in this case).

RESULTS AND DISCUSSION

Results from Table 1 indicate that farmers in the Local Government Area have average age of 51.4years and hence are aging. The average household size in the area was (8.3) and this was higher than the national average of 6, while the average farm holding per family was found at 1.6ha respectively. With a household size of 8.3, a farm size of 1.62 indicates high level of land fragmentation which is capable of bringing much pressure to bear on land in the future. Such pressure may deplete the canopy level needed to trap greenhouse gases and also discourage afforestation (Fifth Report Session; House of Commons Environmental Audit Committee, 2009). The average education level (14.8 years of formal education) shows that the farmers are moderately educated. Education level can influence perception of phenomena like climate change from the scientific perspective as opposed the influence of poor education which might adduce mystic reasons for climate change. The average income of farmers in the area is estimated at of ₦220 or 0.60 USD (based on 365 naira/dollar) per person per day, signifying a high level of poverty, using global poverty standards. High poverty has implication for climate change in that natural resources especially forests are put under serious pressure in attempt to gather fuel and other livelihood materials. Onuche (2010) established a strong negative correlation between poverty and forest depletion in Nigeria (table 1) below. Socioeconomic characteristics of rural farmers are summarized in Table 1.

Table 1: Summary Statistics of Demographic Variables

Variable	**Mean**	**Sd**	**Minimum**	**Maximum**
Age	51.4	12.60	32	66
Household size	8.3	4.6	3	13
Farm size	1.62	1.09	0.7	5.8
Education of head (years of formal education)	14.8	3.1	3	17
Income	667,110.6	365,755.3	98,000	1,378,000
Sex of household head:	**Male=85% Female15=%**			

Source: Computation from field survey, 2018

The perception of the farmers to climate change is presented in Table 2 below. In a nut shell, all respondents agree that there is something unusual about the climatic condition. Some infer this from a number of options. Increased temperature, fluctuation in yield, excessive rainfall and increased pest infestation were the most prominent evidences of climate change.

Perceived causes of climate change presented in Table 3 indicate that about 5% of farmers in the area attribute the cause of climate change to human activities. A few also hold spiritual forces responsible. The majority (61.1%) however feel that nature is taking its normal course. Ttripathi and Mishra (2017) reported that although farmers India were aware of long-term changes in climatic factors, like temperature and rainfall, they are unable to identify these changes as climate change.

Table 2: Awareness/perception of climate change incidence

I have noticed	**Frequency**	**Percentage**
Flooding/too much rain	113	62.8
Fluctuation in yield	129	71.7
Increased temperature	173	96.1
Drought	65	36.1
Increased pests infestation	106	58.9
Increased disease incidence	76	42.2
Strange pest/diseases	57	31.6

Source: Computation from survey data, 2018. Multiple responses analysed.

Table 3: Perception of causes of climate change

Perception	Frequency	Percentage
Man made	09	5.0
Spiritual	16	8.9
Normal natural occurrence	110	61.1
Can't say	45	25.0

Source: Computation from field survey, 2018.

Adaptation and mitigation strategies employed to tackle the menace in the area are presented in Table 4.

Results of mitigation and adaption strategies from the Likert scale operations on Table 4 indicate that farmers are more interested in coping with the situation than in reversing or preventing it. For instance, while adaptation strategies like change in planting time, change in crop mixes, multiple cropping, soil protection measures scored and change in planting material/varieties scored high points, mitigation measures like reduction in greenhouse gasses (reduction in bush burning), afforestation and reduction in felled trees scored low on the 3-points Likert scale.

Table 4: Adaptation and mitigation strategies of climate change.

Strategy	Total ($\sum FX$)	Mean score ($\ddot{X}$)	Proportion of respondents (%)	Rank
Change in planting time	319	1.77	59.1	1st
Change in crop mixes	294	1.63	54.4	3rd
Soil protection measures (e.g mulching)	276	1.53	51.1	4th
Irrigation	180	1.00	33.3	10th
Multiple cropping	310	1.72	57.4	2nd
No bush burning	187	1.04	34.6	9th
Change in planting materials/varieties	278	1.54	51.5	4th
Change in storage style	236	1.31	43.7	5th
Aforestation	195	1.08	36.1	7th
Reduction in felled trees	190	1.06	35.2	8th
Early harvesting of crops	195	1.08	36.1	7th
Diversification into other trades	205	1.14	38.0	6th

Source: Computation from field survey, 2018.

CONCLUSION AND RECOMMENDATIONS

This study was conducted to examine the perception of climate change by rural farmers in Obafemi Owode in Ogun, southwestern Nigeria, and identify the climate mitigation and adaption strategies they have adopted in response to it. It was revealed that although farmers in the area were moderately educated, they were unaware of the term climate change. They are however familiar with the consequences. Because farmers in the area mostly see the consequences of climate change as naturally occurring outcome, they are more interested in coping with the situation than in reversing or preventing it.

Intense compatible education provided at the level of the farmers will assist in making them familiar with the concept of climate change and as a result, adopt more proactive strategies against it. Increased up take of more profitable adaptation strategies like new varieties and other adaptation strategies is also canvassed. It will be helpful if efforts are made to assist farmers with the financial and technical capacities required to mitigate and adapt to climate change in more profound manner.

REFERENCES

Asif, K. (2012). Migration and Adaptation Strategies;. Climate Change in Global Context. A Presentation assessed 25th January 2019.

Asrat, P. and Simane, B. (2018). Farmers' Perception of Climate Changes and Adaptation Strategies in the Dabus Watershed, North-West Eithopia.Asrat and Simane Ecological Processes (2018) (7)7:1 – 13.

Ayanlade, A, Radeny, M and Morton, J. F (2017). Comparing Smallholder Farmers' Perception of Climate Change with Meteorological Data: A case Study from Southwestern Nigeria. *Weather and Climate Extremes,* Vol. 15: 24 – 33.

Badiru, I. O. and Olaoye, A. D. (2015). Sustainability of the Benefits Derived from Fadama II Critical Ecosystem Management Project in Eriti Watershed of Ogun State. *Journal of Agricultural Extension,* 19(2): 148 – 149.

Elum, A. Z., Modise, D. M. and Marr, A. (2017). Farmer's Perception of Climate Change and Responsive Strategies in Three Selected Provinces of South Africa. *Climate Risk Management*, 16: 246 – 257.

FAO (2009). Coping with a Changing Climate: consideration for adaptation and mitigation in agriculture. Environment and Natural Resources Management Series. Food and Agriculture Organization of the United Nations. http://www.fao.org.

Fifth Report of Sessions 2008 – 09.(2009).Reducing Greenhouse Gas Emission from Deforestation; No Hope with Forest. House of Common Environmental Audit Committee. Page 1.

IFAD (2009). Governing Council Roundtables: Smallholder Agriculture and Food Security in the twenty first century. Rural Poverty Portal.

Inusa, B. M., Daniel, P. C., Dayagal, D. F., and Chiya, N. S. (2018). Nigerian Economic Growth and Recovery: Role of Agriculture. International Journal of Economics and Management Science. 7.2, Open Access. DOI:10.4172/2162-6359.1000512

IPCC, (2014). Climate Change 2014: Synthesis Report. In: Core Writing Team, R.K., Pachauri, L.A., Meyer (Eds.), Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, p. 151.

Musa, M. W. and Omokore, D. F (2011). Reducing Vulnerability and Increasing Resiliency to Climate Change: learning from rural communities. *Journal of Agricultural Extension*. June 15 (1): 1 – 9.

National Population Commission (2016). National Population Census Abuja. Accessed on 4th March 2008.

Niles, M. T. and Mueller, N. D. (2016). Farmer Perceptions of Climate Change: Associations with Observed Temperature and Precipitation Trends, Irrigation and Climate Beliefs. *Global Environmental Change*. 39(2016):133– 142.

Odetola, T and Etumnu, C. (2013). Contribution of Agriculture to Economic Growth in Nigeria: Contributed Paper for the 18th Annual Conference of the African Econometric Society (AES)

Accra, Ghanaat the session organized by the Association for the Advancement of African WomenEconomists (AAAWE). Pages 1 – 28.

Odine, A. I., Ogaji, A., Ibrahim, F. D., Ojo, A. O. and Jibrin, S. (2015). Profitability of Wetland Farming: A Case Study of Eriti Wetland in Ogun State, Nigeria. *International Journal of Development and Sustainability*, 4(6): 772 – 773.

Onuche, U (2010). Impact of Poverty on the Sustainability of Forests in Nigeria: Implication for Sustainable Forests and Reduction in Global Warming. *Journal of Sustainable Development in Africa* (JSDA) vol 12 (6):208-215

Onuche, U, Ayodele, J.T and Audu, S. D (2014). Technical efficiency of women cassava farmers in Yagba West Local Government Area of Kogi State. *International Journal of Agricultural Economics, Management and Development, (IJAEMD),* 4(1): 113-127.

Sambo, M. N. (2010). Climate Change in Kaduna State. Paper presented at Second Lagos State Summit on Climate. 4th May, 2010.

Sekumade, A.B. (2009). The Effects of Petroleum Dependency on Agricultural Trade in Nigeria:An error correlation modeling (ECM)approach. Scientific Research and Essay, Vol. 4 (11). Pages 1385 – 1391.

Sharma, V.K., (2015). Climate change and its impacts: understanding some facts, myths, and controversies. In: Mahendra Dev, S. (Ed.), India Development Report 2015. Oxford University Press, New Delhi, pp. 271–282.

Tolongbose, E. B, Auta, S. J, Bidoli, T. D, Jaliya, M. M, Onu, R. O, and Issa, F. O. (2010). Farmers' Perception of the Effect of Climate Change and Coping Strategies in Three Agro-Ecological Zones of Nigeria. *Journal of Agricultural Extension* 14(1): 125 – 128.

Tripathi, A and Mishra, A. K. (2017). Knowledge and Passive Adaptation to Climate Change: An example from Indian Farmers. *Climate Risk Management*, 16: 195 – 207.

Tunde, A. M. (2011). Perception of Climate Variability on Agriculture and Food Security by Men and Women Farmers in Idanre L.G.A, Ondo State Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 4(2):19 – 20.

Umar, S. (2014). Analysis of Indigenous Coping Strategies against Climate Change for Food Security among Irrigation Farmers in Katsina State in Nigeria. Unpublished Ph.D. thesis, Ahmadu Bello University, Zaria, Nigeria.

Zenebe, M.(2018). Observed and Projected Reciprocate Effects of Agriculture and Climate Change: Implications on Ecosystems and Human Livelihood. Climate Change and Global Warming. Intech Open. Pages 1 – 19.

ANALYSIS OF TECHNICALEFFICIENCY AND ITS DETERMINANTS AMONGIRRIGATEDWATERMELONFARMERS BELONGING TO OGUN-OSUN RIVER BASIN DEVELOPMENT AUTHORITY IN OYO STATE.

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Abstract

This study analyzed the technical efficiencyof watermelon (Citrulus lanatus) farmsand its determinants in Ogun-Osun river basin irrigation scheme, Sepeteri, Saki East Local Government area of Oyo State. An input oriented data envelopment analysis (DEA) was used to estimate technical efficiency scores. Tobit regression analysis was subsequently used to explain the variation in the efficiency scores. The data used in this study were based on direct interview survey of 45 farming households that are members of Water-User Association (WUA) in Ogun-Osun River Basin irrigation project in the 2017/2018 production year. The result showed that the average overall technical efficiency scores of censored watermelon farms were 0.33 and ranges from 0.03 to1.00. From the findings of this study, watermelon farmers could reduce their inputs by 67% and still produce the same level of output. In the second step, the result of the Tobit regression techniques showed that farm size and household size negatively influenced technical efficiency while the farmer's age, years of formal education and frequency of contacts with extension workers showed a positive relationship with efficiency.

Keywords: *Efficiency, data envelopment analysis, Tobit model, Ogun-Osun, watermelon farms.*

INTRODUCTION

The agricultural production system in Nigeria is predominantly rain-fed covering 80% of the cultivated land and accounts for about two-thirds of crop production (IWMI, 2007 and UNESCO, 2014). However, the Nigerian Agriculture is largely uncompetitive in major crops (World Bank, 2014).Statistics shows that Nigeria imports about 6.7% and 63.5% of annual demand for staple food consumption of maize and rice respectively(FMWR, 2014).This leads tosituation of foreign exchange depletion and associated increase in price of food items. With increasing need for food production due to upsurge in the population pressure, land and water resources are the two critical but scarce resources for agricultural development and globally these resources are depleting (CPWF 2007).

The United Nations (2013) reported that the projected increase in world population growth rate which suggests higher food demand is expected in the future with a direct consequence on agricultural water use, compounds the challenges of water scarcity. In addition, as a result of the increased water scarcity and drought due to climate change, extensive water use for irrigation is expected to occur in the context of increasing competition between agriculture and other sectors of the economy (Jimenez *et al.,* 2014).

Land and water are essential inputs for growing biofuels in large quantities with attendant consequence of trade-off as a result of the competition for these two resources between fuel and food crop production (Nhatumbo and Salomao, 2010). Expansion of crop production for biofuels confers greater pressure on fresh water use, with a consequent worsening scenario of water stress especially among the most ‘grabbed’ countries including Nigeria (Gerbens and Hoekstra, 2011).Report of water use assessment for agricultural production in the top 24 ‘grabbed’ countries (Rulli *et al.*, 2013) showed that most ‘grabbed’ countries including Nigeria are located in physical or economic water stress areas. Although, irrigated agriculture plays a vital role in contributing to food security and poverty alleviation (FAO, 2003), water use management is a critical factor in the drive to increase the productivity and efficiency of watermelon production particularly in the southern part of Nigeria.

Watermelon (*Citrullus lanatus*) belongs to the family Cucurbitaceae (Schippers, 2000). It is one of the most widely cultivated crops in the world with global production reaching about 89.9 million metric tons(FAO, 2003). Its origin has been traced to both the Kalahari and Sahara deserts in Africa and Middle East(Jarret *et al.,* 1996) andit was later distributed to other parts of the world (Schippers, 2000).China, Turkey, Iran, Brazil, United States, Egypt and Russian Federation are the major producers of watermelon (FAO, 2010). The crop is widely distributed as a garden crop. However, its cultivation as a commercial vegetable is confined to the drier savanna region of Nigeria (Annons, 2006). It is a horticultural crop (Toth *et al*., 2007) that provides a high return and has relatively low water requirement compared to other crops. It is a good source of vitamins such as vitamins A and C in form of disease fighting beta-carotene. (Wang *et al.,* 2004). Watermelon, which is a traditional food plant in Africa with low calorie (Gyulai *et al.*, 2011), has the potential to improve nutrition, boost food security, foster rural development and support sustainable land cares (NRC, 2008).Watermelon is also known to contain Potassium which is believed to help in the control of blood pressure and prevents stroke and other numerous health challenges. However, the increasing demand for this vegetable fruit does not match its supply particularly in the Southern part of Nigeria largely due to high rainfall covering many months of the year (Musmade and Desai, 2001). Moreover, the available evidence suggests that farmers in the developing countries fail to exploit full potential of a technology and are unable toefficiently allocate resources. The foregoing suggests that demand-supply gap in watermelon production is due to the problem of technical inefficiency.

Watermelon performs better during the dry season under irrigation or residual moisture because excessive humidity in the rainy season affects flowering and encourages the prevalence of pests and diseases. Hence, the need to examine the technical efficiencyamong smallholders’ irrigated farmers in Ogun-Osun public irrigation scheme is critical as it provides useful hints for policy making at national or regional level on how to attain self-sufficiency in the production of watermelon food sub-sector, given the existing production technology.

Literature has been inundated with empirical studies (Agbo *et al.,* 2013; Otunaiya and Adedeji, 2014; Amare *et al.,* 2016 and Bishwagit *et al.,* 2017) on technical efficiency (or inefficiency) and its determinants amongstallholders’ irrigated watermelon farmers using the Stochastic Frontier Approach. Shettima *et al.* (2015) also analyzed the technical efficiency of irrigated vegetable production in Borno State, Nigeria using the Frontier Approach. AlthoughSpeelman *et al.* (2015) and Tolga *et al.* (2009)

analyzedtechnical efficiency using data envelopment analysis, the focus of their studies were mainly mixed (multiple crops) and rice farmers respectively.

Evidence above shows a dearth in knowledgethat this study intends to fill usingthe input-oriented efficiency measure of data envelopment analysis.The novelty of this paper is that it does not only examine the technical efficiency and its determinants among smallholders'irrigation farmers (water users) in the area, it provides useful hints on performance ofRiver Basin Development Authorities' in Nigeria with respect to its farmers'-based irrigation project. This will assist the policy making decision on public irrigation scheme towards achieving the objective of effective water management and food security in Nigeria.

MATERIAL AND METHODS

The study uses a two-step approach. In the first step, the DEA model is used to measure technical efficiencies of farms as an explicit function of output-inputs variables. In the second step, farm specific variables that are assumed to affect the efficiency of studied farms are used in a Tobit regression framework to explain variations in measured efficiencies. A brief description of the R-Sepeteri public irrigation scheme of Ogun-Osun River Basin Development Authority was given in the section that follows.

Brief Description of Ogun-Osun River Basin Development Authority

R-Sepeteri is one of the tributaries of River Ogun. It is one of theproject sites of Ogun-Osun River Basin Development Authority (O-ORBDA) in the South Western Nigeria.The Authority is one of the twelve (12) River Basin Development Authorities established between 1973 and 1984 in Nigeria. It has jurisdiction over the area between Nigeria's border with the Republic of Benin to the West and Sasa River to the East. The area which covers the whole of present day Osun, Oyo, Ogun and Lagos State, has an estimated land area of 66,264 square kilometers. It is drained by two main rivers- Ogun and Osun and a number of tributaries and smaller rivers which include Sasa, Ona, Ibu, Ofiki, Yewa, Igbo-Ijaye and Sepeteri. The headquarters of the authority is located on a 236ha estate along Adabata road, off Ibadan-Abeokuta high way, Abeokuta in Ogun state. It has three area offices located at Oshogbo (Osun state), Ibadan (Oyo state) and Ikeja (Lagos state) as well as a liaison office at Gwarinpa in Abuja.Although O-ORBDA does not engage in direct agricultural production, farming operations are carried out directly by participating farmers (under O-ORBDA water user association) in the farmer-based irrigation project established by the Authority. The scheme is instituted with a view to optimizing both ground and surface water for food production. Under the scheme, group of farmers is settled as irrigated farm plot owners who pay subsidized rates for water releases, tractorization and other inputs supplied to them by the Authority (Ogun Osun River Basin Development Authority, 2013).

Efficiency Measures

The performance of a farm can be evaluated based on different efficiency measures, namely technical, allocative and economic efficiency. This study is limited to the calculation of technical efficiencies. Following Farell (1957), technical efficiency is defined as the ability of a farm to produce the maximum feasible output from a given bundle of inputs or to use minimum feasible amounts of inputs to produce a given level of output. These two definitions of technical efficiency lead to what is respectively known as the ‘output-oriented’ and the ‘input-oriented’ efficiency measure (Coelli *et al.,* 2002; Dhungana *et al.*, 2004; Rodríguez Diaz *et al.,* 2004a; Rodríguez Díaz *et al.*, 2004b). Input-oriented models were chosen in this study because the objective here is not to increase production, but to use different resources more efficiently (Rodríguez Diaz et al., 2004a). Technical efficiency itself can be further decomposed into two components: scale efficiency and pure technical efficiency. The former relates to the most efficient scale of operation in the sense of maximizing average productivity. Pure technical efficiency, however, is obtained when separating the scale effect from the technical efficiency. Thus the efficiency scores obtained in the first stage were used as dependent variable in the second stage of the analysis.

Analytical Techniques

Both the descriptive and inferential statistics were used to analyze the primary data collected at the farm level. These include the descriptive statistics, data envelopment analysis and tobit regression model will be used to analyze the determinants of technical efficiency in the study area.

Descriptive Statistics

The descriptive statistics that were used in this study included the main measure of central tendency-mean and standard deviation as well as the minimum and maximum range to show the distribution of variables in the study area.

Data Envelopment Analysis

Data envelopment analysis (DEA) is a mathematical and linear programming technique which is used to measure the relative efficiency of decision making units (DMUs) with multiple inputs and multiple outputs. DEA is one of several techniques that can be used to calculate a best practice production frontier (Helfand andLevine 2004).Although,the stochastic frontier approach is mostly used in the literature on efficiency measurement, data envelopment analysis has some advantages over the parametric approach. Firstly, because it is nonparametric, it does not require assumptions concerning the functional form for the frontier technology or the distribution of the inefficiency term. Secondly, the approach permits the construction of a surface over the data, which allows a relative comparison of the best production method with the others in terms of a performance index. Furthermore, using DEA, efficiency measures are not significantly affected by small sample size as long as the number of inputs is not too much when compared to sample size.The measure of technical efficiency that Farrell (1957) introduced is an input oriented measure-by how much inputs could be reduced while maintaining the existing level of output. The alternative way in which to consider technical efficiency is an output oriented measure—by how much could output be increased while using the given level of inputs. This approach to measuring technical efficiency yields a relative measure as itassesses the efficiency of a farm relative to all other farms in the sample. Farrell argued that this is more appropriate because it compares a farm's performance with the best actually achieved rather than with some unattainable ideal (Fraser & Cordina 1999).Technical efficiency considers optimal combination of inputs to achieve a given level of output (an input-orientation) or the optimal output that can be produced given a set of inputs (an output orientation).This study is focused on input oriented models, because it assesses the ability of decision-making units to consume the minimum feasible inputs, given the level of outputs that can be obtained. Moreover, the choice of this orientation is also supported when considering the degree of farmers’ control over their resources. Farmers have more control over their inputs than output.

According to Coelli *et al.* (1998), the constant return to scale (CRS) DEA model is only appropriate when all firms are operating at optimal scale. Imperfect competition or constraints on finance may cause a firm not to operate at optimal scale. For this reason, an input-oriented variable return to scale (VRS) DEA model is used to calculate technical efficiency in this study. Although, DEA is deterministic and sensitive to measurement errors and other noise in the data, studies have shown that results from both methods - stochastic frontier and data envelopment analysis are highly correlated (Thiam *et al.*, 2001; Aleue and Zeller, 2005).By allowing for variable return to scale, our measure of technical efficiency can be split into pure technical efficiency and scale efficiency. An input oriented VRS-DEA model is given below for N farms, each producing M output by using k different inputs (Coelli *et al.*, 1998):For thei_{th} farm, inputs and output data are represented by the column vectors X_{i} and Y_{i} respectively. The KxN input matrix, X_{i} and the MxN output matrix, Y represents data for all N farms in the sample. The DEA model to calculate technical efficiency (TE) is represented by the equation below:

$$\mathrm{Min}_{\theta\lambda}\theta,$$

$$\text{Subject to} \quad -\mathrm{y}_{\mathrm{i}} + Y\lambda \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\theta \mathrm{x}_{\mathrm{i}} - X\lambda \geq 0$$

$$N1'\lambda = 1$$

$$\lambda \geq 0$$

Where θ is a scalar, $N1$ is a $Nx1$ vector of ones, and λ is a $Nx1$ vector of constants. This is solved once for each farm, where the value of θ obtained is the technical efficiency score for the i_{th} farm which lie between zero and one with a value of 1 indicating a point on the frontier and thus technically efficient. According to the Farrell (1957) definition. Thus, the linear programming problem needs to be solved N times and a value of θ is provided for each farm in the sample.Because the VRS-DEAmodel is more flexible and envelops the data in a tighter way than the CRS DEA, the VRS DEA efficiency score is equal to or greater than the CRS score. Using the relationship between VRS and CRS DEA scores, the scale efficiency (SE) score for a farm is computed (Dhungana *et al.*, 2004) as:

$$\mathrm{SE}_{\mathrm{i}} = \frac{\mathrm{TE}_{\mathrm{i\,CRS}}}{\mathrm{TE}_{\mathrm{i\,VRS}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where SE= 1 indicates a scale efficient farm that isoperating at a point on CRS, a value SE<1 indicatesscale inefficiency.

Tobit model

After calculating the efficiency measures, the next step is to identify the determinants of efficiency.The DEA efficiency measures obtained in the first stage are the dependent variables in the second stage requiring the analysis ofTobit model. It expresses the relationship between the efficiency measures and suspected correlates of efficiency (Binam *et al.*, 2003; Chavas *et al.*, 2005 and Barnes, 2006). Tobit model is used because the efficiency parameters vary between 0-1 and they are censored variables.These models are also known as truncated or censored regression models (the model is truncated if the observations outside a specified range are totallylost and censored if one can at least observe the exogenous variables) where expected errors do not equal zero. The maximum likelihood estimation technique will be used to estimate the parameters of the model because the ordinary least squares (OLS) estimation technique will give a biased parameter estimate since OLS assumes a normal and homoscedastic distribution of the disturbance and the dependent variable (Amemiya, 1984).The standard Tobit model can be defined as follows:

$y_i^* = x_i^t \beta + u_i$ ……………………………………………………………………………… (3)

Where i = 1, 2… n.

$y_i = y_i^*$ if $y_i^* < 0$

y_i = 0, otherwise and u_i is identically and independently distributed with zero mean and constant variance, x_i^t and β are vectors of explanatory variables and unknown parameters respectively. y_i^* is a latent variable and y_i is the DEA score (Amemiya, 1984).Following Tolga et al. (2009) and Speelman *et al.*(2017), the following explanatory variables as specified in the tobit model include farmers' age, household size, cultivated area, frequency of extension contacts, and years of formal education.

Data and Specification of Variables

The primary data used for this study was collected from a census survey of small scale public irrigation scheme comprising of fourty five members of water users' association in Ogun-Osun River Basin Development Authority situated in Sepeteri, Saki East Local Government area of Oyo state. Structured questionnaireswith oral interview were administered to the respondents. Secondary data was obtained from various articles, publications, journals and official website of Ogun-Osun River Basin Development Authority.One output and six inputs were used in the DEA model. The only output is the watermelon yield per farmer. The inputs are land (ha), chemical cost, fertilizer cost, cost of irrigation/water used, seed costs and total labor used (manhr./farm) in watermelon farming from land preparation through harvest (both family and hired labor).After calculating DEA scores, a Tobit technique was used to determine causes of efficiency/inefficiencies. The explanatory variables used to explain the efficiency/inefficiency of studied farms were farm size, farmers' age, farmer's years of formal education and frequency of extension contacts. Technical efficiency scores were computed using DEA/Stataprogramme.

RESULTS AND DISCUSSION

Analysis of Technical Efficiency

An input-oriented DEA model was used for estimating overall technical, pure technical and scale efficiencies of the irrigated watermelon farms in the study area as shown in the Table 3.The mean values of overall technical, pure technical and scale efficiencies were 0.33, 0.87 and 0.42 respectively. Overall technical efficiency score of watermelon farms in the study area was 0.33.This means that, on average, watermelon farms in the study area could reduce their inputs by 67% and still produce the same level of watermelon output. The splitting of the technical efficiency measures produced estimate of 13% pure technical inefficiency and 54% scale inefficiency (Table 3). However, farms can increase their average technical efficiency from0.33 to 0.87 if only they can overcomeinefficiency due to inappropriate scale of production.

Different returns to scale characteristics were shown in Table 4. Of the 45 farms used in this study, 42 showed increasing returns to scale, 2 showed variable returns to scale and only one farm showed constant returns to scale. This indicates that majority (93.3%) of the farms were not producingat the optimum level. This implies that a unit increase in the current input mix by these farmers will lead to more than proportionate increase in output. Similarly, very few farms (4.4%) are operating at decreasing returns to scale. This implies that any attempt by these farms to further increase the level of the current input-mix will lead to less than proportionate increase in output. In the entire study, only one farm (2.2%) is technically efficient as it operates at optimal level of production. Any deviation from the current production practice by this farm will lead to loss in output or rise in the cost of production given the level of output. Generally, inefficiency exists as a result of either inappropriate scale or misallocation of resources. Inappropriate scale suggests that the farm is not taking advantage of economies of scale, whereas misallocation of resources refers to inefficient input combinations. This study revealed thatsubstantialinefficiency exists largely due to inappropriate scale of production(Oren & Alemdar, 2006). The estimates of the Tobit regression coefficients and marginal effects of the explanatory variables on technical efficiency are shown in table 5.

Table 1. Descriptive statistics of the output and inputs variables used in efficiency analysis

Variables	Unit	Mean	SD	Minimum	Maximum
Output	kg/ha	1690.87	1060.39	306	4309.5
	Kg/farm	2298.67	1605.48	306	6936
Inputs					
Land	ha	1.42	0.965	1	7
Fertilizer	Naira	16144.44	11257.97	1750	64000
Labour	man/hr.	272.16	108.50	60	614
Expenses on seed	Naira	13520	5682.49	7000	33000
Expenses on water	Naira	42255	20650.95	12500	100,000
Expenses on pesticide	Naira	5662.22	6624.28	1800	45000

Source: Field Survey, 2018

Table 2.Descriptive statistics of variables used in efficiency model

Variables	**Mean**	**SD**	**Minimum**	**Maximum**
Farm size	1.42	0.965	1	7
Age	48.80	9.80	28	70
Formal education (years)	10.80	4.96	0	16
Household size	7.00	3.697	1	18
Frequency of ext. contacts	2.80	3.035	0	12

Source: Field Survey, 2018

Table 3. Data envelopment analysis (DEA) scores of technical, scale and pure Technical Efficiencies for watermelon farms

	Mean	SD	Minimum	Maximum
Overall technical efficiency	0.33	0.21	0.03	1
Pure technical efficiency	0.87	0.22	0.35	1
Scale efficiency	0.41	0.29	0.03	1

Source: DEA scores were computed using the DEA/Stata programme

Table 4. Summary of returns to scale results (n=45), (CRS, constant returns to scale; DRS, decreasing returns to scale; IRS, increasing returns to scale).

Characteristics	Frequency	%	Mean farm size (ha)	Mean output (kg/ha)
CRS	1	2.2	1	3094.00
DRS	2	4.4	2	1963.50
IRS	42	93.3	1.4	1644.48

Determinants of Technical Efficiency

In the second stage of this analysis, VRS-DEA efficiency scores were used as the dependent variable while farm specific factors were used as independent variables in the tobit model. Positive coefficient implies increase in efficiency of farm operation while a negative coefficient implies itsdecrease. The result of the efficiency/ inefficiency model is presented in table 5.

It showed the estimated coefficients and marginal effects of explanatory variables specified in the model and their corresponding standard errors. Although all the estimated coefficients and marginal effects of explanatory variables in the model are not significant, their signs are consistent with the expectation.However, the coefficient and marginal effects of farm size is negatively and significantly correlated with VRS-DEA technical efficiency scores. This finding is inconsistent with the expectation.Farmers' age may show both positive and negative effects on technical efficiency depending whether or not older farmers are more experienced and receptive to new ideas and innovation that can improve the technical efficiency. In this study, the estimated coefficient with respect to age of watermelon farmers in the study area is positively correlated with technical efficiency. This implied that older farmers are more experienced, receptive to new ideas and innovation and are therefore technically efficient than younger farmers. As farmers' age advances so does the experience and the effect of error correction factors improves over the years.

Table 5. Tobit regression result of the determinants of technical efficiency

Variables	Coefficients	p-values	Marginal Effects
Constant	1.6350 (0.9665)	-	-
Farm size	-0.3172 (0.0872)*	0.01	-0.3168 (0.0875)
Age	0.0029 (0.0155)		0.0044 (0.0152)
Years of education	0.0037 (0.0211)		0.0023 (0.0208)
Frequency of extension contacts	0.0156 (0.0348)		0.0156 (0.0348)
Household size	-0.0211 (0.0306)		-0.020 (0.0307)
LR chi^2 (6) = 17.16			
Prob. > chi^2 = 0.0087			
Pseudo R^2 = 0.3148			

*N.B: *indicates 1% level of significance. Figures in parenthesis are coefficients of standard errors.*

The estimated coefficient with respect to years of formal educationand frequency of extension contacts of watermelon farmers in the study area are positively correlated with the technical efficiency scores. This showed that educated farmers with higher frequency of contacts with extension workers are more technically efficient than non-formally educated farmers with lower or no contact with extension worker. On the other hand, the estimated coefficient with respect to farm size and household size are negatively correlated with technical efficiency scores. Although the negative sign on the coefficient of farm size ishowever contrary to the expectation, Haji (2006) also reported similar findings. This showed that as farm size increases, the technical efficiency reduces. This may be attributed to the fact that watermelon production is highly labour intensive and this excessive cost expended on labour may neutralize the gain in output due to increased farm size, thus leading to inefficiency.The marginal effect coefficients with respect to years of formal education and age which are positivelycorrelated with technical efficiency are 0.37% and 0.29% respectively. This implied that technical inefficiency will reduce by 0.37% and 0.29% as a result of a unit increase in years of formal education and age of farmers respectively. This is so because educated farmers adopt improved agronomic practices and technology more than non-educated/ illiterate farmers. This finding is consistent with Bifarin *et al.* (2010) and Asogwa *et al.* (2011).The marginal effect of frequency of contacts with extension workers is 0.0156. This implied that inefficiency experienced in the production of watermelon reduces by 1.57% as a result of a unit increase in frequency of extension contact.

On the other hand, the marginal effect of farm size or area of land under cultivation which is negatively correlated with technical efficiency and significant at $p < 0.01$ is 0.317.This implies that technical efficiency will reduce by 31.7% as a result of a unit increase in area of land under cultivation. However, this finding seems inconsistent with the increasing returns to scale for overall technical efficiency found in VRS-DEA outcomes. However, some farm-specific variables could not be included in the model because the sample size is relatively small and this might as well affect the non-significance of the coefficient of the specified variables. Hajj (2006) also reported negative relationship of farm size with technical efficiency. Similarly, the marginal effect of household size is 0.0211 and is negatively correlated with the technical efficiency. This showed that technical inefficiency increases by 2.1% as a result of a unit increase in the number of household size. It is note-worthy of mentioning that as the size of household increases;there is a trade-off between the farmer's need to feed his family and that of optimally allocating farm inputs in the production. This finding is consistent with Dhungana *et al.* (2004) Haji, (2006) and Ibrahim, (2011).

CONCLUSION AND RECOMMENDATIONS

The analysis of technical efficiency revealed that watermelon farms could benefit from the current production technology using the appropriate input mix and increasing the size of their production. On average, majority of studied farms were relatively inefficient with the potential to reduce their inputs by (67%), given the same level ofoutput. Splitting the technical efficiency into pure technical and scale efficiency, it can be concluded that majority of the farms are operating at increasing return to scale. Substantial inefficiency (54%) that occurs in the studied farms is largely due to inappropriate scale of production. The result of the Tobit regression model in the second stage of the analysis indicates what aspect of the studied watermelon farms could be targeted for improved efficiency. The study showed that factors such as farm size and household size negatively influenced technical efficiency, whereas years of formal education, frequency of extension contacts and age of the farmers showed positive relationship with technical efficiency.

Recommendations

From the foregoing, the Federal Ministry of Water Resources and other relevant agencies concerned with the management of fresh water resources such as River Basin Development Authorities (RBDAs) in Nigeria and specifically, the Ogun-Osun River Basin Development Authority in the South West should review the existing policies on irrigation to accommodate increased access to farm land and irrigation water at affordable price. Increasing the number of hectares available for cultivation forwater-users'association (WUA) in the dry season farming is a necessary condition but not sufficient to guarantee optimal production.Farmers should also be provided with technical assistance and training on the best agronomic practice in order to reduce the economic burden of technical inefficiency among watermelon farmers in the study area.

REFERENCES

Agbo, F.M., Ojo, O.O. and Taru, V.B. (2013).Resource Use Efficiency among Fadama Crop Framers in Ibadan/Ibarapa Agricultural zone of Oyo state, Nigeria: A Stochastic Frontier Approach. Journal of Statistical and Econometric Methods, 2 (2) pp 29-38.
agriculture: a meta-analysis. Agricultural Economics 25, 235-243.

Alene, A.D., Zeller, M. (2005). Technology adoption and farmer efficiency in multiple cropsproduction in eastern Ethiopia: A comparison of parametric and non-parametric distance functions. *Agricultural Economics Review* 6, 5-17.

Amare, H., Zeleke, A.,Teku, E.,Dirk, H.,Petra, S. and Simon, L (2016).On-farm Smallholder Irrigation performance in Ethiopia. From water use efficiency to equity and Sustainability. LIVESworking paper 19, Nairobi, Kenya: International Livestock Research Institute.

Amemiya T., (1984). Tobit models: a survey. Journal of Econometrics 24: 3-61.
An analysis of the productivity and Technical efficiency of smallholder irrigation in Ethiopia.Water SA vol. 43 (1).Available online at http: doi.org/10.4314/wsa.v43il.08

Anons (2006). Nasarawa State Agricultural Development Programme, Annual Crop Area and

Asogwa, B.C., Ihemeje, J.C. and Ezehe, J.A.C. (2011). Technical and Allocative EfficiencyAnalysis of Nigerian Rural Farmers: Implication for Poverty Reduction. *Agricultural Journal*, 6(5): 243 - 251.

Barnes, A.P. (2006). Does multi-functionality affect technical efficiency? A non-parametricAnalysis of the Scottish dairy industry. Journal of Environmental Management, 80,287-294.

Bifarin, J. O., Alimi, T., Baruwa, O.I. and Ajewole, O.C. (2009). Determinants of Technical, Allocative and Economic Efficiencies in Plantain (*Musa spp.*) Production Industry, Ondo State, Nigeria. *Proceedings of International Conference on Banana and Plantain in Africa*. Mombasa, Kenya, 8th October, 2008. 199-210.

Binam, J.N., Sylla, K., Diarra, I. and Nyambi, G. (2003). Factors Affecting Technical Efficiencyamong Coffee Farmers in Côte d'Ivoire: Evidence from the Centre West Region. R&DManagement 15, 66-76.

Bishwajit S., Khatun M.A (2017).Technical Efficiency, Determinants and Risks of Watermelon Production in Bangladesh. *IOSR journal of Economics and Finance;* 8 (2) pp 51-59. Also available onlie at www.iosrjournal.org

Chavas, J., Petrie, R. and Roth, M. (2005). Farm household production efficiency: evidence fromthe Gambia. *American Journal of Agricultural Economics* 87, 160-179.

Coelli, T., Rahman, S. and Thirtle, C. (2002). Technical, Allocative, Cost and Scale Efficiencies

Coelli, T., Rao, P.D.S., and Battese, G.E.(1998). An introduction to efficiency and productivity Analysis. Kluwer academic publishers. Boston.

CPWF, (2007). Water for food, water for life: A Compressive assessment of Water management determinants of efficiency of rice (*Oryza sativa*) farms in Mamara region, Turkey. *New*

Dhungana, B.R., Nuthall, P.L. and Nartea, G.V (2004). Measuring the economic inefficiency of Nepalese rice farms using data envelopment analysis. *The Australian Journal ofAgricultural and Resource Economics* 48 (2), 347-369.

Energy Environ. Science. 4, 2658–2668.

FAO (2003).World Agriculture: towards 2015/2030. Summary Report, Rome.

FAO (2010). FAOSTAT. Available online at http://www.faostat.fao.org/site/339/default.aspxFederal Ministry of Water Resources, (2014). The Project for Review and Update of NigeriaNational water Resources Master Plan. Volume 4: National Water Resources Master Plan.

Farrell, M.J. (1957). The measurement of productive efficiency. *Journal of the Royal StatisticalSociety;*Vol.120, pp. 253-281.

Fraser, I., Cordina, D, (1999). An application of data envelopment analysis to irrigated dairyFarms in Northern Victoria, Australia. Agricultural Systems 59, 267-282.

Gerbens-Leenes, W.; Hoekstra, A.Y (2011). The water footprint of biofuel-based transport.

Godswill, M., Regassa, E.W., Seleshi, B.A Fitsum, H., Mekonnen, A. and Matshidisu, K. (2017).

Gyulai G, Toth Z, Bittsanszky A (2011). Medieval Citrullus DNAs-Unlocking domestication Effects (13th and 15th Cent). In Plant Archaeogenetics.Ed.by G Gyullai. Chapter 7.*Nova Science Publisher* Ics., New York, USA.ISBN 978-1-61122-644-7

Haji, J. (2006). Production Efficiency of smallholders' vegetable-dominated Mixed Farming System in Eastern Ethiopia: A non-parametric Approach. *Journal of African Economies* Volume 16(1), pp.1-27.

Helfand S. M., Levine E. S. (2004). Farm size and the determinants of productive efficiency in the Brazilian center-west. Agricultural Economics 31(2-3): 241-249.

in Agriculture. London: Earth scan, and Colombo: International water Management Institute.

in Bangladesh Rice Cultivation: A non-parametric Approach. *Journal of AgriculturalEconomics* 53 (3) 607-627.

International Water Management Institute (2007). Water for Food, Water for Life*:* A Comprehensive Assessment of Water Management in Agriculture; Earthscan: London, UK, 2007.

Jarret B.R.,Bill, R. Tom W. and Garry, A.(1996). Curcubits Gerriplasm Report, Watermelon National Germplasm System, *Agricultural Services* Pp. 29-66, U.S.D.A

Jiménez Cisneros, B.E.; Oki, T.; Arnell, N.W.; Benito, G.; Cogley, J.G.; Döll, P.; Jiang, T.;Mwakalila, S.S. Freshwater resources and Climate Change (2014). Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change;* Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., et al. Eds.; Cambridge University Press: Cambridge, UK and New York, NY, USA, 2014; pp. 229–269.

management in Nigeria Project. World Bank, Washington.

Musmade A.M., Desai U.T.(2001). Cucumber and melon in handbook of vegetables science and technology: Production, Composition,Storage and Processing (eds) Salunkhe, D.K and Kadan, S.S) Marcel dekker, Inc, NY.pp 25-34.

National Research Council (2008). Lost Crops of Africa. Vol. III: Fruits, Washington, D.C.The National Academies Press.

Nhantumbo, I.; Salomao, A. (2010). Biofuels, Land Access and Rural Livelihoods in Mozambique; *Institute for Environment and Development: London, UK, 2010.*

Ogun Osun River Basin Development Authority (2013). Operational Mandates of Ogun Osun River Basin Development Authority. Available on http://www.oorbda.com.ng/home.php

Oren MN, Alemdar T 2006. Technical efficiency analysis of tobacco farming in southeastern Anatolia. *Turkish Journal Agricultural Forestry* 30: 165-172.

Otunaiya, A.O and Adedeji, I.A (2014).Technical Efficiency of Watermelon (*Citrulus lanatus*) production in Ogun State, Nigeria. *International Journal of Agricultural and Apicultural Research,* Faculty of Agricultural Sciences, LAUTECH, Ogbomoso, Nigeria. Volume 10, issue 1and 2), pp. 44-53.

Plateau of North west China. *Agric water Manage.* Vol. 69 pp 29-41

Rodríguez Díaz, J.A., Camacho Poyato, E. and López Luque, R. (2004a). Applying Benchmarking and Data Envelopment Analysis (DEA) Techniques to irrigation districts in Spain. *Irrigation and Drainage 53*, *135-143*.

Rodríguez Díaz, J.A., Camacho Poyato, E., López Luque, R. (2004b). Application of DataEnvelopment Analysis to Studies of Irrigation Efficiency in Andalusia. *Journal ofirrigation and drainage engineering 130, 175-183.*

Rulli, M.C.; Saviori, A.; D'Odorico, P (2013). Global Land and Water Grabbing. *Proc. Natl. Acad. Sci.110*, 892–897.

Schippers R.R, (2000).African Indigenous vegetable: An overview of the cultivated species, N.R/ACO, EU pp 56-60 Chatthan, UK.

Shettima, B.G, Amaza, P. and Iheanacho, A.C (2015).Analysis of technical efficiency of irrigated vegetable production in Borno State, Nigeria. Journal of Agricultural Economics, Environment and Social Science 1(1):88-97.Available online at hhp: www.unimaid.edu.ng/jaaass.

Speelman S., Marijke D'H., Jeroen B and Luc D. H. (2007).Technical Efficiency of water use and its determinants, study at small-scale irrigation schemes in North-West Province, South Africa: *Paper presented for presentation at the 106th Seminar of the EAAE, 25-27 October- Montpellier, France.*

Thiam, A., Bravo-Ureta, B.E. and Rivas, T.E. (2001). Technical efficiency in developing country

Tolga T., Nural Y., Mehmet, N. and Bahattin, C.(2009). Measuring the technical efficiency and

Toth Z, Gyulai G., Szabo Z., Horrath L., and Heszky, L. (2007). Watermelon *(Citrullus lanatus)* Production in Hungary from the middle ages (13th Century).*Hungarian Agric. Resource* Vol.4 pp 14-19.

UNESCO, (2014). Water and Energy: Facts And Figures. World Water Assessment Programme(WWAP). The United Nations World Water Development Report 2014. http://unesdoc.unesco.org/images/0022/002269/226961E.pdf

United Nations Department of Economic and Social Affairs, Population Division (2013). WorldPopulation Prospects*: The 2012 Revision, Volume II, Demographic Profiles (ST/ESA/SER.A/345)*; UnitedNations: New York, NY, USA, 2013.

Wang, Y., Xie ZK, Lim, F., Zhang, Z.(2004). The effect of supplemental irrigation on Watermelon (Citrullus lanatus) production in gravel and sand mulched field in the loess

World Bank (2014). Project Appraisal document on a proposed credit for transforming irrigation Yield Survey (CAYS), Lafia, Nasarawa State.

Zealand Journal of Crop and Horticultural Science vol. 37 pp 121-129.

SOCIO ECONOMIC STATUS OF SMALL SCALE FISHERS AND DIVERSITY OF FISH FAUNA IN ILAJE LOCAL GOVERNMENT AREA OF ONDO STATE

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Abstract

Environmental changes result in either increase or decreases various species of fishesin a particular water body. Fish exhibit enormous diversity in number of size, morphology habitat, biology and behavior hence, fish fauna availability must be access. This study therefore, examined the socio economic status of small scale fishers and diversity of fish fauna in Ilaje Local Government Area of Ondo State, Nigeria. Both primary and secondary data were used. Ilaje Local Government Area was purposively selected because it geographical location along the coast in Ondo State, Nigeria. Ten questionnaire were administered in each of the seven randomly selected fishing villages making a total of seventy (70) small-scale fisherscross-examined in all. The fish fauna diversity was identified at the landing sites of each of the fishing villages according to their taxonomy. Data collected were subjected to descriptive statistics. The result indicated that the small-scale fishers were predominantly male (57%) with family size ranging between 11-20, 53% of whom areilliterateand 83%were married. The results affirmedfishing as the major occupation (86%) of the Ilajes and 90% of the fishers were within the active agerange of 26-55 years. Sixty percent of the respondents made used of active gear, 71% made used of cast nets. This implies that the most of the respondents were still very active. The motive of the fishers is mainly for income generation as attested by 43% of the respondents. Among several economically important fish fauna identified in the study area, Orechromis niloticus, Sardinella eba, Clarias gariepinus were the abundant fish species found in the at the landing sites in the study area.The most preferred species in the study area is Sarotherodon galilaeus(29%), Orechromis niloticus(11%), Auxius rochei (11%) respectively. The study revealed other fish species in the study area, the level of diversity is sparse. It is therefore, recommended that, more efforts should be geared towards the preservation of fishery resources in the coastal area of Ondo State, Nigeria to prevent some fish going into extinction.

Keywords: *Socio Economic Status, Small Scale Fishers, Fish Fauna*

INTRODUCTION

Fishes forms almost half of the total number of vertebrate in both fresh and marine water the largest of species occurs in the tropics. Fish (subphylum vetebrata) can be grouped into two super class which are Agnatha, (jawless vertebrates) and Gnathostomata. It can further be classified into different classes and subclasses , it is recognized as a gill breathing ecothermic (cold blooded), aquatic vertebrate that possesses fins, tail, gills, and muscles and are usually covered with scales (Cleveland *et al.,* 2000). The life span of fish may vary from one year to about 120years.

The distribution of fish in a particular region or habitat is affected by ecological conditions e.g. fishes living in total darkness (or caves), in the fast torrential stream (in mountainous regions), in the swampy conditions, in the slow running shallow or deep rivers; in deep, cold, oligotrophic lakes; in shallow, warmer eutrophic lakes; in the different depths of the oceans (littoral, limnetic, benthic regions), coast e.t.c. (Gupta and Gupta, 2008).

Common fish species in Nigeria Coast are; *Pseudotolithuselongates,Pseudotolithus. senegalensis, Pseudotolithusstypus*,(croaker),*Ethmalosafimbriata (bonga), Illishaafricana (*shad*), Polynemusquadrifilis,Galeoidesdecadactylus, Lutjanusdentatus (snapper), Ariusspp (*marine catfish*), Sardinellaspp, Sphyraenaspp* (barracuda), etc. (Sikoki, 2013).In Nigeria, fishery production industries can be categorized into commercial and artisanal fishing. The commercial and industrial fishing compose of coastal trawling and fauna fishing. The artisanal is divided into coastal canoe fishery, brackish water fishery, fresh water fishery and fish farming or aquaculture. Generally, artisanal productions from coastal and brackish inter in rivers and lakes dominate the activities in Nigeria fishery industries (Ukpabio, 2010).

Fish is highly nutritious with other economic importance giving the opportunity for increase in harvesting with various use of gears and methods. Hence fish fauna availability must be assessed to ensure effect of the abundant of fish migrating (diadromous),abundant of fish species, harvesting gears used, and different species in the study area coast for sustaining yield.The study enumerate fish fauna in the coastal area of Ilaje Local Government Area of Ondo State, Nigeria. Specifically, determined the socio economic characteristics of the respondents; identifying availability of different species of fish fauna in the area; determine fishing gears used for harvesting each species of fish and determine economic importance of fish species to the community

MATERIALS AND METHODS

Study Area

The study area is Ilaje Local Government Area (LGA) in Ondo State, Nigeria. It is situated at the Southern part of Ondo State, Nigeria. The origin of the Ilaje’s could be traced back to Ile-Ife ancestral home of the Yoruba’s in 10th century, they mainly occupy the Atlantic coastline of Ondo State which has an area of 1318km^2 and a population of 290, 615 (2006 Census). Ilaje land is about 75 kilometers from Lagos and it aquatic environment for tourist.Fishing is the major occupation of the Ilajes. This enhanced about 80% of the area being revering and easy access to the sea. The largest fish market in Nigeria is located at the Igbokoda, the Headquater of Ilaje Local Government.

Ilaje Local Government Area has the longest coastline of about 78km in Nigeria with long history in fishing to date. There are several fishing communities located within the river tributaries discharging into the Atlantic Ocean and those along the coastline are the major fish producers. The inhabitants (natives) are the Ilajes’ and are involved in three types of fishery activities; making and selling of fishing gears, harvesting and marketing of fish, fish processing (Ogunlade, 2010).

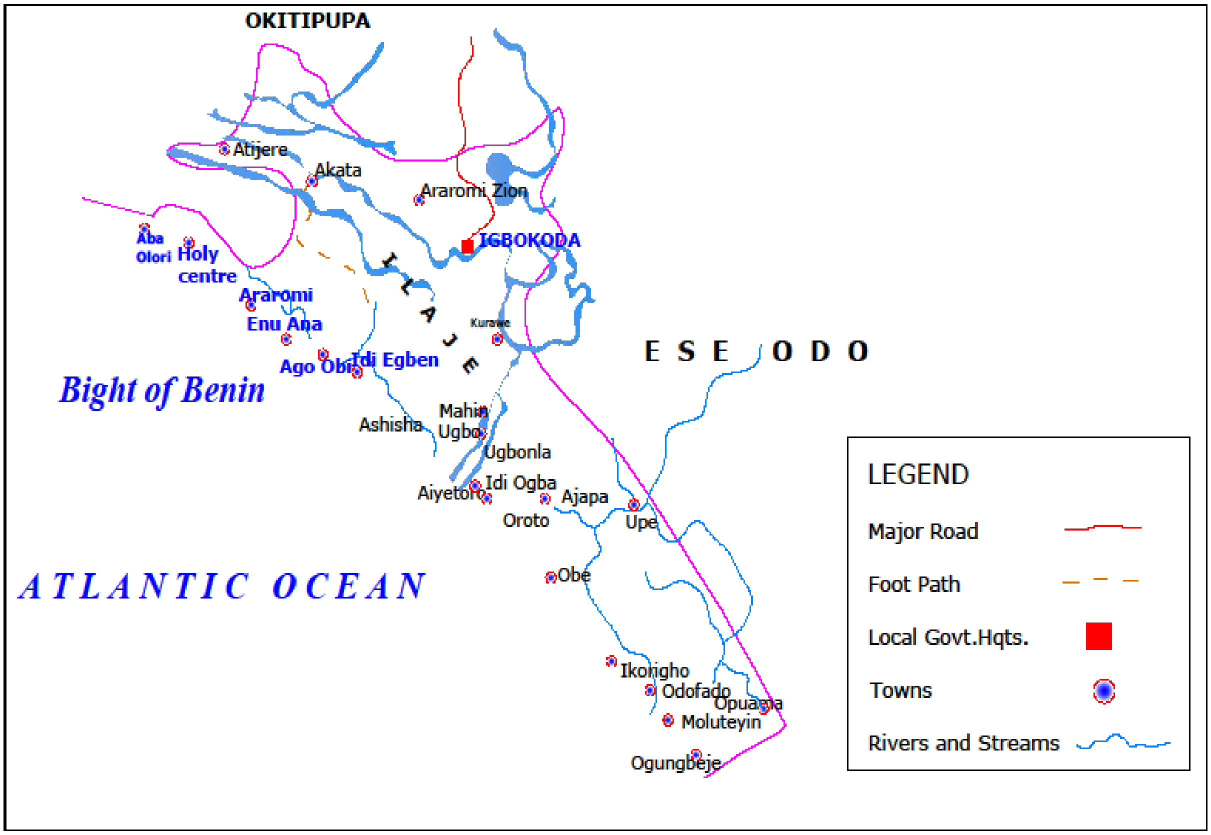

Figure 1: Map of the Study Area (Ilaje Local Government Area, Ondo State).
Source: Online Google Map, accessed 2015.

Data Collection

Primary and secondary data were used in this study. Multistage sampling technique was used to select the study area and sample size (respondents).Visit to the fishing villages was used to complement findings obtained through administration of structured questionnaire. Town and villages that were purposively selected include Igbokoda, Enuama, Idiegben, Araromi, Holy Center, Aba- Olori, and Ago-Obi.

Research was carried out in seven major fishing communities in Ilaje Local Government Area of Ondo State. The site selection was based on the geographic distribution; catch volume and species diversities of the fish catches in the area. Photographs of the gears and various species of fish available in the study area were taken with the use of digital or analog camera (specify the megapixel of the camera used). The fishing gears were subsequently classified into various types(active and passive). Data relating to socio-economic indices of the fisher-folks in the area were obtained with the use of questionnaires, fisher folk were randomly selected from each of the communities. Information relating to sex, age, marital status, educational status, species of fish harvest in different water body, method of fishing, gear types in use, preferred fishing period, size of fishing fleet, economic important of fish were obtained with the use of questionnaire and personal interview. The specific objectives were analyzed descriptively.

RESULTS AND DISCUSSION

Socio -Economic Characteristic of the Respondents

The result of the analysis of data collected on the socioeconomic characteristics of the respondents revealed that 57% of them were male while 43% were female (Figure 2). This implies that more men were involved at various stages of fish production in the study area. This is in variance with the finding of (Olanike *et al.,* 2013) that more female were into fish marketing compare to their male counterparts. The age range between 26-30 years were 6%, 31-35 years were 23%, 36-40 years were 17%, 41-45 years were 37%, 46-50 years were 7%, 51-55 years were 7% and 56- 60 years were 2%. 90% of the fishers were within the active agerange of 26-55 years. Sixty percent of the respondents made used of active gear, 71% made used of cast nets. This implies that the most of the respondents were still very active. This distribution shows that the fisher folks were energetic and were in their working ages, this probably explain the preponderance use of active gears in the study area. This support the findings of Inoni and Oyaide (2007) that active men were predominant in artisanal fishing in the Southern region of Nigeria.

Eighty percent of the fishers were married while only 20% were single. The implication of this is that most of the fishers in the study area were family men and women and are responsible to take care of their households. The percentage of those that were educated were 47% while those without any form of education were 53%. Though, 80% of the educated fisher had primary school education. The result is in line with the study of Adeleke, 2013; which affirmed that most (96%) of the respondents in the coastal area of Ondo state had one form of education or the other because education is paramount to Ondo State Government since the creation of the state in 1976. Family sizes of 11-20 members have the highest percentage (66%)(Figure 3). This implies that most of the respondents keep large family sizes. It might be due to the fact that, the campaign of family planning is not widely spread among the dwellers on the coast or the fishers might find no relevance in keeping small household sizes compare to their counterpart in the cities. Hence, there should be sensitization and government should intensify action on this subject matter especially in the coastal area of the State where 86% of the respondents took fishing as the only occupation and a way of life (Adeleke *et al.,* 2013).

Table 1: Socio -Economic Characteristic of the Respondents

Marital status	Percentage	Cumulative percent
Single	17.0	17.0
Married	83.0	100.0
Educational status	**Percentage**	**Cumulative percent**
Educated	47.0	47.0
Not Educated	53.0	100.0
Level of Education	**Percentage**	**Cumulative Percent**
Primary school	80.0	80.0
Secondary school	16.0	96.0
Polytechnic	4.0	100.0
Main occupation	**Percentage**	**Cumulative percent**
Fishing	85.7	85.7
Fish marketer	14.3	100.0
Additional Occupation	**Percentage**	**Cumulative percent**
None	79.0	79.0
Furniture	11.0	90.0
Hairdresser	6.0	96.0
Student	4.0	100
Age Distribution (Range)	**Percentage**	**Cumulative Percent**
26-30	6	6
31-35	23	29
36-40	17	46
41-45	37	83
46-50	7	90
51-55	7	97
56-60	3	100
Total	**100**	**100**

Source: Computed Field Survey, 2015

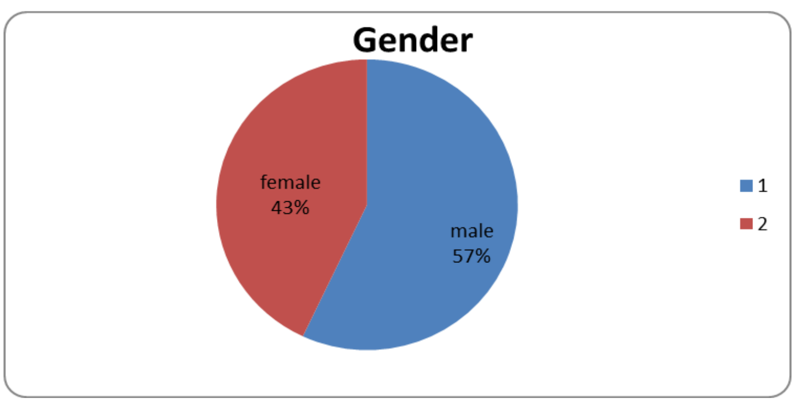

Figure 2: Gender Distribution of the respondents

Source: Computed Field Survey, 2015

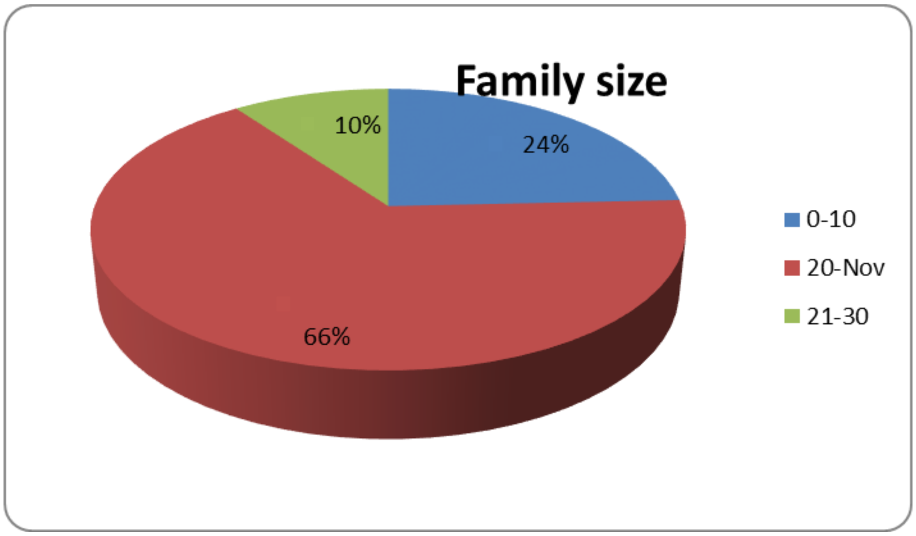

Figure 3: Distribution of the respondents by Family sizes
Source: Computed Field Survey, 2015.

Different Species of Fish Fauna and Fishing Gears in the Study Area

The type of water bodies and various species of fishes landed during the course of the study in the area were revealed (Table 2). The respondents emphasized the fact that species of fish fauna were mostly altered by fishing effort. Nevertheless, the most abundant species found as at the time of study were *Orechromis niloticus*(23%),*Sarotherodon galilaeus*(17%),*Sardinella eba* (16%),*Penaeus species*(13%) among others.The fish abundance was determine by physical identification/taxonomy and counting. The most preferred species in the study area is *Sarotherodon galilaeus*(29%), *Orechromis niloticus*(11%),*Auxius rochei* (11%) respectively. Through the discussion session, it was ascertained that, abundance of fish species could be determined by the period of reproduction. For example; *Sardinella eba* and *Axius rocheic* are more abundant between the month of August to December, *Monododattylus sebae*are more abundant in February and December. *Ethmalosa fimbriata* are more abundant during October to December, and *Cynoglossus senegalensis* around June to July. You need one or two literatures to support this paragraph.

The result also revealed the preponderance use of active gears (60%) of the respondents in the study area. The gear used by fisher folks across the study location were: cast nets (71%),trap nets (14%) and set nets/trammel nets (11%)(Figure 4). Cast net was the most frequently used in the area and effective in catching Tilapia species and mostly used for the pelagic species of fish. Cast net have high efficiency of fish catching compare to other nets as presented by the respondents in the study area. Set net were used for catching of *Clarias gariepinus, Hetrotis niloticus, Polydactylus quadrifilis* and some pelagic species. Fyke net (cast net) were used in catching shrimps and some pelagic species.

Table 2: Abundance of diverse Species of Fish Fauna in the Study Area

Water body	**Frequency**	**Percentage**	**Cumulative percent**
Fresh water	31	44.3	44.3
Marine water	39	55.7	100.0
Total	70	100.0	
Most abundant species	**Frequency**	**Percentage**	**Cumulative Percent**
Sarotherodon galilaeus	12	17.1	17.1
Sarotherodon species	8	11.4	28.5
Sardinella eba	11	15.7	44.2
Orechromis niloticus	16	22.9	67.1
Chloroscobrus chrysurus	4	5.7	72.8
Clarias gariepinus	3	4.3	77.1
Penaeus species	9	12.8	89.9
Auxius rochei	3	4.3	94.2
Odiya spp	2	2.9	97.1
Heterobranchus bidosalis	2	2.9	100.0
Total	70	100.0	
Preferred species	**Frequency**	**Percentage**	**Cumulative Percent**
Sarotherodon species	12	17.1	17.1
Sarotherodon galilaeus	20	28.6	45.7
Orechromis niloticus	8	11.4	57.1
Sardinella eba	7	10.0	67.1
Penaeus species	4	5.7	72.8
Gymnarchus niloticus	5	7.1	79.9
Auxius rochei	8	11.4	91.3
Pomadasys jubelini	6	8.7	100.0
Total	70	100.0	
Method of capturing	**Frequency**	**Percentage**	**Cumulative Percent**
Active	42	60.0	60.0
Passive	10	14 .3	74.3
Both	18	25.7	100.0
Total	**70**	**100.0**	

Source: Computed Field Survey, 2015

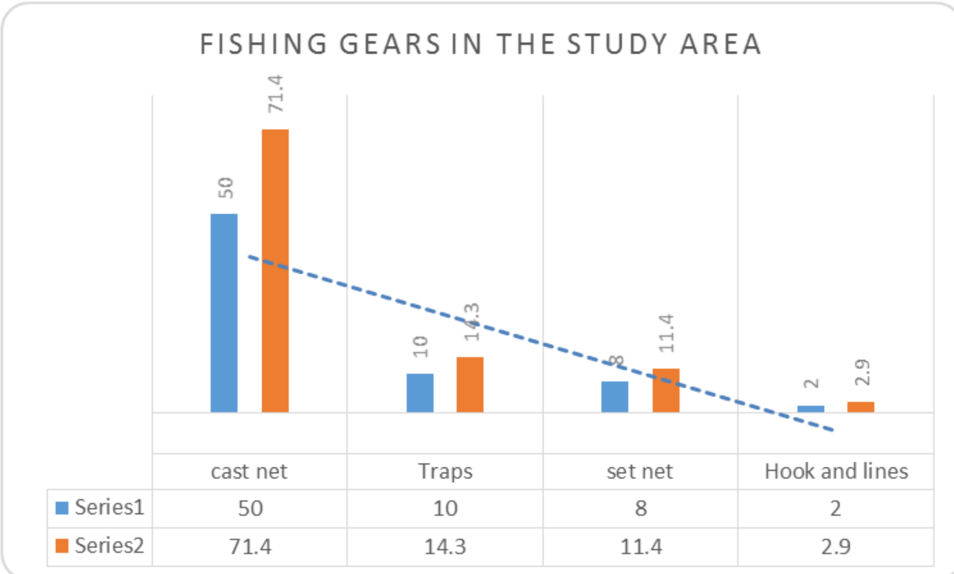

Figure 4: Fishing Gears in the Study Area

Source: Computed Field Survey, 2015

Economic Importance of Fish Species in the Study Area

The economic importance of fish fauna to the people in the study area is represented in Table 3. According to the result of the study, fish and fishing provide different economic important to fisher folks in various capacities and ways. These include: Income generation (43%), for consumption as food (16%), Source of protein (7%), Source of job creation (10%), Exchange of goods (4%), Used as bird feed (1%), Source of life survival (11%), give opportunity of fish distribution (7%) among others.Fishing serves as great economic level especially to the people in the study area. Inspite of declining catches due to climate change and other environmental factors (Adeleke *et al.*, 2018a andAdeleke *et al.*, 2018b), the average annual household income of fisher folk might be higher than the income of most government/ public employees holding equivalent qualifications in Nigeria. The implication of this result showed that fisher folks in the study area control economic power since they can generate their income from the free gift of nature/natural resources available in their geographical location. This contradict the popular belief that fishers folks are among the poorest of the rural population in coastal areas of the world as opined by Anyanwu *et al.*, 2009. Although, the study revealed various problems encountered by the fisher folks in the study area among which were lack of education and technical knowledge by the fisher folks; lack of social amenities; and lack of cooperative societies or association. These encounters directly and indirectly affect the fish fauna and might have adverse effect on the economic status of the fisher folks in the study area.

Table 3: Economic Importance of Fish fauna

Economic important	Frequency	Percentage	Cumulative Percent
For generating income	30	42.9	42.9
For food consumption	11	15.7	58.6
Source of protein	5	7.1	65.7
Source as job opportunity	7	10.0	75.7
Exchange of goods	3	4.4	80.1
Used as bird feed	1	1.4	81.5
Source of life survival	8	11.4	92.9
Give opportunity of fish distribution	5	7.1	100
Total	**70**	**100.0**	

Source: Computed Field Survey, 2015

CONCLUSION AND RECOMMENDATIONS

The study examined the socio economic status of small scale fishers and fish fauna in Ilaje Local Government Area of Ondo State, Nigeria.The motive of the fishers in the study area is mainly for income generation. Nevertheless, the study revealed that, the coastal area of Ilaje Local Government of Ondo State holds potentiality in term of fish fauna availability which could support the government strides towards employment, poverty alleviation, also protect, conserve fish fauna and other aquatic life by maintaining the balance of nature and support the availability of fish fauna resources for future generation. Hence, the need to increase biodiversity of fish fauna and preserve the rare species for sustainability.

Recommendation

It is therefore necessary, for Government and Non-Governmental Organizations (NGOs) to organize an effective programme to sensitize the fisher folks, on how to maintain coastal water. Social amenities like electricity, toilet, good road, water supply, effective and efficient storage facilities should be provided to improve the living status of the fisher folks in the study area.

REFERENCES

Adeleke M.L., Akinwalere O.B., Olajubu O.K., Onibi E.G. (2018a). Climate Change and Coastal Resilience in Nigeria. In: Leal Filho W. (eds) Handbook of Climate Change Resilience. Springer, Cham, DOI https://doi.org/10.1007/978-3-319-71025-9_126-1. eBook Packages Earth and Environmental Science. Online ISBN 978-3-319-71025-9.

Adeleke M. Lydia, Oluwatosin O. John, Fagbenro O.A., Amos T.T. and Ajibefun I. A. (2018b). Biodiversity, Ecosystem Degradation and Climate Change Presence and effects on Livelihood Management in the Bitumen Area of Nigeria. In: Leal Filho W. (eds) Handbook of Climate Change Resilience. Springer, Cham, DOI https://doi.org/10.1007/978-3-319-71025-9_126-1. eBook Packages Earth and Environmental Science. Online ISBN 978-3-319-71025-9.

Adeleke, M. L. (2013). Socioeconomic characteristics of the artisanal fisherfolks in the coastal region of Ondo State, Nigeria. Journal of Economics and Sustainable Development www.iiste.org. ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online) Vol.4, No.2, 2013133.

Adeleke, M.L. and Fagbenro, O.A. (2013). Livelihood diversification and operational techniques of the artisanal fisherfolks in the coastal region of Ondo State, Nigeria. International Journal of Innovative Research and Development, 2(1). 262-273.

Anyanwu D.C, Mkpado M, Ohaka C.C (2009). Economic analysis of artisanal fishing at River Niger, Onisha Anambra State, Nigeria. Agro. Sci 8(3): 175-179.

Cleveland P, Hickman J.R, Larry Robert (2006). Biology of animals. Six ed. Fishes. Chapter 26; pp 651

Gupta P.C. and Gupta S.K (2008). General and applied ichthyology ‘Fish and Fisheries; Reprint 1st ed. S. Chand and Company PUT. LTD. 1,2-5,31and 51.

Inoni O.E, Oyaide W. J. (2007). Socio-economic analysis of artisanal fishing in the South Agro-ecological zone Delta State, Nigeria, Agric. Trop, subtropic 40 (4) 135-149.

Sikoki F. D. (2013). Fisheries in Nigeria Water; No place to hide. Pp14.

Tietze U., Rihan D., Lash R., Thomsen B. (2005). Economic performance and fishing efficiency of marine capture fisheries.

Ukpabio E. (2010). Economic of fish marketing in Ini Local Government Area of Akwa Ibom, Nigeria.

MONITORING THE SPATIAL LAND USE TRANSFORMATION OF THE FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE BETWEEN 2002 AND 2018

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Abstract

The spatial transformation of the Federal University of Technology, Akure, Nigeria between year 2002 and year 2018 using Satellite Remote Sensing and Geographical Information System techniques is the focus of this study.Satellite images consisting of Landsat 7 ETM+ of year 2002, Landsat 80LI/TIRS of year 2014 and year 2018 were obtained and processed with supervised maximum likelihoodclassificationusing ArcGIS10.3 software. The resultant images were classified into built-up, thick vegetation, light vegetation and bare land landuse/landcover (LULC) classes. Microsoft Excel spreadsheet was used to perform LULC area calculations through which the dynamics of LULC changes and the spatial expansion were thus identified. The result showed Built-up (13.58%, 14.59%, 20.75%); thick vegetation 33.78%, 26.26%, 12.18%); Light vegetation (24.57%, 32.29%, 30.51%); Bareland (28.08%, 26.26%, 36.56%) for the three years respectively. The study recommended that the work should be used to control the removal of trees and thick forest so as to protect ecosystem and preserve biodiversity.

***Keywords**: Land classification, Land use, Remote sensing, Vegetation,*

INTRODUCTION

The global Sustainable Development Goals (SDGs) themed: "Transforming our World: the 2030 Agenda for Sustainable Development" shortened to "2030 Agenda" (2015-2030) comprising of 17 Sustainable DevelopmentGoals (SDGs) adopted by all United Nation countries, is an urgent call for action by all developing and developed countries for a global partnership for sustainable development by the year 2030[6]. It is a follow up on millennium development goals (MDGs)(2000-2015)[5,7]. Among the transition pathways to the SDGs, sustainable landscape development constitutes an important part of environmental management of these Global goals[7]. The geospatial environment remains a major media of the transition and actualization of sustainable development goals[9]. The environment is ever dynamic and the monitoring of the dynamics remains a crucial pathway in the transition. Spatial dynamics is an important factor in the sustainability of any development[10]. The Land Use Land Cover changes of an environment is an indicator of the dynamics of the environment[11]. Hence, through the measurement of the LULC transformation, spatial expansion are monitored. Satellite Remote Sensing and GIS techniques have been preferred in the recent times above conventional techniques for speed, coverage and unlimited reach.

MATERIALS AND METHODS

The materials obtained for this research are Satellite images of Ondo State (Landsat ETM+ 2002, 30m resolution, Landsat OLI/TIRS 2014, 30m resolution and Landsat OLI/TIRS 2018, 30m resolution); the boundary map of the study area, the coordinates of ground control points.The satellite imageries were all pre-processed and as such there was no need for geometric or radiometric correction. The imageries were processedwith ArcGIS 10.3 software. The boundary map of the study area in AUTOCAD format (.dwg file) was converted to shape-file (.shp) in the ArcGIS environment and used to clip out the study areafrom the satellite imagery. To enhance visualization of features in the imagery, creation of false colour composite images was performed using ArcGIS 10.3 (Figure 1) by the combination of Near Infrared (NIR), Red (R) and Green (G) bands of each imagery (Table 1) . To further enhance visualization of features in the composite images, ESRI pan-sharpeningmethod in ArcGIS 10.3 was performed on the composite images by fusing thehigher-resolution panchromatic 8thband of each Landsat image with the low spatial resolutioncomposite image.

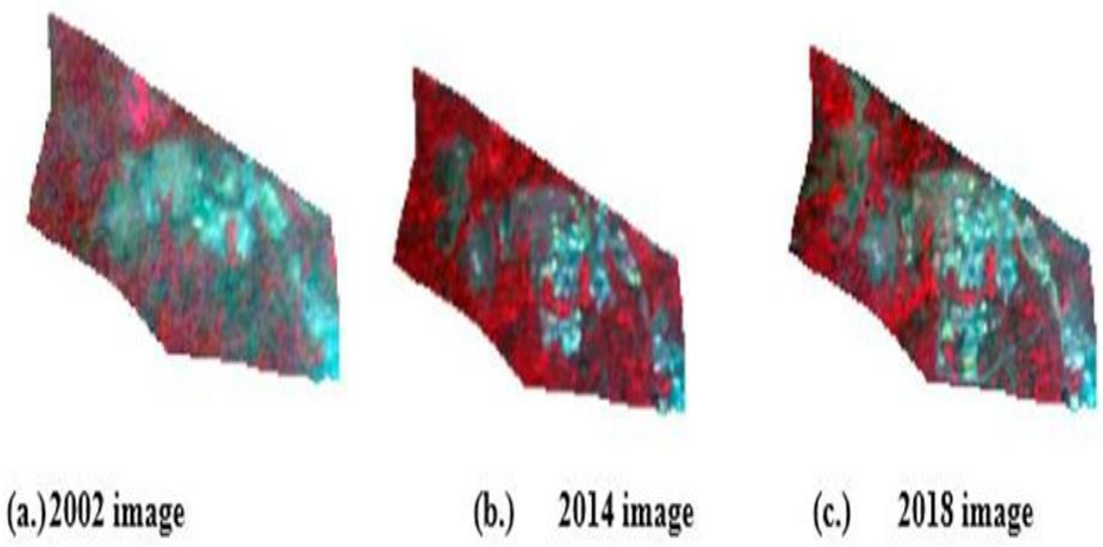

Figure 1: False Colour Composite for each Year of Study

Table 1: Landsat Band Combinations

Image	2002 (Landsat 7 ETM+)	2014 (OLI/TIRS)	2018(OLI/TIRS)
Spectral Band Combination	4,3,2	5,4,3	5,4,3
Spectral Band Names	NIR, Red, Green	NIR, Red, Green	NIR, Red, Green

The image classification to automatically categorized all pixels the images into land cover classes was performed using supervised classification with maximum likelihood. The images were classified under the following four classes as shown in the table below(table 2).

Table 2: Showing the LULC Classes and Description

LULC classes	Description
Built up Areas	Residential (Staff quarters and Student Hostels), Academic and administrative buildings, Commercial Centres, all other levels of housing
Thick vegetation	Heavy green areas, thick forest and trees.
Light vegetation	Grassland, horticultural gardens, farmlands, vegetated open spaces
Bareland	Sand plains,non-vegetated areas (pavements, rocks, roads, open spaces)

To validate the classification and ensure high accuracy, an accuracy assessment was performed to compare the classified image to what actually obtained on the ground. Training samples from 60 points on the each of the satellite imagery were used on a reference image from Google earth combined with ground truth datacollected on actual visitation to the study area to verify the true land-cover type existing on the site. The ground truth data was compared with the classified image and it was discovered to have relatively matched with what was obtainable on the image.The high number of training samples was chosen due to the fact that the areal extent being studied issmall, hence the need for more training sample to ensure a high accuracy of classification. The size of the study area helped in actual visitation for on-the-site verification

Land Cover/Use Area Calculation

After image classification, the area covered by each LULC class was calculated with Microsoft Excel spreadsheet using the formula:

A= (Ct * (CSimg)^2)/10,000 (eqn.1)

Where,

A is the Areal extent of each LULC class in Hectares

Ct is COUNT, the number of pixels in a LULC class. The COUNT value for each class was obtained from the attribute table of the classified map.

CSimg is the cell size of the classified image for each year, which was 15m by 15m.

RESULTS AND DISCUSSION

From the supervised image classification carried out to assess the spatial expansion of the study area through the landuse/landcover changes for a period of 16 years,four land cover classes were identified (Figure 2). The areal extent for each land cover class in each year were calculated and tabulated (Table 3) while the corresponding LULC maps were created for the year 2002 (Figure 3), 2014 (Figure 4) and 2018

(Figure 5). Table 4 shows the transformation that occurred within the LULC classes in the epochs of study.

Table 3: Combined Areal Extent of LULC classe.

Year	2002		2014		2018	
LULC Type			Areal	Extent		
	(Ha)	(%)	(Ha)	(%)	(Ha)	(%)
Built Up	78.48	13.58	84.33	14.59	119.90	20.75
Bare Land	162.25	28.08	151.76	26.26	211.25	36.56
Thick Veg.	195.19	33.78	155.21	26.86	70.40	12.18
Light Veg	141.98	24.57	186.59	32.29	170.33	30.51
Total	**577.89**	**100.00**	**577.89**	**100**	**577.89**	**100**

Table 4: LULC Transformations in two epochs

Year	2002		2014		2018
LULC Type	AREAL EXTENT (%)				
	(%)	∆%	(%)	∆%	(%)
Built Up	13.58	**1.01**	14.59	**6.16**	20.75
Bare Land	28.08	**-1.82**	26.26	**10.3**	36.56
Thick Veg.	33.78	**-6.92**	26.86	**-14.68**	12.18
Light Veg	24.57	**7.72**	32.29	**-1.78**	30.51

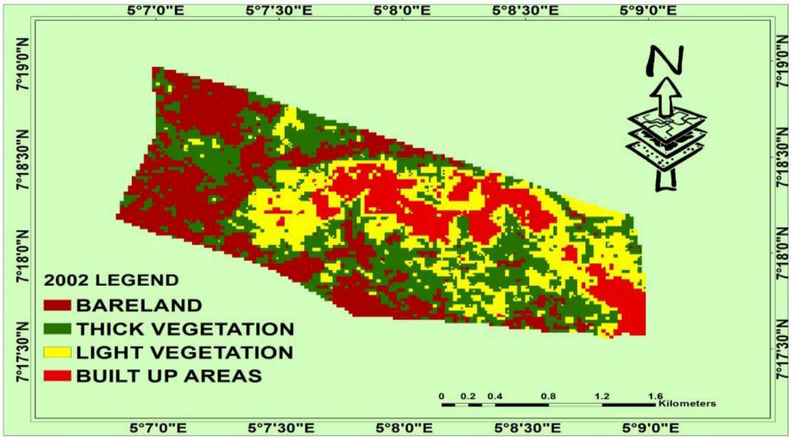

Figure 2:Landuse/Landcover Map of FUTA In 2002

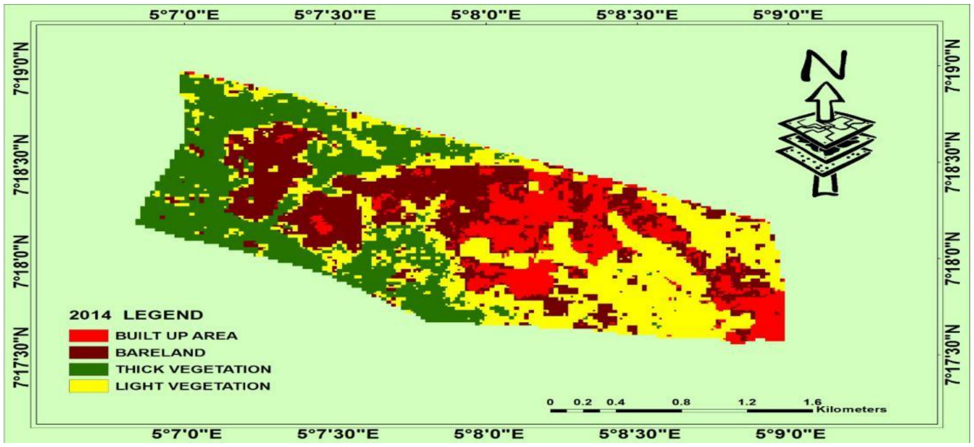

Figure 3: Landuse/Landcover Map of FUTA In 2014.

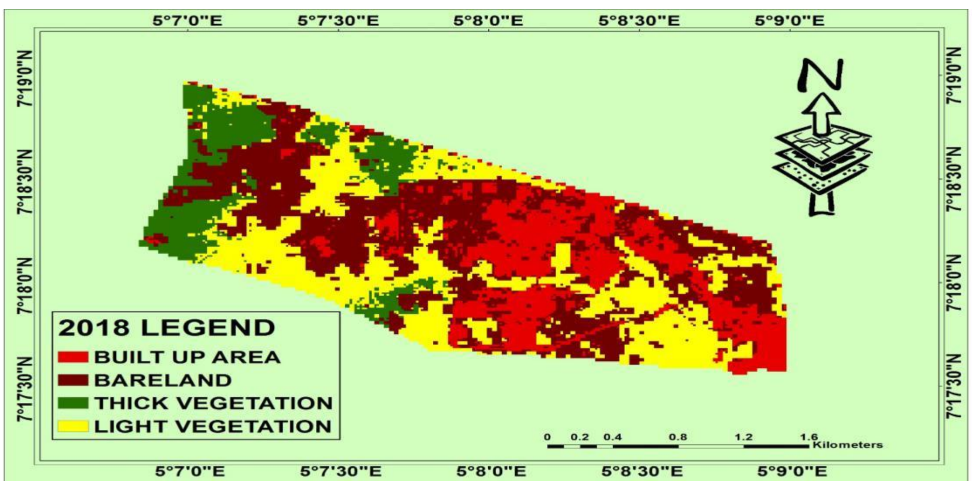

Figure 4: Landuse/Landcover Map of FUTA In 2018.

In the two epochs (Table 3), the transformation in the lulc classes showed an appreciable gain of 7.17% and 8.48% of the Built-Up and Bare Land classes respectively. These are all at the expense of the thick forest even though light vegetation gained a 5.94% in the overall. The overall perception can be pictured in Figure 5. While individual LULC class transformation is shown in Figure 6.

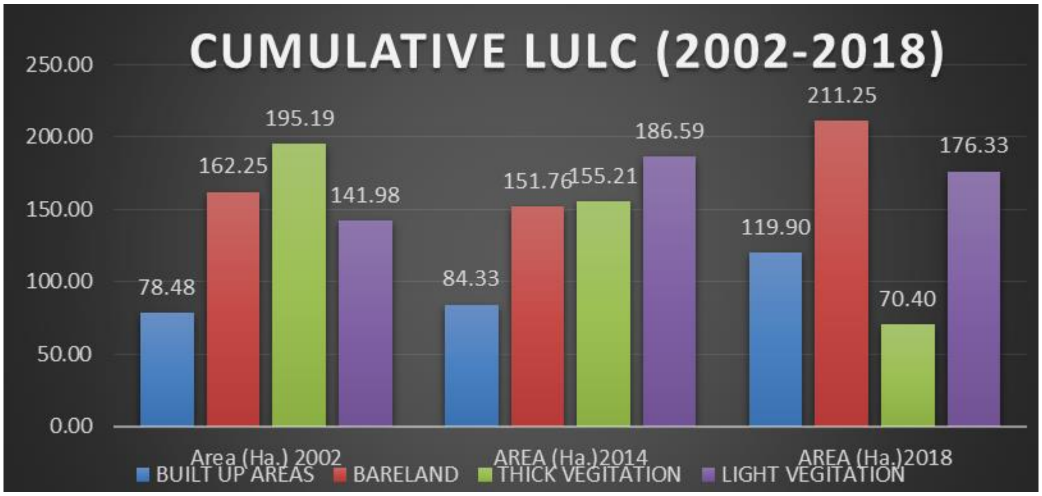

Figure 5: Overall View of the LULC transformation in the two epochs

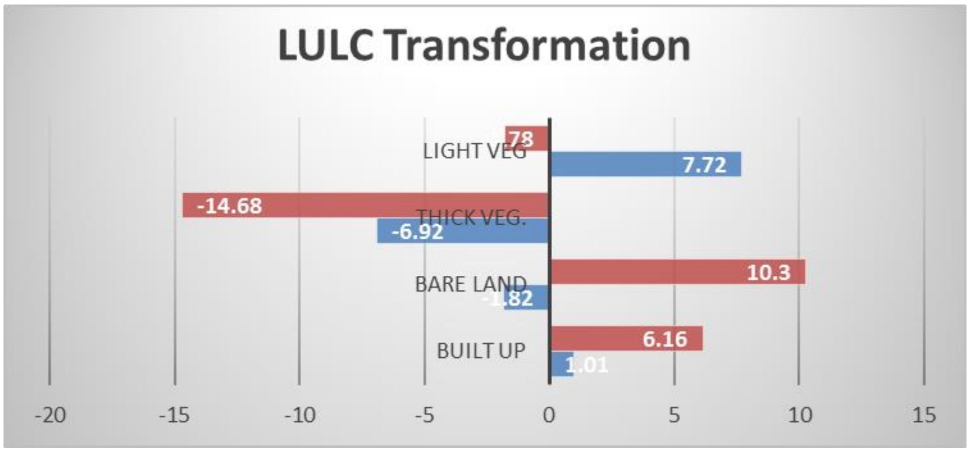

Figure 6: Individual LULC transformation

It was observed that the green ecosystem is suffering the overall loss. There was a reduction of the light vegetation to -1.78 between 2014 and 2018, a space of four years. Worse still the thick vegetation depleted by a lump sum of 14.68% within a space of four years!

Effect of Green loss in the transition pathway to the SDGs

The major actor in the SDGs is the human being, the goals are by man and for man, and Humans are the lifewire and the colour of the ecosystem. Plants have been known as carbon sink in the ecosystem. They absorb carbon dioxide which is released by man and release oxygen that is highly needed for the survival of man. They reduce carbon emission. From research 1 tree can absorb 150kg (330lb)of CO_2 in a year[1,2]. A deficiency in this flow amounts to dangers for the man such as ill-health, social vices, and even death. Pollutants in the atmosphere escalates climate change causing harsher weather hampering the economy causing more stress[3]. Absence of trees make stress to sky rocket. MRI scan have revealed that our brains perceive cities as hostile environments, where as natural features tap into the part of the brain responsible for empathy and compassion. Without trees our harsh environment will breed a ‘fight or flight’ mentality among city inhabitants thereby causing anxiety, depression and aggression in an already violent, de-stabilized world.

The campus will be louder as trees are known to absorb sound waves and are buffers from noisy traffic and construction. There will be severe temperature cange due to direct exposure to sun's rays.Trees can cool the ecosystem by 45°F[3]. Quality of fresh air drops where there are no trees. From research, 1 acre of trees can supply oxygen to 18 people per day.

Trees are natural water filters that filter heavy down pour and prevent free flow of storm water, their disappearance causes erosion, landslides and flooding. Tress absorb water and protect the soil. Their disappearance means there will be increased run off, higher mud and sediments getting into our water reserves, water becoming unsafe for drinking and contaminated for growing foods[3].

Trees brings a welcoming environment. It has been researched that there are more violence where there are less trees. Absence of Trees will result into crimes of all sort. On commerce and productivity, it has been found by research the trees grow sales. Consumers shop longer and pay 10% more for goods on tree-lined streets. Also workers who do not have a view of nature from their desks call in sick 23% more often.

CONCLUSION AND RECOMMENDATIONS

The transition pathways to the SDGs is dependent on the well being of the ecosystem. And the ecosystem has its rest on the green economy. The green economy and sustainable development are inseparable concepts in the pathway to the SDGs. Removal and disappearance of trees has very gruesome effect on living and life in general. The environment's sustainability become questionable and doubtful.

Recommendations

The control of the removal of trees and thick forest on our campuses should be taken with all seriousness so as to protect ecosystem and preserve the biodiversity. The health consequence of the disappearance of trees should be avoided by the replacement of felled trees and strong afforestation. The campus ecosystem must be preserved. The campus soil requires great preservation from climatic conditions: direct heat from the sun, erosion, flooding and many hazards of the environment.

REFERENCES

Breakdown of U.N. Sustainable Development Goals. Retrieved 26 September 2015.

Caballero, Paula (2016). "A Short History of the SDGs" (PDF). *Deliver 2030*. Archived from the original (PDF) on 18 November 2017.

Christopher Bergland (2019). Psycology Today: The Neuroscience of Empathy-Neuroscientists identify specific brain areas linked to compassion.https://www.psychologytoday.com/us/ blog/the-athletes-way/201310/the-neuroscience-empathy. "Transforming our world: the 2030 Agenda for Sustainable Development". *United Nations – Sustainable Development knowledge platform*. Retrieved 23 August 2015.

Development, World Commission on Environment and. "Our Common Future, Chapter 2: Towards Sustainable Development - A/42/427 Annex, Chapter 2 - UN Documents: Gathering a body of global agreements". *www.un-documents.net*. Retrieved 17 November, 2017.

Ezeomedo, I., Igbokwe, J. I. (2013). Mapping and Analysis of Landuse and Land Cover for a Sustainable Development Using High Resolution Satellite Images and GIS FIG Working Week 2013.*Environment for Sustainability Abuja, Nigeria*, 6 – 10 May 2013. TS03B - Remote Sensing for Landuse and Planning, 6421

http://www.tenmilliontrees.org/trees/: All about Trees

https://projects.ncsu.edu/project/treesofstrength/treefact.htm.

https://www.precisiontreemn.com/tips/14-fun-facts-about-trees.html.

Lambin, E., Meyfroidt, P. (2011). Global landuse change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences of the United States of America*, 108(9), 3465–3472. doi:10.1073/pnas.1100480108.

Ogunlade, S. O. (2018). Mapping and Analysis of Spatiotemporal Landuse Dynamics of Akure and Environs, Ondo State Nigeria. [Doctoral Desertation]. Nnamdi Azikiwe University, Awka-Nigeria.

GROWTH RESPONSE OF *SOLANUM MACROCARPON* L. TO ORGANIC AND INORGANIC FERTILIZER

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Abstract

Indigenous vegetables are important sources of food and medicine and in an effort to ensure their domestication, availability and consumption, it is necessary to determine the suitable agronomic practices forproduction. A pot experiment was carried out to determine the effect of organic and inorganic fertilizers on the growth of Solanum macrocarpon. The experiment was laid out in a Complete Randomized Design with four treatments: NPK200 kg /ha, - T1, Poultry manure 6t/ ha - T2, NPK and Poultry manure 100 kg/ha + 3 t/ha - T3, Control, No Fertilizer - T4. Leaf area, plant height, number of leaves, and stem diameter were measured using standard methods. The growth of S. macrocarpon was improved by fertilizer application. All parameters measured increased with plant age and significant differences ($p < 0.05$) were observed among the treatments. Results obtained from this study highlighted the potential of poultry manure as an alternative source of nutrients required for growth of egg plant. Although both organic and inorganic fertilizers improved the growth performance of the vegetable, the inorganic fertilizer produced the best results for all the parameters measured.

Keywords: Growth, fertilizers, indigenous vegetables, Poultry manure, *Solanum macrocarpon*.

INTRODUCTION

Continuous cultivation of a farmland for a long period of time without replenishment or fallowing depletes the soil nutrient status, reduces soil fertility and plant yield. Some authors have opined that African soils such as those of Nigeria are usually deficient in essential macro nutrients such as phosphorus and nitrogen, but contain adequate amounts of micro nutrients such as boron, manganese, copper, sulphur and zinc (Mandiringana *et al.*, 2005; Olowoake and Adebayo, 2014). These elements play important roles in optimal plant development and lack of these nutrients may lead to poor plant growth and eventual senescence. As such soils with low levels of nutrients need to be boosted with soil amendments in order to improve crop production (Bvenura and Afolayan, 2014).

Organic fertilizers can be of plant or animal origin such as crop residues, animal droppings and household wastes and they usually contain a great amount of organic matter which helps to improve soil fertility and decrease soil porosity. Dauda *et al.*, (2008) opined that organic manure help to improve the soil structure, microbial mass and provide nutrients, although such nutrients are often slowly mineralized and may not be available during the first season of application (Bvenura and Afolayan, 2014). This explains why some farmers prefer inorganic fertilizers since they quickly become available to the plant after application, nevertheless, they may become toxic to soil biota and humans (Arisha and Bardisi, 1999).

Furthermore, the use of manure in crop husbandry helps to preserve the ecosystem (Farhad *et al.*, 2009), as the substantial residual effect on the succeeding crop cultivation cannot be overemphasized (Reddy *et al.*, 2004). Adeoye *et al.*, (1995) observed that the use of organic-based fertilizer to enhance the fertility of the soil and that it is a good soil management strategy for the low activity clay African soils, particularly those of Nigeria. Inorganic fertilizers are chemical compounds containing one or more essential nutrients in the form of mineral salts applied to soils to provide nutrients for plants. A continuous use of inorganic fertilizers may adversely affect soil quality via soil nutrient imbalance, increased acidity, soil degradation and soil erosion consequent on the instability of soil aggregates (Akande *et al.*, 2010; Olowoake and Adeoye, 2010).

Poultry manure otherwise known as chicken droppings is an organic-based fertilizer. Ali (2005) reported that poultry manure contains more nutrients, readily supplies phosphorus to plants than other organic manure sources such as those from other animals such as cow, goat and sheep manure. Poultry manure usually contains high nitrogen, phosphorus, potassium and other essential nutrients which contribute to soil organic matter and improves soil structures, nutrient retention, aeration, soil moisture holding capacity and water infiltration (Deksissa *et al*., 2008).

Currently, there is an increasing awareness of the value of leafy vegetables in contributing to balanced diet, particularly in areas where animal protein is deficient (Olowoake and Adebayo, 2014). *Solanum macrocarpon* is an herbaceous leafy vegetable in the family Solanaceae grown in the tropical regions of the world. It is cultivated for its leaves in the warmer and non-arid parts of Africa (Schippers, 2000). *Solanum macrocarpon* is one of the indigenous underutilized vegetables consumed by the resource poor women in the southwest Nigeria to meet daily vegetable requirements to supply minerals, vitamins and protein because of their inability to purchase highly nutritious food items such as egg, meat and milk (NICANVEG, 2014). In Nigeria, *Solanum macrocarpon* is intercropped with staple food crops like yam and cassava and rarely cultivated singly by farmers for commercial purposes (Olaniyan *et al.*, 2006). Despite the inherent genetic endowment of *Solanum macrocarpon*, inadequate soil nutrient availability usually suppresses its re-growth and prolific characteristics.

Improved cultivation of leafy vegetables has the potential ofpromoting national, regional and international market opportunities for the indigenous vegetables species of southwest Nigeria (Idowu *et al.*, 2014; Agong and Makinde, 2003). Idowu *et al.*, (2014) also opined that helping women who are vegetable farmers improve the productivity of more nutritious, high-value products such as vegetables, will not only increase family income but also promote ground-level nutrition by increasing the amount of healthy food available for home consumption. Olaniyan and Nwachukwu (2004) have established the importance of fertilizer application the cultivation of *Solanum* species. There is however little information on the response of *S. macrocarpon* to organic and inorganic fertilizer applications. This study therefore seeks to provide information on the effects of fertilizer application on the growth of this wild vegetable, this is with the aim of ensuring its domestication and thus promoting food security.

MATERIALS AND METHODS

The experiment was carried out in the greenhouse of the Department of Plant Science and Biotechnology, Ekiti State University, Ado Ekiti (Latitude 24^0 33'S and Longitude 25^0 54'E). Soil was collected at the

Parks and Gardens Unit of Ekiti State University, Ado-Ekiti, Nigeria. A portion of the soil sample was also taken to the laboratory for the determination of soil physicochemical properties according to standard methods. Mature fruits of *Solanum macrocarpon* were harvested during field surveys from different areas in Ekiti State, Nigeria. The freshly harvested seeds were removed from their capsules, air-dried andthen sown in germination trays. After a period of two weeks, seedlings at two-leaf stage with a height of about 10 – 15cm were transplanted from germination trays into experimental pots filled with 3kg topsoil. This was done at the early hours of the morning in order to reduce transplanting shock. Organic fertilizer (poultry manure) was obtained from the poultry unit of the Ekiti State University Teaching and Research farm while inorganic fertilizer NPK (Nitrogen Phosphorus and Potassium, 15:15:15) was purchased from a local agricultural inputs dealer.

Seedlings were arranged in Completely Randomized Design (CRD) with four treatments and four replicates, however each replicate consisted of 10 experimental units. Each unit represents a stand of *Solanum macrocarpon* in a pot, making a total of 40 experimental pots. Both NPK and organic manure were applied to the soil at transplanting. NPK was applied by ring method at a distance of 5 cm from the plant stand and at a depth of 2 cm into the soil, the organic fertilizer was however applied by mixing with the topsoil. Seedlings were also watered daily to field capacity.

The treatments consisted of:

1. NPK 200 kg /ha, - T1
2. Poultry manure 6t/ ha - T2
3. NPK and Poultry manure 100 kg/ha + 3 t/ha - T3
4. Control, No Fertilizer - T4

The physicochemical properties of soil and organic fertilizer (poultry manure) used for the experiment are shown in Table 1.

Table 1: The physical and chemical properties of the experimental soil and organic fertilizer

Parameters	Soil	Organic Fertilizer
Ph	6.39	7.97
Bulk density (%)	1.44	1.22
CEC (meq/100g)	4.66	11.84
Organic Carbon (%)	4.94	0.86
Exchangeable acidity (Cmol/kg)	1.54	1.62
Exchangeable Aluminum (mol/kg)	1.00	1.29
Particle density (g/cm^3)	2.59	2.24
Acidity (mol/kg)	2.43	0.34
Electrical Conductivity (EC) (µS/cm)	32.17	45.00
Sand (%)	52.90	-
Silt (%)	16.00	-
Clay (%)	31.15	-
Nitrogen (mg/kg)	0.73	3.63
Available Phosphorus	14.06	25.70
Zn (mg/kg)	2.36	12.91
Mn (mg/kg)	0.67	1.01
Cu (mg/kg)	0.23	16.01
Na (mg/kg)	22.62	56.15
Fe (mg/kg)	6.46	26.15
Mg(mg/kg)	5.15	91.21
K (mg/kg)	12.34	81.21
Ca (mg/kg)	66.32	77.21
P (mg/kg)	16.74	71.14
Textural class	Sandy clay loam	-

Measurement of Growth Parameters

The experiment was allowed to stabilize for three weeks before the assessment of growth parameters commenced. Growth parameters such as plant height, stem collar diameter, leaf number, leaf length and leaf breadth were assessed weekly. Plant height was measured from the base of the plant to the tip of the apical bud using a ruler calibrated in centimeter, leaf length and breadth were also measured using a meter rule, stem diameter with the aid of a digital Vernier Caliper while leaf number was obtained by physical counting. Leaf area was determined using the non destructive method(Saxena and Singh, 1965) and computed using the formula:

$$\text{Leaf area} = 0.75\ (\text{Leaf Length} \times \text{Leaf Breadth})$$

At nine (9) weeks after transplanting, the experiment was terminated and seedlings were carefully uprooted, washed and separated into shoot and root, after which they were weighed using an electronic weighing balance. The shoot and root components were then put into separate envelopes for ease of identification. The envelopes together with their contents were oven dried for at 80 °C to constant weight. The samples were removed and reweighed to get the dry weights.

Statistical Analysis

Data obtained from various treatments were subjected to statistical analysis using Statistical Package for the Social Sciences(SPSS 20) A one way analysis of variance was used to compare the means of each treatment. Means were segregated using Duncan's Multiple Range Test. The means were treated as significantly different at $P < 0.05$.

RESULTS AND DISCUSSION

The effect of fertilizers on leaf area of *Solanum macrocarpon* is shown in Table 2. The treatment varied significantly in the 4 WAT while no significant differences were obtained in the other weeks. Treatment means for the experimental period ranged from 208.40 cm^2 and 477.97 cm^2. The order of increase was observed to be T1 > T2 > T3 >T4. The mean leaf area was highest in T1 (477.97 cm^2) and lowest in T4 (297.18 cm^2). Leaf area is a vital tool in understanding the water and nutrient use of the plant as well as its growth and yield potential (Pandey and Singh, 2011). It determines the plant's surface area for sunlight impingement during photosynthesis. In the present study, leaf area was highest in plants treated with inorganic fertilizer followed by those treated with poultry manure. In a similar study by Bvenura and Afolayan (2014), the leaf area of *Solanum nigrum* was found to be highest (88.48 cm^2) in plants treated with 50 kg N/ha and 4.07 t manure/ha, this is lesser compared to the present study where plants treated with manure 100 kg/ha + 3 t/ha had a mean leaf area of 354.50 cm^2. The large difference can be attributed to the morphology of the leaves as *Solanum macrocarpon* posses very large leaves with extensive surface area when compared to the relatively small leaves of *Solanum nigrum*.

Plant nutrition, plant-soil-water relations, plant protection measures, plant competition, respiration, light reflectance as well as heat transfer are usually determined by a plant's leaf area (William, 1987). Therefore, in order to understand water and nutrient use, photosynthesis, light interception, crop growth and yield of a plant, it is important to estimate its leaf area. The leaf has been described as the main organ of the plant as it is involved in the photosynthetic activity and also the sink for plant nutrients (Hortesteiner and Feller, 2002). Furthermore, the leaf size of a plant is usually very responsive to nitrogen supply due to enhanced cell production and cell expansion, and its deficiency limits the production of protein and chlorophyll molecules which are essential for production of new cells thereby reducingthe plant's growth (Trapani *et al.*, 1999; Ng'etich *et al.*, 2012).

The mean plant height of *Solanum macrocarpon* measured weekly after application of organic and inorganic fertilizer is presented in Table 3. A steady increase in plant heights was observed from 3 WAT to 6 WAT, however a decrease was observed at 7 WAT across all the treatments. At 8 WAP, plant height continued to increase till the termination of the experiment at 9 WAT. The order of increase of the plant height was also observed to be T1 > T2 > T3 >T4. Plant height varied significantly among the different treatments, the differences were shown to be statistically significant at 4, 5, 7 and 8 WAT.

Plant height was significantly affected by the different fertilizer treatments. The highest height was obtained in plants treated with inorganic fertilizer. This is contrary to the study of Eghball *et al.* (2004)

and Farhad *et al.* (2011) where the highest plant height was recorded in soils treated with organic fertilizer (poultry manure). It should be noted however that maize plant has been reported to respond positively to organic manure application by several authors (Otitoju *et al.,* 2016). Nitrogen, phosphorus and potassium present in the inorganic fertilizer are usually readily available to the plants as they get easily mineralized into the soil in order to promote vigorous vegetative growth. The lowest plant height obtained in the control plant may be due to the fact that the plant had to rely on the native minerals present in the soil since there was no fertilizer application to them. This is in accordance with the findings of Ng'etich *et al.* (2012) which stated that nitrogen fertilization enhanced the vegetative growth of plants especially by increasing the yield of most leafy vegetables.

Table 4 shows the stem diameter of *Solanum macrocarpon* as affected by fertilizer application. Mean stem diameter increased with plant age. Stem diameter was significantly affected by fertilizer application at 3 WAT and 9 WAT. The highest stem diameter was obtained in T1 (7.88 mm) and lowest in T3 (5.78 mm). Stem diameter was observed to increase in the following order T1 > T2 > T4 >T3.Stem diameter was positively affected by fertilizer application. This observation is in line with the reports of Sowunmi (2014) and Otitioju *et al.* (2016) who observed increase in stem diameters of *Cleome gynandra* and *Zea mays* respectively with fertilizer application.Bvenura and Afolayan (2014) reported a stem diameter of 7.35 mm in *Solanum nigrum*as well as Onideki *et al.* (201l) obtained a smaller stem diameter (6.64 mm) in *Solanum scabrum* when compared with the highest stem diameter value (7.88 mm) reported in the current study. The transport of materials in plants are carried out within the stems and as such healthy plant stems are necessary to aid distribution of fluids to the root and shoot, store nutrients, support leaves and flowers as well as produce new tissues (Ogunrotimi and Kayode, 2018), plant stems also function to support and elevate leaves, flowers as well as fruits (Raven *et al.,* 1981).

The effects of fertilizer on number of leaves of *Solanum macrocarpon* are shown in Table 5. Significant differences were observed among the different treatments from the 3WAT to 6 WAT. The number of leaves increased with plant age up till 6 WAT, however at 7 WAT, plant leaves reduced before they began to increase steadily from 8 WAT till the end of the experiment. The number of leaves was highest in T1 while the lowest was obtained in T3. Leaf number was observed to increase in the following order T1 > T2 > T4 >T3.Leaf number increased with plant age. Increase in leaf number is a measure of a crop yield and productivity, Olaniyan *et al.* (2014) observed highest number of leaves in *Solanum macrocarpon* treated with inorganic fertilizer and the lowest in control, this is in agreement with the findings from this study. The authors stated further that the number of leaves affected**dry** matterproduction, edible and economic yields of *Solanum macrocarpon*.

Table 2: Effect of organic and inorganic fertilizer on leaf area (cm^2) of *Solanum macrocarpon*

	Plant Age (WAT)						
	3	4	5	6	7	8	9
T_1	208.40 ± 7.98^a	361.36 ± 22.46^b	384.31 ± 21.83^a	430.31 ± 49.26^a	445.75 ± 57.09^a	453.19 ± 58.11^a	477.97 ± 56.07^a
T_2	273.19 ± 66.54^a	331.28 ± 67.08^b	355.12 ± 70.86^a	368.17 ± 74.03^a	373.37 ± 75.79^a	384.05 ± 79.80^a	398.23 ± 84.70^a
T_3	233.31 ± 40.84^a	256.14 ± 51.58^b	293.07 ± 56.37^a	306.46 ± 52.62^a	328.00 ± 61.84^a	341.10 ± 64.99^a	354.50 ± 71.89^a
T_4	170.51 ± 39.35^a	150.21 ± 29.77^a	219.12 ± 37.43^a	248.07 ± 49.88^a	272.57 ± 52.03^a	288.98 ± 54.82^a	297.18 ± 56.45^a

Table 3: Effect of organic and inorganic fertilizer on plant height (cm) of *Solanum macrocarpon*

	Plant Age (WAT)						
	3	4	5	6	7	8	9
T_1	17.58 ± 3.54^a	24.18 ± 3.12^b	25.90 ± 3.42^a	26.75 ± 1.82^a	26.68 ± 4.21^b	28.63 ± 4.66^a	30.30 ± 5.32^a
T_2	16.25 ± 1.61^a	19.45 ± 1.37^{ab}	20.18 ± 1.42^{ab}	24.53 ± 3.05^a	21.40 ± 1.34^{ab}	22.70 ± 1.64^{ab}	23.23 ± 1.79^a
T_3	16.23 ± 0.63^a	18.28 ± 0.98^{ab}	19.28 ± 1.21^{ab}	22.13 ± 2.19^a	19.93 ± 1.49ab	20.68 ± 1.41^{ab}	21.15 ± 1.42^a
T_4	12.68 ± 0.59^a	14.23 ± 1.11^a	15.85 ± 1.38^b	19.98 ± 2.38^a	17.28 ± 2.18^a	18.68 ± 2.78^b	19.58 ± 2.91^a

Table 4: Effect of organic and inorganic fertilizer on Stem diameter (mm) of *Solanum macrocarpon*

	Plant Age (WAT)						
	3	4	5	6	7	8	9
T_1	5.01 ± 0.62^b	5.52 ± 0.95^a	5.93 ± 1.05^a	6.52 ± 0.89^a	6.70 ± 0.94^a	7.36 ± 0.74^a	7.88 ± 0.81^b
T_2	4.31 ± 2.37^b	5.09 ± 0.36^a	5.60 ± 0.42^a	5.52 ± 0.64^a	5.68 ± 0.64^a	6.11 ± 0.60^a	6.59 ± 0.51^{ab}
T_3	2.74 ± 0.13^a	4.13 ± 0.19^a	4.61 ± 0.37^a	4.79 ± 0.49^a	5.02 ± 61.84^a	5.35 ± 0.63^a	5.73 ± 0.65^a
T_4	2.29 ± 0.24^a	3.73 ± 0.32^a	4.17 ± 0.23^a	4.76 ± 0.25^a	4.99 ± 0.31^a	5.42 ± 0.46^a	5.78 ± 0.49^a

Table 5: Effect of organic and inorganic fertilizer on leaf number of *Solanum macrocarpon*

	Plant Age (WAT)						
	3	4	5	6	7	8	9
T_1	11.50 ± 1.44^b	12.00 ± 1.47^b	12.50 ± 1.26^{ab}	11.75 ± 0.85^a	8.25 ± 1.44^a	9.50 ± 2.25^a	9.75 ± 2.72^a
T_2	14.00 ± 0.91^b	14.75 ± 0.63^b	13.50 ± 1.66^b	13.00 ± 2.12^a	11.75 ± 2.39^a	9.50 ± 1.44^a	9.00 ± 1.29^a
T_3	8.00 ± 1.00^a	8.75 ± 1.11^a	9.50 ± 1.66^a	8.00 ± 1.41^a	8.25 ± 1.65^a	7.25 ± 0.75^a	6.75 ± 0.75^a
T_4	7.50 ± 0.65^a	8.25 ± 0.63^a	8.50 ± 0.29^a	8.25 ± 0.85^a	8.25 ± 0.85^a	8.25 ± 0.85^a	9.25 ± 0.48^a

* WAT: Weeks after Transplanting. Values shown are mean ± S.E. Means with different letters along the same column represent significant differences at $p < 0.05$.

CONCLUSION

Consequent on the results obtained in this study, it can be concluded that different fertilizer rates had different effects on the growth and yield of *Solanum macrocarpon*. The application of organic fertilizer also produced good results in terms of the growth parameters studied, and thus could serve as a good alternative to resource-poor small scale farmers who may not be able to purchase inorganic fertilizers in large quantities as required during cultivation due to cost.

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REFERENCES

Adeoye, G. O., Omueti, J. A. I., Sridhar, M. C. K., Hassan, U. A., John, N. M., Ogazi, J. N., Sule, A., and Olajuyigbe, O. (1995). A case study of organomineral fertilizer in different ecological zones of Nigeria. A paper presented at the 3rd All African soil science society conference held at the University of Ibadan, Ibadan, Nigeria on August 19-20, 1995.

Akande, M. O., Oluwatoyinbo, F. I., Makinde, E. A., Adepoju, A.S., Adepoju, I. S. (2010). Response of Okra to Organic and Inorganic Fertilization.Nature and Science, 8, 261-266.

Arisha, H.M. and Bradisi, A. (1999). Effect of mineral fertilizers and organic fertilizers on growth, yield and quality of potato under sandy soil conditions. Zagazig Journal of Agricultural Research, 26, 391-405.

Bvenura, C., and Afolayan, A. J. (2014). Ethnobotanical survey of wild vegetables in Mbashe and Nkonkobe municipalities, Eastern Cape Province, South Africa. Acta Botanica Gallica: Botany Letters, 161(2), 189 – 199.

Dauda, S. N., Ajayi, F. A. and Ndor, E. (2008). Growth and yield of water melon (*Citrullus lanatus*) as affected by poultry manure application. Journal of Agriculture and Social Sciences,4:121-124.

Eghball, B., Ginting, D., and Gilley, J. E. (2004). Residual effects of manure and compost applications on corn production and soil properties. Agronomy Journal, 96, 442-447. http://dx.doi.org/10.2134/agronj2004.0442.

Farhad, W., Saleem, M. F., Cheema, M. A., and Hammad. H. M. (2009). Effect of poultry manure levels on the productivity of spring maize (*Zea mays* L.). The Journal of Animal and Plant Sciences, 19(3), 122-125.

Hörtensteiner, S. and Feller, U. (2002). Nitrogen metabolism and remobilization during senescence. Journal of Experimental Botany 53, 927-937.

Idowu, M. K., Oyedele, D. J., Adekunle, O. K., Akinremi, O. O. and Eilers, B. (2014). Effects of Planting Methods and Seed Density on Vegetable Yield and Nutrient Composition of *Solanum macrocarpon* and *Solanum scabrum* in Southwest Nigeria. Food and Nutrition Sciences, 5: 1185-1195. http://dx.doi.org/10.4236/fns.2014.513129.

Mandiringana, O. T., Mnkeni, P.N.S., Mkile, Z., van Averbeke, W., van Ranst, E. and Verplancke, H., (2005). Mineralogy and fertility status of selected soils of the Eastern Cape Province, South Africa. Communications in Soil Science and Plant Analysis, 63: 2431-2446.

Ng'etich, O. K., Aguyoh, J. N. and Ogweno, J. O. (2012). Growth, yield and physiologicalresponses of spider plant (*Cleome gynandra* L.) to calcium ammonium nitrate rates. International Journal of Agronomy and Plant Production, 3: 346-355.

NICANVEG,2014.http://nicanveg.org/sites/default/files/factsheets/NICANVEG_igbagba_factsh.eet_1.pdf

Ogunrotimi, D. G. and Kayode, J. (2018). Effect of Watering Regimes on Early Seedling Growth of *Solanum macrocarpon* L. (Solanaceae). Journal of Applied Sciences, 18: 79-85.

Olaniyan, A. B. and Nwachukwu (2003). Response of *Solanum macrocarpon* to different sources of nitrogen fertilizer. In Proceedings of the 6th Biennial Conference of the African Crop Science Society, Hilton Hotel Nairobi, Kenya October 12th -17th.

Olaniyan, A. B., Akintoye, H. A. and Olasanmi, B. (2006). Effect of Different Sources of Nitrogen on Growth and Yield of *Solanum Macrocarpon* in Derived Savanna of Nigeria. Journal of Agronomy, 5: 182-185.

Olowoake, A. A. and Adeoye, G. O. (2010). "Comparative efficacy of NPK fertilizer and composted organic residues on growth, nutrient absorption and dry matter accumulation in maize," International Journal of Organic Agriculture Research and Development, 2: 43–53.

Olowoake, A. A. and Adebayo, G. O. (2014). Effect of Fertilizer Types on the Growth and Yield of *Amaranthus caudatus* in Ilorin, Southern Guinea, Savanna Zone of Nigeria. Advances in Agiculture, Article ID 947062, 5 pages, http://dx.doi.org/10.1155/2014/947062.

Ondieki M.J., Aguyoh J.N., Opiyo A.M. (2011). Fortified compost manure improves yield and Growth of African nightshades. International Journal of Science and Nature, 2: 231-237.

Otitoju, O. M. Adewole, M. B., Olowoake, A. A. and Ilesanmi, A. O. (2016). Direct and Residual Effects of Different Poultry Compost and NPK Fertilizer Applications on Drought-Tolerant Maize Production. Journal of Sustainable Development, 9(4): 61 – 69.

Pandey, S. K. and Singh, H. (2011). A simple, cost effective method for leaf area estimation. Journal of Botany, 658240: 1–6.

Reddy, S. S., Shivaraj, B., Reddy, V. C. and Ananda, M. G. (2004). Effect of direct and residual fertility and yield components of maize (*Zea mays* L.). Karnataka Journal of Agricultural Sciences, 17(4): 676-681.

Saxena, M.C. and Singh, Y. (1965). A note on leaf area estimation of intact maize leaves. Indian Journal of Agronomy,10: 437-439.

Schippers, R. R. (2000). African Indigenous Vegetables an Overview of Cultivated Species. Natural Resources Institute, Chatham, UK., pp 89-98.

Trapani, N., Hall, A. J. and Weber, M.(1999). Effects of constant and variable nitrogen supply on sunflower (*Helianthus annus* L.) leaf cell number and size. Annals of Botany 84, 599-606.

Williams, I. E. (1987): Growth of Thompson seedless grapevines: I. Leaf area development and dry weight distribution. Journal of America Society of Horticultural Science, 112, 325-330.

A COMPARATIVE ANALYSIS OF DISCHARGE MEASUREMENT TECHNIQUES UPSTREAM OF RIVER KUBANNI, ZARIA NIGERIA

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Abstract
River or stream discharge is of great importance ranging from flood control, power generation, irrigation, water supply and dam construction. Hence, the need for stream discharge measurement becomes a paramount importance in water resources evaluation. A comparison was made between stream discharge values using the Weir, Current metre and Float methods upstream of River Kubanniin order to establish the most effective method for measuring stream discharge for small rivers. F-calculated for Malmo was 1.189 while F- critical was 3.09, Tukurwa has F-calculated of 0.510 while F-critical was 3.09, Maigamo has F-calculated of 0.911 while the F-critical was 3.09 and Goruba has F-calculated of 1.663 while the F-critical was 3.09 all at 0.05 significance level. The result show that there is no significant difference between the river discharges values obtained from the three techniques. Thus, both methods were suitable for the stream discharge measurements on the stream channels. The study therefore recommends that there should be continuous monitoring of stream discharge since it is the first requisite for planning of water resources development, measures to mitigate siltation should be employed because there is a relationship between stream discharge and sediment yield and lastly it is recommended that for small river channels, the weir method is the most effective technique for stream discharge measurement because of its consistency.

Keywords: *River Kubanni, Stream discharge, Tributaries, Weir method.*

INTRODUCTION

Almost every day, water makes the headlines somewhere in the world. Drought, Flood and Pollution are all big News, as water becomes the most precious and most contested essential resources. Man requires water for cooking, drinking, sanitation, agriculture and manufacturing processes. However, because water is freely available through rainfall, man has, until fairly recently, taken this unique resource for granted. The threat of a world water crisis is becoming increasinglyreal in the face of increasing demand, relative static supply and deteriorating quality due to pollution (Ayoade and Oyebande, 1978).

Research on water quantity and quality has become very vital, particularly in the developing countries like Nigeria where water availability continues to be a problem of great concern. Perhaps more embarrassing is that lack of running water has killed more people in Nigeria in 2015 alone than the murderous Boko Haram did in its six years insurgency. While the terror has claimed about 17,000 lives, the shortage of potable water and poor sanitation led to about 73,000 deaths (Wateraid, 2016).

The scarcity of water and threats of flash floods in Nigeria require further understanding of the natural processes of water resources in order to manage and sustain current and future water resources. To make matters worse, rainfall fluctuation and climate change are expected to increase water scarcity in Nigeria. These combined factors will drive Nigeria to severe water stress. Hence, hydrological measurement become more essential in order to interpret water quality data and for water resource management (Ibrahim, 2011). When a dam is constructed across a river, the resultant reservoir receives water and sediments from the catchment areas of the river network (Yusuf, 2013). However, sediments yield in any reservoir or river has a relationship with the river discharge. Hence, the need for stream discharge measurement becomes a paramount importance in water resources evaluation. Stream discharge is quite important on both concentration of substance dissolved in the stream and on the distribution of habitat and organism throughout the stream, Discharge is also a major factor influencing water chemistry (Zubairu, 2009).

Stream flow or discharge is defined as the volumetric rate of flow of water in an open channel including any sediments or other solids that may dissolved or mixed with it that adhere to the Newtonian physics of open channel hydraulics of water. Stream flow cannot be measured directly but must be computed from variables that can be measured directly such as stream width, stream depth and stream flow velocity. Even though stream flow is computed from measurement of other variables the term "Discharge measurement" is generally applied to the final result of the calculations (Whiting, 2003).

Several methods are available for the measurement of river discharge and the choice will depend upon the magnitude and character of the channel and associated flow, cost and the accuracy required (Gregory and Walling, 1973). These include velocity area techniques, dilution gauging, volumetric gauging, slope area technique, weirs and flumes methods. However the weir method was used for this study because of its consistency (Yusuf, Iguisi and Bello, 2007). The type of structure used and details of its design will depend upon the purpose of measurement, the nature of the stream channel, the sizes of the channel and the resources available (Gregory and Walling 1973). Weirs may be classified into sharp-crested or thin plate weirs, and broad crested weirs. In the sharp-crested weirs, the notch and crest is formed by a sharpened metal plate, while in the broad crested weirs a thicker construction usually made of concrete is used.Sharp-crested weirs are commonly used in small catchments and the triangular form is especially suited to the accurate measurement of flow as low as 0.1 m/s. The 90° V notch is the commonly triangular weir form, although 120°notch are also employed depending on the sizes of the channel.

MATERIALS AND METHODS

The Study Area

The study area is located in Zaria, Kaduna State, Nigeria between Latitudes 11°05'50" to 11°10'25"North and Longitudes 7°35'40"to 7°38'50" East. Zaria is one of the province that make up the Central high plains of Northern Nigeria and it is approximately 670m above mean sea level. It is located about 950km away from the coast. Zaria is the second largest city in Kaduna State, covering a total land s of about 61km^2 making it a nodal point in terms of road and rail transport because of locational factors (Jatau, 1999; Arowolo, 2000). The Kubanni River takes its source from the Kampagi Hill, in Shika, near Zaria and flows in a southeast direction through Ahmadu Bello University main campus, Samaru. It has four major tributaries upstream of the Kubanni Reservoir.

The study area belongs to the tropical continental type of climate corresponding to Koppen's tropical wet and dry climate zone, characterized by strong seasonality in rainfall and temperature distributions (Oladipo, 1985). It has two distinct seasons: the dry or harmattan season (October to March) and wet season (April to September). The seasons generally coincide with the southward and northward movement of the surface transition known as Inter-Tropical Discontinuity (ITD) between the hot, moist tropical maritime air-mass (mTs) of Atlantic ocean origin to the south and the cold, drier tropical continental air-mass (cTs) blown by the northeast trades from the Sahara Desert.

Zaria is drained by three major rivers, the largest of which is River Galma that originates from Jos plateau and is a tributary of River Kaduna. It is a perennial river. The second river in Zaria is River Kubanni which have many tributaries including Malmo, Tukurwa, Maigamo and Goruba. The northernmost tributary, Malmo has its major source from Kampagi hill in Shika near Zaria. It flows in south east direction through Ahmadu Bello University. The third major river is River Saye which drains through the south western section of Zaria. These rivers are very important to the economic development and survival of Zaria as they provide most of the useful water for domestic, industrial and irrigational purposes (Yusuf, 2013).

In order to achieve the aim and objectives of this study, both Primary and Secondary data were used. The primary data is the stream discharge data that was obtained from the gauging stations using the weir method during the flow periods of the four tributaries; Malmo, Tukurwa, Maigamo and Goruba from May 2017 to January, 2018. The topographic map sheet of Zaria SW 102 served as secondary data and was utilized to present the gauging stations in Figure 1.

A calibrated 120° V-Notch sharp-crested weir was used for the Malmo tributary. The 120° V-Notch was already installed for the Malmo tributary by Yusuf (2006) with discharge formula of:

$$Q = 2.47H^{2.5} \qquad \text{---------------------} \ (1)$$

While the 90° V-Notch sharp-crested weir was used for Tukurwa which was also installed by Yusuf (2013). Two new 90° V-Notch sharp-crested weirs were constructed and installed at Maigamo and Goruba tributaries. The 90° V- Notch has a discharge formula of:

$$Q = 1.38H^{2.5} \qquad \text{---------------------} \ (2)$$

Where Q = Discharge in m^3/s H = Head of water in metres (stage).

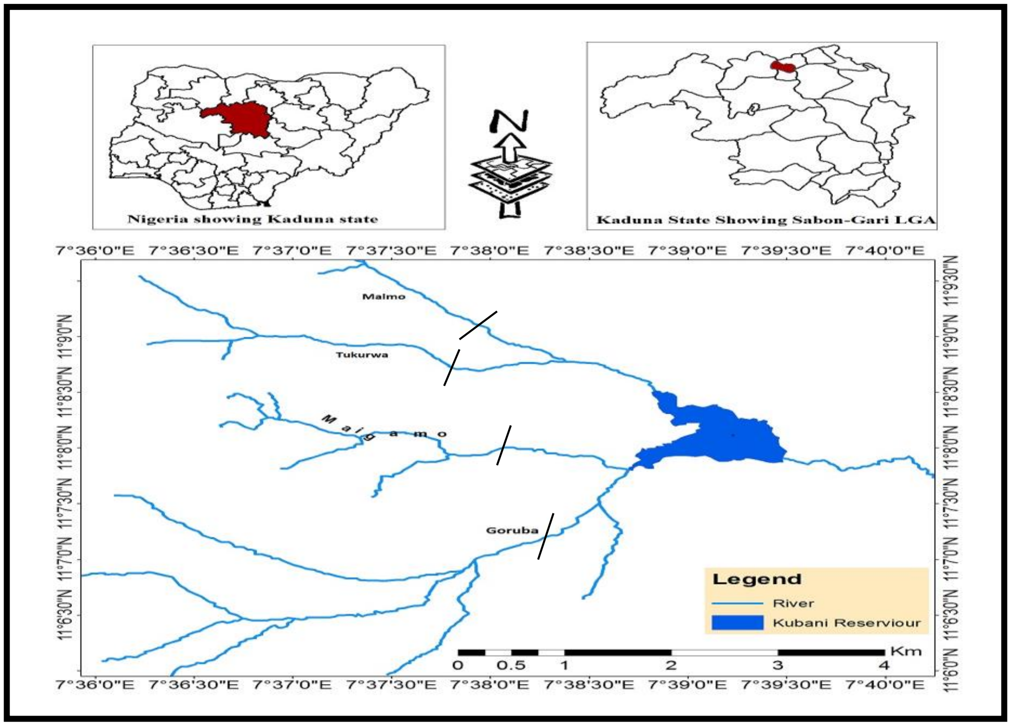

Figure 1: Map showing the Sampling Points along the Tributaries

Source: Adapted from Topographic Map of Zaria sheet SW 102

Measurements were observed after rainfall events and twice a day; in the morning (7.00am) and in the evening (6.00pm) everyday, which represent instantaneous and regular interval monitoring from May 2017 to January 2018. Subsequently, the daily average readings were inserted into the discharge formula in order to obtain the stream discharges. The instantaneous stream discharges data which were obtained from the gauging stations using the weir method were presented in a tabular form for all the tributaries. These were converted from cubic metres per second (m^3/s) to cubic metres per month (m^3/m) by multiplying the monthly sum totals by 60 seconds, 60 minutes and by 24 hours respectively to present the stream discharge regimes in charts.

Finally, Analysis of Variance (ANOVA) was used to compare the Stream Discharges of the tributaries upstream of River Kubanni.

Also for the four tributaries however, the velocity-area techniques were used in measuring the stream discharges. This is based on the fact that discharge, Q, is a direct function of average stream velocity, V, and the cross-sectional area of the channel, A, at the point of measurement:

$$Q = AV \qquad \text{-------------------- (3)}$$

The cross-sectional areas of the channels at the gauging stations were obtained by multiplying the channel width by depth. The relevant depth here is that measured from the water level to the bottom of the channel using installed weirs. The stream velocity can be obtained by using one of the several methods described by Gregory and Walling (1973). In this study however, the current metre and the float method were used because of its simplicity, accuracy and safety.

The current metre consist of a rotor which rotates at a speed proportional to the flow velocity. The revolution was counted over a fixed period of time. For this study however a fixed period of 30 seconds was used so as to get the velocity from the calibration data. Measuring tape was also used to obtain the width and the installed weirs to obtain the depth or head of the water.

Since Q= VA ---------------------(4)

Where Q = Discharge

V = Velocity measured in m/s

A = Cross sectional area (width X depth).

Since discharge by definition is the product of velocity and cross sectional area. Therefore, in order to obtain the discharge both the velocity and the cross sectional area were computed.

For the float method, a float that will not be submerged in the river were used, the weir which serves as the staff gauge was used to determine the head or depth of the stream and a stop watch were also used to determine the length of travel by the float at a given time. Since velocity is a product of length over time, a distance of 15 meter was used divided by the time obtained from the stop watch. Measuring tape was also used to obtain the width and the installed weirs to get the head of the water.

Since V= velocity measured in m/s

V= length / time A = cross sectional area (width X depth).

Though the float can be obstructed by vegetation, eddy current and wind, a float coefficient was used to compute the discharge. A generally accepted conversion factor is that the mean velocity in any given vertical profile is 0.85 times the surface velocity (Yusuf, 2012).

RESULTS AND DISCUSSION

Comparison between the Weir, Current metre and Float method in determining the stream discharge upstream of River Kubanni

A comparison between of discharge values obtained from the weir, current metre and float method were made for the four tributaries to see if there is significant difference in the result obtained from the techniques. Comparison were only made between the days it rains for that of the weir since the current metre and the float method can be applicable only after a rainstorm or when the rainfall is well established. By virtue of this, discharge data are only available for 37 days.

Similarly Analysis of Variance (ANOVA) was used to see if there is no statistically significant difference between the result obtained from the weir, current metre and float method in determining the stream discharges of the four tributaries upstream of River Kubanni at 0.05 significance level.

STREAM DISCHARGE FOR THE STUDY AREA

Table 1: Summary of Malmo Instantaneous Stream Discharges Using the Weir, Current Metre and Float Methods

Month	Weir Method	Current Metre	Float Method
May	0.2762	0.4828	0.4394
June	0.8784	1.0483	0.9430
July	1.1429	1.1520	1.0935
August	0.9650	1.2354	1.1338
September	1.3370	1.5008	1.3652
October	0.0060	0.0109	0.0263
Total	4.61	5.43	5.00
Mean	0.5117	0.6034	0.5557
SD	0.5608	0.6286	0.5743
CV%	109.6%	104.2%	103.3%

Source: Fieldwork, (2017).

Table 2: Summary of Tukurwa Instantaneous Stream Discharges using the Weir, Current Metre and Float Methods

Month	Weir Method	Current Metre	Float Method
May	0.387	0.6569	0.5728
June	1.4925	1.6054	1.5239
July	1.0134	1.3946	1.3257
August	1.9483	1.8924	1.7719
September	2.5075	2.5486	2.3156
October	0.0625	0.0259	0.0598
Total	7.41	8.12	7.57
Mean	0.8235	0.9026	0.8411
SD	0.9809	0.9801	0.9046
CV%	119.11	108.6%	107.6%

Source: Field Survey, (2017).

Table 3: Summary of Maigamo Instantaneous Stream Discharges using the Weir, Current metre and Float Methods

Month	Weir Method	Current Metre	Float Method
May	1.0698	1.5160	1.4990
June	2.2305	2.7806	2.8158
July	1.5790	1.8888	1.5623
August	2.7229	3.1152	3.1094
September	1.7017	2.3249	2.0437
October	0.0217	0.0261	0.0732
Total	9.34	11.65	11.10
Mean	1.0362	1.2946	1.2337
SD	1.0789	1.3050	1.2634
CV%	104.1%	100.8%	102.4%

Source: Field Survey, (2017).

Table 4: Summary of Goruba Instantaneous Stream Discharges using the Weir, Current Metre and Float Methods

Month	Weir Method	Current Metre	Float Method
May	1.2056	1.6124	1.4419
June	1.4481	1.8954	1.7572
July	1.8487	2.4766	2.2868
August	6.3136	7.2026	6.8766
September	2.6138	4.1994	3.7224
October	0.0738	0.0543	0.0647
Total	13.50	17.44	16.15
Mean	1.5004	1.9379	1.7944
SD	2.0435	2.4506	2.3067
CV%	136.2%	126.5%	128.6%

Source: Field Survey, (2017).

Table 5: Effectiveness of the methods for Malmo stream

Techniques		Sig	Remark
Weir	Current Metre	0.284	No Significant difference
	Float Method	0.843	No Significant difference
Current Metre	Float Method	0.599	No significant difference

Source: Authors Computation, (2017)

Variables	Sum of Square	Df	Mean Square	F- cal	F-Critical	Remark
Between Groups	0.007	2	0.004	1.189	3.09	No Significant difference
Within Group	0.320	108	0.003			
Total	0.327	110				

Table 6: Effectiveness of the methods for Tukurwa Stream

Techniques		Sig	Remark
Weir	Current Metre	0.977	No significant difference
	Float Method	0.733	No significant difference
Current Metre	Float Method	0.604	No significant difference

Source: Authors Computation,(2017)

Variables	Sum of Square	Df	Mean Square	F- cal	F-Critical	Remark
Between Groups	0.010	2	0.005	0.510	3.09	No significant difference
Within Group	1.031	108	0.010			
Total	1.041	110				

Table 7: Effectiveness of the methods for Maigamo Stream

Techniques		Sig	Remark
Weir	Current Metre	0.387	No Significant difference
	Float Method	0.639	No Significant difference
Current Metre	Float Method	0.909	No significant difference

Source: Authors Computation, (2017).

Variables	Sum of Square	Df	Mean Square	F- cal	F-Critical	Remark
Between Groups	0.083	2	0.042	0.911	3.09	No Significant difference
Within Group	4.942	108	0.046			
Total	5.025	110				

Table 8: Effectiveness of the Methods for Goruba Stream

Techniques		Sig	Remark
Weir	Current Metre	0.183	No Significant difference
	Float Method	0.428	No significant difference
Current Metre	Float Method	0.858	No significant difference

Source: Authors Computation, (2017).

Variables	Sum of Square	Df	Mean Square	F- cal	F- Critical	Remark
Between Groups	0.222	2	0.111	1.663	3.09	No Significant Difference
Within Group	7.218	108	0.067			
Total	7.440	110				

The analysis of variance was used in this study in order to make a comparison of the discharge values obtained using the current metre, float and weir techniques from tables above The results shows that the F- calculated for all the four tributaries are less than the table values at 0.05 significant difference. This means that there is no significance difference between the stream discharges results obtained from the techniques. Thus implying that both methods are suitable for measuring stream discharges for small rivers like Kubanni River. However, the field observation shows that the weir technique is of greater applicability and more advantageous for continuous discharge measurements than the current metreand float methods. The weir technique can be used throughout the year and when the river becomes too shallow for current metre to be used. Also, the weir is of greater advantage compared to the float method, because float method is sometimes affected by vegetal growth, eddy current and wind. It is therefore recommended that for small river channels, the weir method is the most effective technique for stream discharge measurement.

CONCLUSION AND RECOMMENDATIONS

The study has shown that there is no significant difference between the weir technique and the Velocity Area method in determining the stream discharge upstream of River Kubanni, Zaria, Nigeria. Although the weir technique is more superior to the current metre and float method because its consistency.

Recommendations

Based on the results obtained from the research, some recommendations were made

a. The study recommend that there should be a continuous monitoring of stream discharge upstream of the Kubanni, since the first and foremost requisite for planning of water resource development is the availability of accurate data of stream flow for a considerable period of time to determine the extent and pattern of available water supply.

b. Measures such as construction of check dams should be put in place upstream to minimize siltation of the reservoir since sediment yield in any reservoir has a relationship with the stream discharge

c. Pollution control measures should be employed. For example poor farming practices and irrigation should be discourage since stream discharge involves the transportation of both sediment and dissolved substances into the river or reservoir there by influencing the water chemistry.

d. Measures to prevent or control flooding should be established since there was an increment in the flow period from each tributary, as water will be forced into the land destroying the farmland and properties since it's exceed its carrying capacity.

e. Lastly it is recommended that the weir method is the most effective technique for stream discharge measurement because of its consistency.

REFERENCES

Arowolo, O.T. (2000). *An Assessment of Sediment Yield of River Saye and River Kubanni*Unpublished B.Sc. Dissertation, Department of Geography, A.B.U.Zaria.

Ayoade, J.O. and Oyebande, B.I. (1978). Water Resources: Geography of Nigeria Development. Pp. 71-78.

Biswas, A. K. (1998). Water Resources: Environmental Planning Management and Development. McGraw Hill Publication Comp.

Gregory, K.J. and Walling, D.E. (1973). Drainage Basin Form and Processes: A Geomorphological Approach. London: 456 pp.

Herschy, R. W. (1995). *Stream flow treatment* (2nd Ed) Taylor and francis. London pp. 524.

Ibrahim M (2011). A comparative analysis of water quality in the Kano River and the newTamburawa treatment plant in Kano, Nigeria. Unpublished MSc thesis. Department of Geography ABU Zaria.

Iguisi, E. O. (1997). An assessment of the current level of sedimentation of the KubanniDam. Savanna, 18(1), pp. 17-28.

Jatau, F. (1999). 'Nature and Problems of Fadama Farming in Zaria Local Government,Kaduna State, Nigeria.' Unpublished B.Sc. Project. Department of Geography, Ahmadu Bello University, Zaria.

Motimore, M. J. (1970). Zaria and its region. A Nigerian savanna city and its environs occasional paper No 4 Department of Geography ABU Zaria published for the 14th AnnualConference of the Nigerian Geographers' Association, Zaria January 1970.

Ogunkoya, O.O. (2000). Discrepancies in discharge records derived using the staff Gauge, staff gauge-crest stage indicator and water level recorder in S.W. Nigeria. *The Nigerian Geographical Journal, New Series, 3 and 4,* pp. 169-82.

Oladipo, E.O. (1985).*Characteristics of thunderstorms in Zaria, Nigeria*. Weather 40, p. 316

Ologe, K.O. (1971).*Gully Development in the Zaria Area, Northern Nigeria (with particular reference to the Kubanni basin).* Unpublished Ph.D Thesis, University of Liverpool.

Whiting, P. J. (2003*). Flow measurement and characterization in Fluvial Geomorphology*. John Willey and sons Limited, Chechester, pp. 688.

www.wateraid.org "State of water" 22nd March, 2016

Yusuf Y. O., Iguisi E.O. and Bello, A.L. (2007). A comparative analysis between the use of velocity area method & the weir technique in assessing discharge of River Kubanni, Zaria Nigeria, *Journal of Geography, Environment and planning (JOGEP/ 3(1): 14-22.* A publication of the Department of Geography and Planning science, University of Ado- Ekiti Nigeria: ISSN 1595-4373.

Yusuf, Y.O. (2006).*"An Analysis of the Magnitude of Suspended Sediment Production by the Northernmost Tributary of the Kubanni River, Zaria, Kaduna State".* Unpublished M.Sc Thesis. Department of Geography, A.B.U. Zaria.

Yusuf, Y.O. (2012). Sediment delivery into the KubanniResevoir ABU Zaria. Unpublished PhD dissertation. Department of Geography ABU Zaria.

Yusuf, Y. O., Eguisi, E. O. and Abdulsalam, S. (2011). A Comparative Analysis of discharge measurement on a first order stream in Zaria using the current metre and float method. *A paper presented at the fourth annual conference of the science association of* Nigeria, ABU Zaria. 24th – 28th, July 2011.

Zubairu Y. I. (2009). A comparative analysis the use of VAM & Weir technology in determining stream discharge of river tukurwa Zaria. Unpublished B.sc project, Department of Geography, ABU Zaria.

RELEVANCE OF GREEN TECHNOLOGY IN SUSTAINABLE ECONOMIC GROWTH AND HEALTHY ENVIRONMENT IN NIGERIA.

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Abstract
The massive demand for energy has led to increased use of fossil fuels which pollutes the environment and depletes the forests resources. Anthropogenic activities has been associated with increased atmospheric concentrations of greenhouse gases (Cox, NOx, Sox, Methane, tropospheric ozone) since two hundred years ago. This increases has been associated with global climate change and warming. Consequently accelerated desertification, increased melting of snow and ice, sea level rise and stronger storms and tsunami's among others are the resultant effects of climate change.Green technology ensures the application of environmental science to offer economically viable solutions that conserve natural environment and resources, and curb the negative impacts of human involvement on the environment. Green technology aims at slowing down global warming and reducing greenhouse effects. Green technology consists of technological interventions that borders on exploring alternative sources of energy such as; enhanced geothermal systems, nano solar energy and wave power as enumerated. In addition, are recycling of metals, paper, plastics, E-waste and clothing's and other means of reducing energy consumption, which can results into less harm to man, biodiversity and the general health of the ecosystem. This paper hereby review the concept of green technology and eco-friendly technology and the benefits that can be harnessed in, adopting, implementing and sustaining it's ideology.

***Keywords**: Global environment change, greenhouse gases, pollution, technology, tropics.*

INTRODUCTION

Multiple lines of evidence confirm that human activities are the primary cause of global warming for the past 50 years (Melillo, J.M., *et al*., 2014).Global urbanization is in no doubt the major contributor to global warming. Historically, global urbanization has been an essential ingredient for national economic growth and isbeneficial to causing social transformation. However, urban populations generate two-thirds of global greenhouse gas emissions. Fifty-five percent of the global population resides in urban areas, a percentage that is expected to increase to 66 percent by 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2014). Global policymakers are urging mayors and regional leaders to make difficult decisions to reduce the negative impacts of urbanization on the environment. The world's nations focused on both the contributions of and responsibilities inherent to urbanization in achieving global carbon emissions levels in the COP21 Paris Pledge for Action in the Paris City Hall Declaration (2015) and UN Habitat III (2016). Natural factors, such as variations in the sun's output, volcanic activity, the carbon cycle, and others, also affect Earth's radoiactive balance. However, beginning in the late 1700s, the net global effect of human activities has been a continual increase in greenhouse gas concentrations. Especially the rapid rise in fossil fuel combustion has produced a corresponding rapid growth in CO_2 emissions and accounts for over 80% of global anthropogenic green house gas emissions (GHGs) in 2008.This change in concentrations causes warming and is affecting various aspects of climate, including surface air and ocean temperatures, precipitation, and sea levels. Human health, agriculture, water resources, forests, wildlife, and coastal areas are all vulnerable to climate change.Climate change is having a major impact on food security. More than 815 million people are chronically hungry and 64 percent of the chronically hungry are in Asia (FAO, 2017).Mitigating climate change is one of the biggest challenges that confront mankind in the present millennium. It was shown that a substantial amount of CO_2 emissions still emanates from the increased use of heavy polluting fuel like coal by industrializing countries like the United States, Japan and China. Historically, the developed countries have contributed the most to cumulative global CO_2 emissions and still have the highest total historical emission.

Many greenhouse gases are extremely long-lived in the atmosphere, with some remaining airborne for tens to hundreds of years after being released. These long-lived greenhouse gases become globally mixed in the atmosphere and their concentrations reflect past and recent contributions from emissions sources worldwide. Others, like tropospheric ozone, have a relatively short lifetime in the atmosphere.
A report issued in 2001 by the Intergovernmental Panel on Climate Change (IPCC) stated that it is “virtually certain” that emissions of carbon dioxide due to fossil fuel burning are the main cause of increasing atmospheric carbon dioxide during the 21st century.

The graph below shows temperature records and atmospheric carbon dioxide concentrations over the past 1,000 years(figure 1).

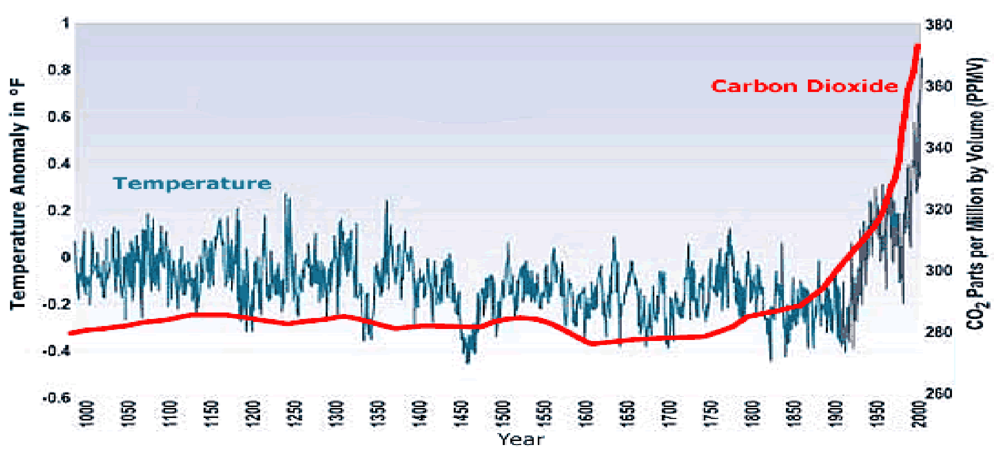

Figure 1: Temperature records and atmospheric carbon dioxide concentrations over the past 1,000 years.

Adapted from USGCRP

Composite graph showing temperature anomaly and carbon dioxide level over the past 1,000 years.

Sources of Green House Gases

Natural Sources of Climate Change

Most of the natural processes that influence climate take place over thousands or millions of years, but some sudden changes in climate have also occurred(Kring, D, A. 2007). Natural sources of climate change are:

Volcanic activity, solar variability, changes in Earth's orbit and tilt, changes in ocean circulation, plate tectonics andbiological evolution.

Human activities have increased greenhouse gas concentrations in the atmosphere.

The most important GHGs directly emitted by humans include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and several others. The sources and recent trends of these gases are detailed below.

Carbon dioxide

Since the 19th century, human-induced CO_2 emissions from fossil fuel combustion, cement manufacture and deforestation have disturbed the balance, adding CO_2 to the atmosphere faster than it can be taken up by the land biosphere and the oceans (HeddaRansan-Cooper *et al.*, 2015).

Carbon dioxide is the primary greenhouse gas that is contributing to recent climate change. CO_2 is absorbed and emitted naturally as part of the carbon cycle, through plant and animal respiration, volcanic eruptions, and ocean-atmosphere exchange. Human activities, such as the burning of fossil fuels and changes in land use, release large amounts of CO_2, causing concentrations in the atmosphere to rise.Atmospheric CO_2 concentrations have increased by more than 40% since pre-industrial times, from approximately 280 parts per million by volume (ppmv) in the 18th century to over 400 ppmv in 2015.

Methane

Methane is produced through both natural and human activities. For example, natural wetlands, agricultural activities, and fossil fuel extraction and transport all emit CH_4.

Methane is more abundant in Earth's atmosphere now than at any time in at least the past 800,000 years (IPCC, 2013). Due to human activities, CH_4 concentrations increased sharply during most of the 20th century and are now more than two-and-a-half times pre-industrial levels. In recent decades, the rate of increase has slowed considerably (IPCC, 2013).

Nitrous oxide

Nitrous oxide is produced through natural and human activities, mainly through agricultural activities and natural biological processes. Fuel burning and some other processes also create N_2O. Concentrations of N_2O have risen approximately 20% since the start of the Industrial Revolution, with a relatively rapid increase toward the end of the 20th century (IPCC, 2013).

Overall, N_2O concentrations have increased more rapidly during the past century than at any time in the past 22,000 years (IPCC, 2013).
Water vapor:They are the most abundant greenhouse gas and also the most important in terms of its contribution to the natural greenhouse effect, despite having a short atmospheric lifetime. Some human activities can influence local water vapor levels. However, on a global scale, the concentration of water vapor is controlled by temperature, which influences overall rates of evaporation and precipitation(IPCC, 2013). Therefore, the global concentration of water vapor is not substantially affected by direct human emissions.

Tropospheric ozone (O_3)**,** which also has a short atmospheric lifetime, is a potent greenhouse gas. Chemical reactions create ozone from emissions of nitrogen oxides and volatile organic compounds from automobiles, power plants, and other industrial and commercial sources in the presence of sunlight. In addition to trapping heat, ground-level ozone is a pollutant that can cause respiratory health problems and damage crops and ecosystems.

Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6), together called F-gases, are often used in coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants. Unlike water vapor and ozone, these F-gases have a long atmospheric lifetime, and some of these emissions will affect the climate for many decades or centuries.

Climate Change Adaptation and Mitigation in the Food Sector.
Agriculture is not only a fundamental human activity at risk from climate change, it is a major driver of environmental and climate change itself. It has the largest human impact on land and water resources. About 1.4 billion ha of arable land (10 percent of total ice-free land) are used for crop cultivation and an additional 2.5 billion ha are used for pasture (Easterling, W.E. *et al*.,2007). Roughly four billion ha are forested land, five percent of which is used for plantation forestry. In addition to land resources, agriculture is a major user of water. Over 200 million ha of arable land is under irrigation, utilizing 2 500 billion mm of water annually, representing 75 percent of fresh water resources withdrawn from aquifers, lakes and rivers by human activity. Irrigation sustains a large portion of total food supply – about 40 percent in the case of cereals.

As a result of these large-scale activities, agriculture is a significant contributor to land degradation and, in particular, a major emitter of greenhouse gases. It emits into the atmosphere 13-15 billion tonnes CO_2 per year, about a third of the total from human activities. Overall, agriculture is responsible for 25 percent of carbon dioxide (largely from deforestation), 50 percent of methane (rice and enteric fermentation), and more than 75 percent of N**4** O (largely from fertilizer application) emitted annually by human activities (Easterling, W.E. *et al*., 2007).
If emissions of greenhouse gases, including those from agriculture, are not controlled in the coming decades, continued growth of their atmospheric concentrations is projected to result in severe climate change throughout the twenty-first century.

If "dangerous anthropogenic interference" with the climate system is to be avoided in coming decades and warming is to be limited to "acceptable" temperature increases, then stabilization of atmospheric concentrations must be achieved. This will require significant cuts in global emissions, starting now and certainly no later than 2020 or 2030.

In particular, a number of mitigation strategies in the agriculture and forestry sectors have been identified as useful in achieving the goal of stabilization of atmosphericconcentrations between 450-550ppm CO_2 (Easterling, W.E. *et al*., 2007). These include reduced deforestation and degradation of tropical forests (REDD), sustainable forest management (SFM) andforest restoration (FR), including afforestation and reforestation (A/R). In agriculture,they involve reduction of non-CO_2 gases through improved crop and livestockmanagement and agroforestry practices, enhanced soil carbon sequestration inagricultural soils via reduced tillage and soil biomass restoration.

Different Types of Green Technology Products

Green technology products are items which factor environmental awareness into their design anduse. Green technologies products aim to reduce waste, cut pollution, and even diminish fossil fueluse. Some of the major types of green technology products include energy creation products, greenchemicals, sustainable or recyclable products, and technology that run on alternative energy.

Products that help create alternative energy, such as solar panels and thermal heating discs, aresome of the most important green technology products used in everyday life. Solar panels, whichcan be installed on homes, apartments, and commercial buildings, use the sustainable heat of thesun to charge solar batteries, which can be used for electricity instead of traditional, nonsustainablesourceslikegas.

Green chemicals are important in many green technology products.These products aim to create the same effects as toxic, polluting chemicals, while reducing risk ofpoisoning and environmental harm. Green chemical products include home cleaning agents madeout of coconut and glycerin, insecticides that use orange or peppermint oil instead of toxicchemicals, and even green laundry detergent that can reduce water pollution. Sustainable andrecyclable green technology products help increase the life cycle of consumer material. Theseproducts may include cell phones made from plastic water bottles, appliances rebuilt from scrapmetal, and even recyclable laptops. Green technology products that use sustainable and recyclablematerials often advertise their involvement in recycling initiatives; consumers shopping for a newcell phone or laptop may wish to inquire about specific models that use recycled materials. Solarpowered charging devices for phones, laptops, and portable appliances are also popular greentechnology products. By converting everyday products to alternative energy power sources, greentechnology can help reduce fossil fuel use and help users cut energy bills.

Applications of Green Technology in our Lifesolar Array

One of the best known examples of green technology would be the solar cell. A solar cell directlyconverts the energy in light into electrical energy through the process of photovoltaics. Generatingelectricity from solar energy means less consumption of fossil fuels, reducing pollution andgreenhouse gas emissions.

Adaptation strategies in agriculture

Undertaking changes in forest management, including hardwood/softwood species mix, timber growth and harvesting patterns, rotation periods; shifting to species or areas more productive under new climatic conditions, planning landscapes to minimize fire and insect damage, adjusting fire management systems;

initiating prescribed burning that reduces forest vulnerability to increased insect outbreaks as a non-chemical insect control; and adjusting harvesting schedules (Howden, *et al.*, 2007).

Synergies in adaptation and mitigation

Reducing methane emissions via integrated rice and livestock systems traditionally found inWest Africa, India, Indonesia and Vietnam, is a mitigation strategy that also results in betterirrigation water efficiency – it can also provide new sources of income while improvingperformance of cultivated agro-ecosystems, and enhance human well-being.

O-emissions – can lead to improved groundwater quality and reduced loss ofbiodiversity.

Reducing N_2Integrating animal manure waste management systems, including biogas capture and utilization, for reductions of CH4 and NO – could result in greater demand for farmyard manure and create income for the animal husbandry sector where many poor are engaged.

Restoring land by controlled grazing – can lead to soil carbon sequestration, have positiveimpacts on livestock productivity, reduce desertification and also provide social security to thepoor during extreme events such as drought (especially in sub-Saharan Africa).

Practicing agroforestry – can promote soil carbon sequestration while also improving agroecosystem function and resilience to climate extremes by enriching soil fertility and soil water retention.(Smith, *et al.*, 2007).

Building with Green Technology

Green buildings use a variety of environmentally friendly techniques to reduce their impact on the environment. Reclaimed materials, passive solar design, natural ventilation and green roofingtechnology can allow builders to produce a structure with a considerably smaller carbon footprintthan normal construction. These techniques not only benefit the environment, but they can produceeconomically attractive buildings that are healthier for the occupants as well. The chief benefit ofbuilding green is reducing a building's impact on the environment. Using green buildingtechniques can also reduce the costs associated with construction and operation of a building.Green ventilation techniques involve open spaces and natural airflow, reducing the need fortraditional air conditioning and preventing many of these problems. Also reducing plastic waste is great for the environment. Hence, trendy reusable water bottles that you can refill yourself are health-promoting, eco-friendly, habit.

Energy Storage

Nanotechnology holds great promise for improving the performance and life-times of the Li-ion batteries. It also has the potential to enhance the energy and power density, shorten the recharge time, as well as decrease the size and weight while improving safety and stability of the batteries (Frost & Sullivan, 2009). A large number of companies such as Altair Nanotechnologies, mPhase Technologies, A123 Systems, Li-Tec Battery GmbH, NanoEner Technologies, Next Alternative Inc., Nexeon Ltd. etc. are actively pursuing the development of nano-enabled batteries while some others are already producing them as summarized below. Nanotechnology has a significant potential to solve or mitigate the problem of global warming. However, one has to approach this issue carefully. Nanotechnology invariably involves use of nanomaterials (nanocatalysts, nanomembranes, nanoparticles, aerogel etc.) and their production requires a significant amount of energy input. If the source of this energy input is fossil fuels, then the whole purpose of reducing CO2 gas emission and preventing global warming is nullified (20). The only option available at our disposal is to use renewable sources of energy, such as, solar or nuclear energy (clean and non-polluting), at every step.

CONCLUSION AND RECOMMENDATION

On the 16thday of March, 2019, a natural disaster caused by Cyclone Idai occurred in Mozambique, south east Africa. It claimed more than 1,000 lives, again 70 villages in Iran were submerged in flood with 45 persons dead. These were rare phenomena where rain water pouring from the sky. These are pointers for increasing need to mitigate the effect of green house gases on climate.

Green technology, welcome ideaologies that are eco-friendly, biomimicry is a better approach to solving most of the climate change challenges. By biomimicry we mean studying nature properly such that whatsoever is manufactured has a way of being recycled into the eco-system. For instance, chemicals used to produce plastics turn which make them non-biodegradable, research should therefore factor out chemicals that will dissolve it back to a biodegradable form. Every production should pass through a cycle of serving it usage and being able to biodegrade back into the eco-system, by this we will not create object, materials, or anything that will be nuisance to our environment. The other aspect that needs to be closely examined is the economics of applying nanotechnologies of global warming. This calls for a detailed cost-benefit analysis. Needless to say, firm commitments from major industries and governments alike are also essential.

The world environment is getting more polluted, more than 8 million plastics are produced annually. A healthy planet depends on us all. Recently, the arctic region increase in temperature by 3^{o}C -5^{o}C leading to rise in sea level. It therefore recommended that technologies which could pull back C from the atmosphere is required. Resolutions from the 4th UN environmental Conference suggest it is time for action. Actions such as sharing of data world wide are necessary to be able to ascertain the level degradation in every continent. Product that allow sustainable development, environmentally-friendly and product that renewable. For instance a Kenyan makes leather shoes from fish skin. Innovations that borders on water bodies, global exploitation of natural resources without having a negative impact on the ecosystem should be a continuum. It is predicted that the earth will become 4^{o}Cin the next 10 years than it is now. Morealso the Himalayan glaciers are melting at a rapid rate, so therefore all of us have to lend our hand to fight global warming. Plant more trees, don't waste water, don't use or burn plastics, are immediate approach to save our world environment.

Further research focusing on how regional and provincial policymakers can successfully differentiate, coordinate, and harmonize the goals of both long- and short-term strategies to achieve low-carbon urbanization can be advantageous.

REFERENCES

Dey, C., Berger, C., Foran, B., Foran, M., Joske, R., Lenzen, M., & Wood, R., (2003). Household environmental pressure from consumption: An Australian environmental atlas. Water, wind, art and 4debate: How environmental concerns impact on disciplinary research. Australia: Sydney University Press.

Easterling, W. E., Aggarwal, P. K. , Batima, P., Brander, K. M., Erda, L., Howden, S.M., Kirilenko, A., Morton, J., Soussana, J.-F., Schmidhuber, J. and Tubiello, F.N. (2007). Food, fibre and forest products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of WG II to the Fourth Assessment Report of the IPCC, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds., Cambridge UniversityPress, Cambridge, UK, 273-313.

FOA, (2017). Food and Agricultture Organization of the United Nations 2017.

Frost and Sullivan, 2009) Impact of Nanotechnology in the Energy Industry (Technical Insights).? December 2007. http://www.frost.com/ (accessed May 7, 2009). 20. ?Nanotech could give Global Warming a Big Chill?, Nanotech Report by Forbes/Wolfe, 5 (7), (2006).

Ghanshyam Das Soni, (2015). Social Issues and Environmental Problems, Vol.3 (Iss.9:SE): Sep, 2015] ISSN- 2350-0530(O) ISSN- 2394-3629(P).Http://www.granthaalayah.com ©*International Journal of Research – GRANTHAALAYAH*.

Grantha Alayah, (2015). Social Issues and Environmental Problems, Vol.3 (Iss.9:SE): Sep, 2015©*International Journal of Research* –[1-5] ISSN- 2350-0530(O) ISSN- 2394-3629(P). Http://www.granthaalayah.com.

Howden, M., Soussana, J.F. and Tubiello, F. N. (2007). Adaptation strategies for climate change. Proc. Nat. Ac. Sciences 104:19691-19698.

IPCC (2013). *Climate Change 2013: The Physical Science Basis*. *Contribution of WorkingGroup I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, (2007). *Mitigation of Climate Change*. Assessment Report 4, Working Group III, InterGovernmental Panel on Climate Change.

Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds.USGCRP (2014).*Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program.

NRC (2010).National Research Council. The National Academies Press, Washington, DC, USA.

Osaka, 2003 (United Nations Environment Programme, *Environmentally Sound Technologiesfor Sustainable Development*, Revised Draft (Osaka, Division of Technology, Industry and Economics, 2003). Available fromwww.unep.or.jp/ietc/techtran/focus/ sustdevest background.pdf (accessed 05 March 2012).

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B. ,Ogle, S., O'Mara, F., Rice, C., Scholes, B. and Sirotenko, O. (2007). Agriculture. In Climate Change2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report ofthe Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R.Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom andNew York, NY, USA.

UNFCCC, (2007). Investment and Financial Flows to Address Climate Change. UNFCCC, Bonn,Germany.

United Nations, Department of Economic and Social Affairs, Population Division, 2014. World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).

UNDERSTANDING ADAPTATION STRATEGIES OF RURAL MAASAI PASTORALIST TO CLIMATE CHANGE IN KAJIADO COUNTY, KENYA.

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Abstract
This study assessed adaptation strategies of Maasai pastoralist in Kenya to climate change and identify viable adaptation options to enhance their resilience. The study was carried out in Kajiado County and multiple data collection techniques such as in-depth interview with 305 households, focus group discussion, and key informant interview were used to assess adaptation strategies of pastoralist household and identify viable adaptation options for the study area. The study also showed that Maasai pastoralists already have many adaptation measures to cope with the impacts of climate extremes. However, increase in drought occurrence in the last few years is reducing their resilience. This study observed that most of the adaptation and coping strategies adopted by Maasai pastoralist are autonomous and are unlikely to build resilience of pastoralist livelihoods and ecosystemsto cope with the projected magnitude and scale of climate change in the 21st Century. The study identified adaptation strategies such as effective early warning system,water harvesting, rapid infrastructural development, encouraging table banking and cooperative societies, Building and equipping schools, migration, livestock diversification and child education as long term no regret adaptation option that can enhance resilience of Maasai pastoralist to climate change and its extremes in the arid and semi arid lands of Kenya.

Keywords*: Adaptation strategies, climate change, Maasai pastoralist.*

INTRODUCTION

Adaptation is a broad concept covering actions taken by individuals, households, communities, private and public organizations. Successful adaptation can reduce vulnerability by strengthening existing coping and adaptation strategies. For many decades, pastoral communities in Arid and Semi Arid Lands (ASALs) have developed indigenous ways of adapting to varying degree of occurrence ofdry spells and drought; however, recent increase in the frequency of occurrence of these weather events is stretching the resilience of the pastoral community and may have adverse effect on the future generation of Maasai pastoralist in Kajiado.Pastoral communities have for a long time used indigenous forecasting methods to predict seasonal climatic events (Winnie et al., 2002). Some of the Maasai pastoral communities observe clouds, wind and lightning that likely have their origins in traditional understandings of what contemporary researchers recognize as atmospheric science. Others watch the behaviour of livestock, wildlife and the local flora (Amwata, 2013). However, many traditional forecasting methods are perceived as becoming less reliable with increasing climate variability.

Studies(Opiyo 2014; Osano*et al.*,2013; Amwata 2013;Silvestri*et al.*,2012) have analyzed and documented pastoralists' adaptation and coping strategies to climate change and variability at the community and household level. Given the projections for increasing drought impacts in the pastoral areas, it is important to inform policy makers on various adaptation and coping responses at local levels in order to reduce risks associated with drought. This study document coping and adaptation strategies and identified viable adaptation strategies that will enhance adaptation of the Maasai pastoralist communities to climate change and variability.

MATERIALS AND METHODS

The study was carried out in selected villages in Kajiado County in Kenya. Kajiado County is located in the southern tip of the former Rift valley province between longitudes 36°5 and 37°5 and latitudes $1^0$0 and $3^0$0 South (Amwata, 2013). It covers an area of 19,600Km^2. The County has 173,464 households and a population of 687, 312 of which 50.2% are male and 49.8% are female. Kajiado County is bordered by Tanzania to the south, TaitaTaveta County to the west, Narok County to the east and Nakuru, Kiamnau, Nairobi and Makueni Counties to the north. Kajiado has a population of 136,482 people and a land size of 2,610.30sq.km(Fg.1).

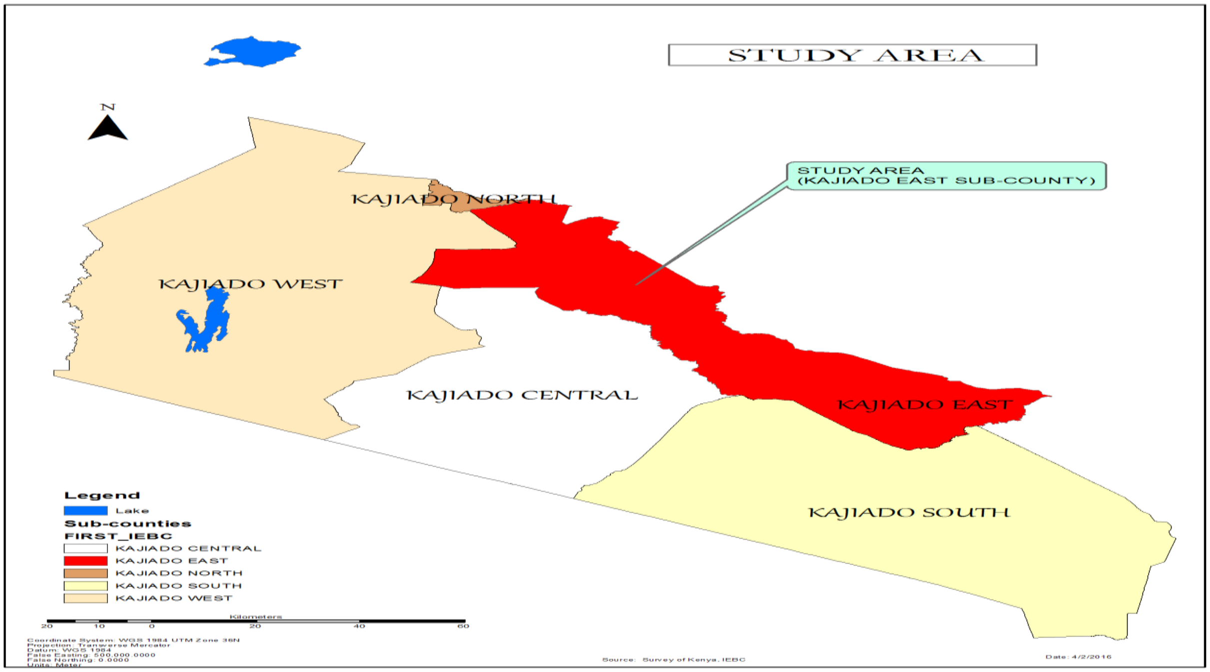

Figure 1: Map of the study area

Field study design and data collection process

The field study was conducted in Kajiado east sub-county. Kajiado east was selected because of its geographical location, sources of livelihood and proneness to extreme climatic events especially drought and dry spells. The study used multistage sampling technique. The sampling was conducted based on the five administrative wards in the sub-county. The list of villages and households were collected by the administrative chiefs. The households in the villages were listed from 1 to N (N = group size) and then systematic selection of the households were carried out. Thus, the choice of the household interviewed was based on systematic sampling procedure (Prewitt, 1975). A random start was used in choosing the first household to be interviewed and the interview was conducted in every seventh household. A total of 305 households were interviewed between November 2014 and February 2015.

Questionnaire interviews

Information on different aspects of the study was obtained through the administration of questionnaire on individual pastoralist households and community leaders. The information collected using the questionnaire included (1) demographic information about households; (2) socio-economic characteristics of individual households, including resource endowments, poverty levels, sources of income and infrastructural status; (3) climate-related extreme events and their impacts on the pastoralist livelihood; (4) adaptation and coping strategies of households to climate change and climate variability. The information collected from the questionnaire interviews was further validated through FGDs, informal interviews and general observations.

Focus group discussion and key informant interviews

A total of four (4) focus group discussions (FGDs) were conducted separately with a gender parity (of eight men and eight women) from the sampled villages. The pastoralists that participated in the FGD were selected based on gender with the help of the local leaders. Focus group discussion created opportunity for further interaction with the community members and lead to verbal expression and opinions about climate change and its effect on the pastoralist livelihood. The discussions captured the local knowledge on climate variability and its impacts on pastoralist communities, vulnerability, and adaptation and coping options to extreme climate events

Further discussions were held with a total of 30 people considered to be key informants individually between November 2014 and January 2015. The key informants were selected from local organizations in Kajiado County, Staff of the County meteorological department, local chiefs, village elders and drought monitors, community-based animal health workers, and opinion leaders.

RESULTS AND DISCUSSION

Gender and Educational level of respondents

Figure 2 shows the gender of household heads interviewed in the study area. Majority of the household interviewed 88% are headed by males while only 12% of the household interviewed were headed by females. This shows that the Maasai communities are patriarchal in nature and this may affect the access of female headed households to information and education about climate change and climate extremes that can enhance their coping strategies. Studies by (Omolo, 2010; and Ongoro and Ogara, 2011) reported that women in pastoralist communities in Kenya are more vulnerable to climate change and extreme climatic events because they are not always involved in decision making in the communities and pastoralist women also have less access to family resources and finances reducing their ability to manage risk and external climatic shock.

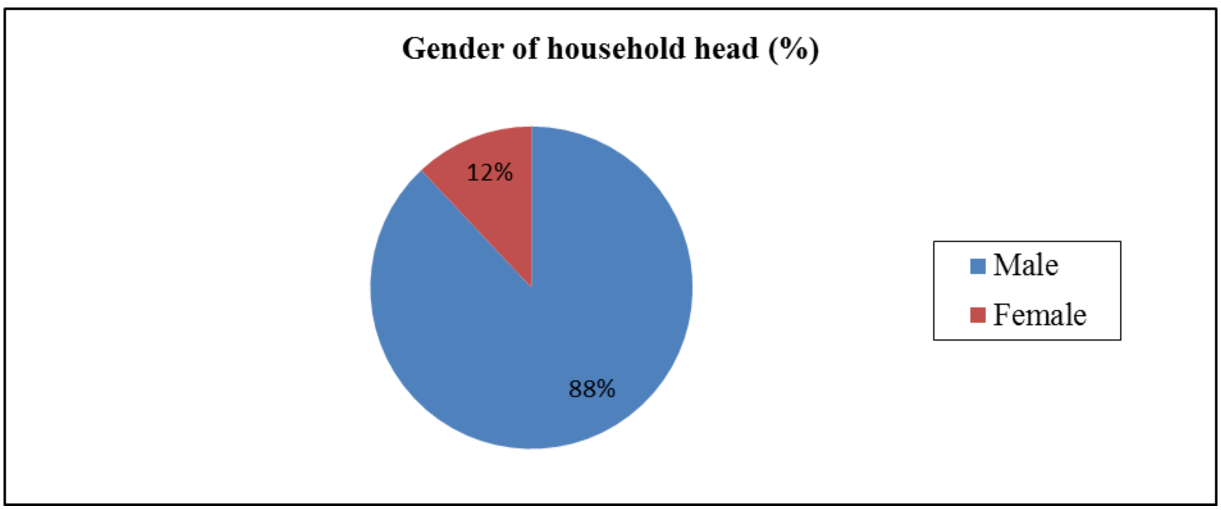

Figure 2: Gender distribution of household head

The educational level of respondents (Table 1) shows a high level of illiteracy amongMasaai pastoralist in Kajiado County. Half of (50%) female and 31% of male respondents have no formal education. This shows a higher level of illiteracy among Maasai women when compared to men. Illiteracy hinders access to information and also speed of recovery from a climatic events and also constraints options for livelihood diversification (Omolo, 2010; Kanguyu, 2014). 38% of female and 49% of male had access to primary education; 13% of female and 13% of male had access to secondary education; 3% of male had diploma degree and 2% of the male respondents have University degrees. This concurs with the findings of (Ongoro and Ogara, 2011 and Kanguyu, 2014) who reported high illiteracy levels among pastoralist in Kenya. GOK, 2013, also reported a high illiteracy rate of 65.2% for Kajiado County. Illiteracy limits the ability of an individual to take up opportunities such as employment and inhibits access to information and technical advice that could enhance adaptation to climate change.

Table 1: Educational level of respondents

Gender	Informal Education	Primary Education	Secondary Education	Diploma	University	Others	Total
Female	50%	38%	13%	0%	0%	0%	100%
Male	31%	49%	13%	3%	2%	1%	100%
Average	40.5%	43.5%	13%	1.5%	1%	0.5%	100%

Sources of livelihood of respondent

The sources of livelihood of are presented in Figure 3. The reports shows that 93% of respondent interviewed are involved in livestock keeping (pastoralism). Several studies (Bryan et al., 2009; Rao et al., 2011; Silvestri et al., 2012; Opiyo 2014) reported that pastoralism is the main source of livelihood in ASALs and pastoralist over years has developed mechanisms to cope with climate variability in the ASALs. However, increase in extreme climatic events such as drought in recent decades has made pastoralist develop alternative sources of livelihood such as engaging in business. This study shows that 66% of respondent are involved in business. Bead works, belt production and scandal production are the main business identified by respondent in this study. The study also shows that 8% of respondent are government employees, 7% are involved in crop production and 1% provide services such as tourist guards and house security.

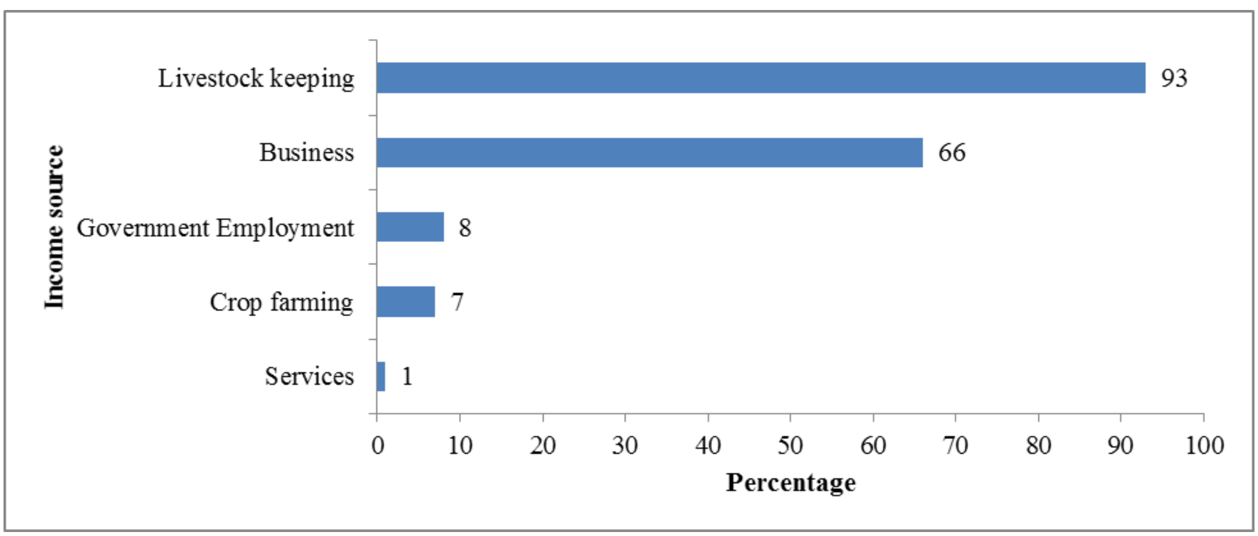

Figure 3: Source of livelihood of respondents

Adaptationstrategies of Maasai pastoralist to climate change and variability

Maasai pastoralist communities in Kajiado County over the years have developed strategies of coping and adapting to climate change and it's extreme. However, respondents agreed that increase in frequency and magnitude of extreme climatic events is increasing their vulnerability to these extreme climatic events. This study revealed the different strategies used by Maasai pastoralist to adapt to climate change and its extremes.

Table 2 summarizes the adaptation and coping strategies and the percentage of household using the adaptation strategies in the study area. Migration in search of pasture (79%), Destocking (68%), buying of hay (60%), livelihood diversification (74%), table banking and self held group (55%) were some of the strategies identified by respondent. Other strategies identified by the households include Harvesting of wild fruit, slaughtering of weak animals, diversification of herds, sending children to school and rain harvesting.

Table 2: Adaptation and coping strategies to climate change and variability

S/N	Adaptationstrategy	% of household
1	Migration	79
2	Destocking	68
3	Buying hay	60
4	Paddock grazing	55
5	Diversify livelihood (employment, bead making, tourist guide)	74
6	Table banking and self help group	55
7	Irrigated farming using borehole	25
8	Selling of land	27
9	Rain harvesting	35
10	Sending children to school	63
11	Tree planting	39
12	Building dams	23
13	Greenhouse farming	8
14	Diversification of herds	58
15	Animal health training	54
16	Food aid	38
17	Slaughtering of weak animals	45
18	Harvesting of wild fruit	59

Source: Authors compilation

Identified best adaptation options in the study area

The Maasai pastoralist households were asked to rate the adaptation strategies identified based on their level of importance. They rated the adaptation strategies that will significantly reduce their vulnerability to climate change and also areas where they will need assistance from external bodies such ad government organizations and NGOs. Table 3 shows the level of importance of adaptation strategies based on the rating of Maasai pastoralist. A five point rating scale was used to rate the level of importance of the adaptation strategies. The 5 point ordinal scale were graded either as 5= very important, 4= important, 3= moderate importance, 2= low importance, 1= no importance.

Rain harvesting and solving water problem was identified as the most important adaptation strategy in Kajiado County. Respondent identified water shortage as the biggest problem facing Kajiado County. Table 3 shows that 62.00% of respondent believed that solving water problem through water harvesting, building boreholes, dams and water pans is a very important adaptation strategy in Kajiado County. 25.4% reported that it's important, 10.8% reported that it is moderately important and 1.8% reported low importance. Lack of water for both human and animal use is a major challenge in Kajiado County. This challenge is further compounded by frequent drought that leads to drying up of water pans, wells and rivers. Rain harvesting, traveling long distance to fetch water and buying of water are some the adaptation strategy used by pastoralist. The importance of solving the water challenge was echoed by the FGDs with one the discussant stating:

Lack of water is one of the biggest challenges facing Kajiado County. We need the government and NGOs to assist in building borehole, dams and water pans for us and our livestock. This will stop the water borne diseases affecting people and also save our women and children the danger of traveling long distance in search of water.

Table 3: Level of Importance of Adaptation strategies to Maasai pastoralist households

Level of importance	% Respondent					Mean
	Very important	important	moderately	Low	No	
Rain harvesting/solving water problem	62.00	25.4	10.8	1.8	-	4.80
Child Education	45.6	35.8	9.5	7.2	1.9	4. 10
Improved infrastructure	42.6	36.8	10.4	5.6	4.6	4.05
Migration	32.4	35.8	15.0	8.2	8.6	3. 82
Promote table banking and cooperative organization	33.8	32.4	21.5	10.9	2.3	3.80
Livestock diversification	30.0	32.8	25.4	8.0	3.8	3. 76
Early warning system	30.4	30.6	26.8	7.9	4.3	3.72

Child education was also identified as one of the most important adaptation strategy among Maasai pastoralist. Maasai pastoralists in Kajiado County believe that child education is a long term adaptation strategy to climate change. They perceive education as a viable livelihood diversification strategy in a fast changing society that is making sustainability of pastoralism in the County uncertain. Table 3 shows that 45.6% of respondent reported that child education is a very important adaptation strategy, 35.8% believed it is important, 9.5% believed it is moderately important, 7.2% said it's of low importance and 1.9% said it is of no importance. Maasai pastoralists for decades saw education as an exit strategy and were not keen in educating their children. However, with increase urbanization, change in land use and increased climatic extremes, child education is now seen as the best way to prepare for an uncertain future. Previous studies by Opiyo et al., 2013 and Kagunyu 2014 also reported child education as a viable adaptation option in ASALs of Kenya.

Maasai pastoralist believed that improved infrastructure (better road network and availability of electricity) will improve their resilience to climate change and variability. 42.6% of respondent stated that improved infrastructure is a very important adaptation strategy and 36.8% believed it is important. GOK (2013) reported that Kajiado County has only 300km tarmac road out of the 2,344.2km road available in the County; it also stated that about half of the available road network (1111.9km) are earth roads. Improved road network will improve access to major town to seek for alternative sources of income by the pastoralist. It will also increase access to major markets in the County. Only 39.8% of the households in Kajiado County have access to electricity and this are mainly concentrated in the urban areas (GOK, 2013). Access to electricity especially in the rural areas will improve their access to information and early warning systems that will help in making fast decisions during climatic extremes. Respondent also reported that electricity will enhance livelihood diversification especially into electricity based livelihood.
Herd migration is one of the main adaptation strategies identified by pastoralist particularly in times of drought and dry spell. 32.4% of respondent reported that herd migration is a very important adaptation strategy and 35.8% reported it as an important adaptation strategy. Herd mobility enables opportunistic use of resources and help to minimize the effect of drought and dry spells (Opiyo, 2014). Maasai pastoralist in Kajiado has for years developed migratory route in search of pasture, water and market for

livestock. In times of extreme drought, pastoralists graze their animals in restricted national parks and sometimes cross the border to Tanzania in search of pasture and water. Focus group discussant reported that herd migration in Kajiado County is reducing due to increasing land sub division and sales; and increase in the chance of disease outbreak and death of animals during migration. FGD discussant suggested the creation of livestock migratory route in the County. This will allow pastoralist move their animals freely during drought and dry spells. Studies (Ellis and Swift 1988; Little and Leslie 1999) revealed that seasonal decisions to migrate ensure that households maintain the productivity of their herds and security of their families. This form of mobility is pursued primarily for livelihood purposes and is very strategic to the survival of the pastoralist system (McCabe 2006).

Table banking is a group funding system where members of a particular group meet regularly to save money, repay loans and other contributions and also borrow money as long term or short term loans (FGD, Entayiankat). 33.8% of respondent reported that table banking and cooperative society are very important adaptation strategies during extreme climatic events. Table banking and cooperative societies is a fast way of securing loans without collateral and also minimal interest rate among rural dwellers. Maasai pastoralist women in Kajiado County use table banking to secure loans for livelihood diversification and paying for children school fees.

Table 3 shows that 30.0% respondents reported that livestock diversification is a very important adaptation strategy in the study area, 32.8% reported that it is important, 25.4% reported moderate importance, 8.0% reported low importance and 3.8% said it is of no importance. Livestock diversification is one of the key adaptation strategies that have enable pastoralist communities to survive harsh environmental conditions for centuries (Speranza, 2010). Diversification of livestock herds has both ecological and economic implications as different livestock species had different water and pasture requirements and reacted differently to droughts and diseases. Respondents reported that new breeds that are drought tolerance and consumes less pasture such as Saiwal cattle, dairy goats and black headed Maasai sheep are now been reared by Maasai pastoralist in the area. They reported that dairy goats consume less forage when compared to cattle and they also produce nutritious milk.
Early warning against extreme climatic conditions gives communities ample time to take decisions (Amwata, 2013). Result shows that 30.4% of respondents stated that early warning system is a very important adaptation strategy in the study area. Discussants at the FGD agree with the statement made by one of them that:

Timely and reliable climatic information would enable the Maasai household make informed decision on whether to increase his herd size or sell part of his animals. It also helps to make decisions on the specie of livestock to retain. It is also useful in making important agricultural decisions by agro-pastoralist.
However, discussant at the FDGs complained that climatic information does not get to the communities early. They also complain about the accuracy of climatic information from government sources.

CONCLUSION
This study showed that the Maasai pastoralists in Kajiado County have always responded to climate variability using various strategies that are discussed in this paper. However, the study showed that most of the adaptation strategies adopted by the pastoralist are largely autonomous adaptation and are unlikely to build resilience of pastoralist livelihoods and ecosystemsto cope with the projected magnitude and scale of climate change in the 21^{st} Century. Moreover, the vulnerability of the Maasai pastoralist is exacerbated by the interaction among ‘multiple stresses’ including poverty, land use change and a low adaptive capacity. Planned adaptation actions are therefore needed to respond to current and anticipated impacts of climate change and variability among pastoralist in the arid and semi-arid lands of Kenya.
Effective early warning system, seasonal climate forecasting and information dissemination can be an effective planned adaptation strategy against drought among Maasai pastoralist in Kajiado County. For early warning information to beeffective and more than just a projected events, communities need to be

endowed with a wider range of information and capacities upon which they can rely to mitigate imminent crises. A clear understanding of the knowledge and experience of communities can guide early warning information and services content in such a way that valuable information can be provided at the grassroots level. Early warning information should include provision of seasonal climate and disease risk forecasts, timely information on the distribution of prices of key commodities across major markets and provision of information on the geospatial distribution of forage and water availability; it should also offer advice on effective and available risk mitigation strategies and how best to respond in the advent of a shock. The use of community radios to promote drought early warning system among pastoralist in Isiolo County in northern Kenya is a good example of community based early warning system. The vastness of land in most Maasai communities and poor infrastructure substantiates the use of community radio as an effective tool for effective early warning system in pastoralist communities.

REFERENCE

Amwata, D.A. (2013). The influence of climate variability and change on Land–use and Livelihoods in Kenya's Southern rangelands. A PhD thesis submitted to the Department of Land Resource Management and Agricultural Technology, University of Nairobi.

Bryan, E., Deressa, T.T., Gbetibuo, G.A., and Ringler, C. (2009). Adaptation to climate change InEthiopia and South Africa: options and constraints. Environmental Science Policy 12(4):413–426.

Ellis, J.E. and Swift. D.M. (1988). Stability of African pastoral ecosystems: alternate paradigms and implications for development. Journal of Range Management 41: 450–459.

GOK (2013). Government of Kenya. County Government of Kajiado, County Integrated Development Plan 2013-2017.

Huho, J.M. and Kosonei, R.C. (2014). Understanding Extreme Climatic Events for Economic Development in Kenya. IOSR Journal of Environmental Science, Toxicology and Food Technology 8 (2): 14-25.

Kagunyu, A.W. (2014). Effect of climate variability on the livelihood and coping strategies of theBorona community in Isiolo County, Northern Kenya. A PhD thesis submitted to the Institute of Arthropology, Gender and African studies, University of Nairobi.

Little, M.A., and P.W. Leslie. (eds). (1999). Turkana herders of the dry Savanna: Ecology and biobehavioral response of nomads to an uncertain environment, Oxford University Press, New York.

McCabe, J.T. (2006). Cattle bring us to our enemies. Turkana ecology, politics, and raiding in a disequilibrium system. Human Ecology 34(1): 147-149.

Ogallo, L.A. (2004). Traditional indicators used for climate monitoring and prediction by some rural communities in Kenya. ICPAC, Nairobi, Kenya.

Omolo, N. A (2010**).** "Gender and climate change induced conflict in pastoral communities: Case study of Turkana in Northwestern Kenya''. In*: African Journal of Conflict Resolution*, 102:81-102

Ongoro, E. B. and Ogara W. O. (2011). The Niche of Sociology in the Climate Change Debate. The Professional Journal Vol.3, 21-26.

Opiyo, E. O. (2014). Climate variability and change on vulnerability and adaptation among turukana pastoralist in north-western Kenya. A PhD thesis submitted to the Department of Rangeland management, University of Nairobi.

Osano, P. M., Mohammed Y. S., de Leeuw, J., Stephen S. M., Ole Kaelo, D., Schomers, S., Birner, R. and. Ogutu, J. O. (2013). Pastoralism and ecosystem-based adaptation in Kenyan Masailand. International Journal of Climate Change Strategies and Management 5(2): 198-21.

Rao, K.P.C., W.G. Ndegwa, K. Kizito, and Oyoo, A. (2011). Climate variability and change:farmer perceptions and understanding of intra-seasonal variability in rainfall and associated risk in semi-arid Kenya. Experimental Agriculture 47, 267–291.

Silvestri, S., Bryan, E., Ringler, C., Herrero, M. and Okoba, B. (2012). Climate change perception and adaptation of agro-pastoral communities in Kenya. Regional Environmental Change 12 (4): 791-802.

Winnie, L., J. Mcpeak, C. Barret, P. Little and G. Getchew (2002). *Assessing the Value of Climate Forecast Information for Pastoralists: Evidence from Southern Ethiopia and Northern Kenya.*Ithaca, New York: Cornell University Press.

EMERGING ISSUES IN THE USE OF AGRO-CHEMICALS AMONG ARABLE CROP FARMERS IN NIGERIA-A REVIEW

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Abstract
The paper appraised the emerging issues in the use of Agro-chemicals among arable crop farmers in Nigeria. The paper described the concept of agrochemicals, identified the classification of agrochemicals, identified it's application among arable crop farmers and the effects of the use and misuse on human lives, soil, water and the environment. The review used literature approach and cited empirical evidences. In an attempt to solve problems such as pest infestation of arable cropslow agricultural yield and production through indiscriminate use of agrochemicals other issues such as threats to human health, animal life, plant forms, soil, water and gradually destruction of environment are evolving .The review concluded that agrochemical usage is an integral part of crop production which should be well guided by experts in order to achieve the desired results by arable crop farmers. The paper recommended that farmers should be educated on the necessity of reducing the indiscriminate use of agrochemicals and the risk associated with its use so as to forestall further degradation of the ecosystem and the environment.
Keywords*: *Agrochemicals*, *Arable crop farmers*, *Water, Soil, Health*, *Environment

INTRODUCTION

Agriculture remains an important sector in Nigeria's economy as it serves as a resilient sustainer of the economy in terms of employment generation, food supply for the populace and means of generating income nationally (Abiwon, 2017). Agriculture over the years has played a tremendous role in food production, production of raw materials for agro-based industries and foreign exchange earnings which have contributed to the economic growth and development of the country.In tandem to this assertion, Oji-Okoro(2011) opined that agricultural sector is seen as an engine that contributes to the growth of the overall economy of Nigeria.

Nigeria's agricultural sector is generally dominated by small scale farmers whose farmlands varies from 0.10-5.99 hectares in size and constitute about 80.35 percent of all 29,800 million farm holdings (Ogunwale, 2005). The major problem of crop production among others as opined by Akobundu (1987) includes weed control, low soil fertility as a result of reduced fallow periods and the problem of insect pests and diseases. Other problems associated with Nigeria agricultural sector include but not limited to low yield which can be associated with weed, pest and disease invasion, climate change, lack of good storage and processing facilities and use of crude implements. According to Alabi, Banwo and Alabi (2006) pest damages crops at different stages of growth on the field, at harvest, during transportation and in storage leading to about 5-40% crop loss yearly which results in a serious effect on food security for the ever increasing population of the country.

In Nigeria authors have reported an indiscriminate and unsafe use of agrochemicals which has resulted in several health challenges and environmental issues. The use of agrochemicals as reported by Tijani (2006) among arable crop farmers in Nigeria have proven to be an indispensable tool in combating damage from pests and ensuring sustainable food production with improved yield and greater availability of food all year round. However despite the benefits of agrochemical in ensuring sustainable food production, agrochemicals on the other hand pose potential hazards to human health and the environment when used inappropriately (Kishi, 2005).

Dada (2002) further noted that poorly regulated and unsafe use of pesticides coupled with the absence of adequate education has led to increasing pesticide impact on public health and in particular the health of farmers. Findings by (Ajayi, 2000; Frampton*et al*., 2006) also emphasized that the misuse and abuse of chemicals has a direct and indirect effect on the environment. The authors emphasized that the indirect effects includes negative impacts on human health, degradation of the environment, loss of biodiversity and irreversible changes to ecosystems.In a country like Nigeria where environmental legislation is either non-existent or ineffective as opined by (Osinbajo, 2001) it becomes imperativeto consider the emerging issues surrounding the adverse effects of the use and misuse of agrochemicals on human health, soil, water and other environmental factors.To this hence the study described the concepts of agro-chemicals, discussed its application and usage among arable crop farmer and the cumulative effects of agrochemicals on soil, water, health and environment.

The Concepts of Agro-chemicals

Agrochemicals are chemicals that can be applied to crops in order to give the farmer higher yield and better quality produce. Ndaghu, Bunu and Dire (2017) defined Agrochemicals as chemically synthesized compounds, devices or organisms that are routinely utilized in agriculture to manage, destroy, attack pest, pathogens and parasites which can be organic or inorganic. Agrochemical covers a wide range of compounds which includes insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others.Modern farming as opined by Desalu, Busari and Adeoti(2014) relies on many chemicals such as fertilizers, pesticides and crop preservatives to produce and preserve an abundance of high quality food.

Several scholarsDhameja (2006), Olufemi (2009) and Don-Pedro (2009) have classified agrochemicals into different groups, based on their target organism as fungicides, insecticides and herbicides; and on the basis of chemical identity as organ chlorines, organophosphates and carbamates. Fungicides as the name implies are chemical compounds produced and intended to kill fungal organisms that attack plants and animals including man. Most fungicides as identified by (Seymour and Girardet 1987; Okeke 1993) are based on compounds containing metals such as copper and sometimes mercury or on hydrocarbons containing sulphur which are readily very toxic to both plants and consumers of plant products with long residual effect. The common groups of fungicidesreadily available in the market are Carbamates which are used for preservation of fibre food and seed for example thirom, ziram; Quinones used as seed and

fruit protectants example of which are chloranil and dichlone; Benzene Compounds used in the control of powdery mildews, fruit rot and for post- harvest treatments against deterioration an example of which is thiabendozole and; Benzimidazole (Benomyl) used for control of ascomycete and basidiomycete fungi because they are important systemic fungicide. Fungicides in most cases are sprayed directly onto the part of a crop that can be attacked by fungi. There has been an increase in the trend of Fungicide patronage and usage worldwideranging from an estimate of 340 million USdollars in 1960 to 7,486 million US dollars in 2005 (Zhang, Jiang and Ou, 2011) and more million tons in the current dispensation.
Insecticides on the other hand were classified by Sarwar (2015) on the basis of mode of entry into the host as stomach fumigant or contact poison. Insecticidescommonly found in the market used to control insects like aphids, weevils and other insect pests includescarbamates, organ chlorines and organophosphates. The Organochlorines as explained by Jayaraj, Megha and Screedev (2017) were the earliest group of synthetic man-made agrochemicals widely used all over the worldagainst pests of plants and animals. They are composed of chlorine, hydrogen, carbon and occasionally oxygen and sulphur. These chemical substances are readily accumulated in the fat tissues of animals due to the higher atomicweight of chlorine present in the substances compared to hydrogen chlorinated compounds. Examples of these substances that are most prevalent in the environment are DDT, aldrin, eldrin and lindane. These chemical substances according to Rani, Shanker and Jassal (2017) have long time persistence, highly toxic to wide range of animals as the toxins can be transferred through food chain and they are the most prevalent pesticides in the environment, potentially dangerous as pollutants hence, most pest species have become resistant to these insecticides. Most of these organ chlorines especially lindane as reported by Maton, Dodo, Nesla and Ali (2016) are still in use in most parts of the world including Nigeria, although banned in USA, European countries, Australia and some Asia countries.

Organophosphates as the name implies are organic molecules containing phosphorus which are esters of organic salts of phosphoric acid and its derivative developed in Germany to replace nicotine during World War II (Olufemi 2009). This chemical substance belongs to the major groups of synthetic man-made pesticides which are water-soluble and sprayed on fruits and vegetables. They are less stable and persistent than chlorinated hydrocarbons because they easily leach to ground water and degrade rapidly by hydrolysis on exposure to sunlight, air and soil; Therefore, making them less toxic and serve as alternative to the persistent organ chlorine pesticides. Some of these pesticides are systemic in plants and animals. When taken up by plants they are transferred to leaves and stems, then they become available to leaf-eating and sap-sucking insects where they render the plants sap and insect’s blood toxic (Cui, Sun, Yang Yan and Yuan 2009). According to Don-Pedro (2009) this substances kill by damaging an enzyme (acetyl cholinesterase) responsible for the control of nerve signals in the body. Considering critically the way organophostate works Maton*et al* (2016) concluded that uncontrolled use of organophosphates can lead to poisoning the wrong organisms as spray drift can carry over into stream and uncultivated land, wildlife, bees and human beings.

Carbamates as described by Smith *et al.*, (1998) are esters of unstable carbonic acid which are systemic and whose insecticidal activity resembles acetylcholine having a high affinity for enzymes cholinesterase. They kill insects in a similar way as organophosphate insecticides by inhibition of sterase enzymes which affect nerve impulse transmission. They are said to kill a narrow spectrum of insect and highly toxic to vertebrates hence, highly neutrotoxicants to man therefore they must be handled and used with care (Ware and Whitacre, 2004).

Herbicides which are chemical substances used for eradicating weedsare a group of highly varied chemicals which mimic natural poisonous substances within plants as defined by Seymour and Girardet (1987). Weeds which compete with plants for nutrients are killed either through foliage sprays as post-emergence or application of the chemicals to the soil as preemergence sprays. As identified by Okeke (1993) the major sites of action of herbicides includes soil acting on germinating weed seeds, contact which burns off foliage of emerged weed and systemic whichtranslocate throughout the plant after foliage application. Herbicides can be non-specific killing all plants and may be specific, killing a particular sets of plants for instance broadleaved weeds growing in cereal crops. Some herbicides are deadly if accidentally consumed while others may cause nonfatal illness when eaten in food. Ideally the use of agrochemicals must be lethal to the targeted pests, but not to non-target species, including man. Unfortunately, this is not the case hence, the controversy of use and abuse of pesticides. The rampant use of these chemicals, under the adage, “if little is good, a lot more will be better” has played and is playing more havoc with human and other life forms.

Application and Usage of Agrochemicals among Arable Crop Farmers in Nigeria

The need to increase food production to feed the ever increasing populace has led to intensification of agriculture in Nigeria and consequently an increase in the use of agrochemicals to control weeds, pests and diseases.According to World Health Organization (2010), 20% of pesticides are used in the developing countries and the trends of pesticide usage keep increasing. Nigeria among other West African countries ranked first in the importation of pesticides from United Kingdom (Okunade, 2009). Corroborating this assertion, Asogwa*et al* (2009) also reported high dependence of arable crop farmers in Nigeria on agro-chemicals use in their productionlending credence to this assertions Ndaghu*et al.*,(2017) affirmed that majority (98.0%) of arable crop farmers in Adamawa state Nigeria used agro-chemicals in their farming activities for the purpose of crop protection from pests and diseases, ease of cultivation as well as increased yield to meet the increasing food demands at the family and national levels. A similar study in South-west Nigeria by Matanmi, Oladipo, Adefalu, Olabanji, Yusuf and Abdulkareem (2015) revealed that majority (96.67%) of arable crop farmers used insecticides to control insect pest on their farms once a season. Furthermore, in Nigeria as reported by Okwoche, Obinne and Onugba (2011) herbicides are widely used by arable crop farmers to reduce the drudgery that is associated with persistent weeds and chronic labour shortage. These and many more studies across Nigeriaindicate a high prevalence of agrochemical use among arable crop farmers.

Farmers and farm households are at the receiving ends of the immediate effects of pesticide use and abuse in most cases corroborating this claim Coronado, Thompson, Strong, Griffith and Islas (2004) identified exposure to pesticides as one of the most important occupational risks among farmers in developing countries of the world. This could be due to inappropriate use of agrochemicals.

The application of Agrochemicals according to Beseler*et al.* (2008) for the control of wide variety of insectivorous,herbaceous pests and green leaves, has contributed immensely to the success of agricultural advancement globally, but with some visiblepollution effects on ecosystem and human health. In developing world most farmers are not aware of the environmental impacts of using agrochemicalson their farms, human being and wildlife (Kamel, 2004). This finding is in tandem with the report of Ndaghu *et al* (2017) which indicated majority (74.5%) of the respondents of a study carried out among arable crop farmers in Adamawa state Nigeria were not aware of safety practices in agrochemical handling and use even though they use agro-chemicals in their production activities.

Effects of Agro-Chemicals on Soil, Water, Health and the Environment

Agrochemicals as opined by Ndaghu*et al*., (2017) may appear harmless and safe, but they are complex chemical compounds which can have serious and harmful effects on humans, animals and environment upon exposure.Pesticide sprays can directly hit non-target vegetation, or can drift or volatilize from the treated area and contaminate air, soil, and non-target plants. It was reported that more than 50% of applied fertilizer are lost to leaching, while more than 90% of pesticides do not reach the target pest. It was further reported that Millions of tons of pesticides are applied annually, but it is estimated that less than 5% of these products reach the target organism, with the remainder deposited into the air, soil, and groundwater (Anjum, Rahman, Masood and Malik, 2012). There are implications for human health arising, from the presence of high levels in drinking water with the occurrence of methemoglobinemia in infants (Hord, Tang and Bryan, 2009).

Frequent application of agrochemicals has been reported by several authors to affect soil pH, soil fertility and death of several soil organisms upholding the ecosystem. According to Tayebi and Ahangar (2014) heavy treatment of soil with pesticides can cause populations of beneficial soil microorganisms to declinewhich degrades the soil. Indiscriminate use of chemicals might work for a few years, but after a while it can lead to lack of enough beneficial soil organisms to hold onto the nutrients (Aktar, 2009). For example, plants depend on a variety of soil microorganisms to transform atmospheric nitrogen into nitrates, which plants can use. Common landscape herbicides disrupt this process: triclopyr inhibits soil bacteria that transform ammonia into nitrite (Singha, Pandeyb and Singhb, 2018); glyphosate reduces the growth and activity of free-living nitrogen-fixing bacteria in soil (Busse, Ratcliff, Shestak and Power, 2001) and 2,4-D reduces nitrogen fixation by the bacteria that live on the roots of bean plants (Remans, Beebe, Blair, Manrique, Tovar, Rao and Vanderleyden, 2008), reduces the growth and activity of nitrogen-fixing blue-green algae (Vig, Megharaj, Sethunathan and Naidu, 2003), and inhibits the transformation of ammonia into nitrates by soil bacteria (Martens and Bremner, 1993). Mycorrhizal fungi grow with the roots of many plants and aid in nutrient uptake. These fungi can also be damaged by herbicides in the soil.

In addition to the effects of agrochemicals on the environment the presence of pesticide residue in water make it toxic and unsuitable for use by both humans and animals (Agrawal, Pandey and Sharma, 2010).The bulk of pesticide residues in soil according to FAO (2000) are generally confined to the upper 5 cm of the topsoil. Agrochemicals in soil can move from the surface when they are dissolved in runoff water, or when they percolate down through the soil. Those that have infiltrated the soil through leaching will eventually reach the groundwater. Nitrate which is one of the many determinants of water quality remains one of the residues from agrochemicals that contaminate water bodies.Ngidlo (2013) maintained that clean and healthy water must be free from nitrates or does not exceed the required maximum level of 50 mg/L. He further emphasized that Nitrates in drinking water interferes with the ability of red blood cells to carry oxygen hence making children and infants more vulnerable to nitrate poisoning as babies can turn blue when there is insufficient oxygen in their blood.

Other residues from agro chemicals which are emptied into the water bodies which serve as household water supply for both drinking and domestic purposes for farmers in rural areas can pose serious danger to the lives of farming households; endanger aquatic species leading to an imbalance in the ecosystem as most of the active ingredients as opined by (U.S. Geological Survey, 1999)are highly toxic to fishes and other aquatic lives.
A more direct effect of use and misuse of Agrochemical in the environment is the threat it poses to human life. Annually there are dozens of million cases of pesticide poisonings worldwide (Richter, 2002) According to Ibitayo, (2006) the improper storage, disposal and use of these chemicals in agriculture over the years have caused exposure and serious health problems in many developing countries including Nigeria. Some of the outcome of agrochemical use on health and life of humans as reported by Chitra, Muraleedharan, Swaminathan, Veeraaghavan(2006) includes 250,000 deaths which occur annually from pesticide self-poisoning worldwide which accounts for 30% of suicides globally. A report by World Health Organization (2000) likewise revealed that an estimated 3 million farmers in developing countries experience acute poisoning from pesticides of which 18,000 of them eventually die from this. In Nigeria there have been several cases of harmful effects of agrochemicals on human health and life through food poisoning and direct exposure to the chemicals. First of all as reported by Shaibu (2017) 112 people were hospitalized and two childrendiedafter eating beans preserved with pesticides in Cross Rivers states. Secondly 120 students of a secondary school in Gombe State became sick as a result of eating food items contaminated by pesticides. All of these effects and more are emerging issues that calls for an urgent attention on the need to educate and sensitize Nigerian farmers on the risks involved in the use and misuse of agrochemicals and the need toreduce the indiscriminate use of agrochemicals so as to forestall further degradation of the ecosystem and the environment as a whole.

CONCLUSION AND RECOMMENDATIONS

The review concluded that agrochemicals has been of great use to arable crop farmers in Nigeria in reducing drudgery associated with persistent weeds and chronic labour shortage, control of wide variety of insectivorous, herbaceous pests and green leaves. However, the indiscriminate use of agrochemicals has also immensely contributed to visible pollution effects on the ecosystem and human health. To this ends the need to guide the use of agrochemicals among arable crop farmers to prevent further damage to the environment is therefore necessary. .

Recommendations

The paper recommended that farmers should be educated on the necessity of reducing the indiscriminate use of agrochemicals and the risk associated with its use so as to forestall further degradation of the ecosystem and the environment.Regulatory bodies should work towards getting banned agrochemicals out of the market and ecofriendly organic alternatives should made available for farmers use.

REFERENCES

Abd'Razack, N. T., Medayese, S. O., Shaibu, S. I., and Adeleye, B. M. (2017). Habits and benefits of recycling solid waste among households in Kaduna, North West Nigeria. Sustainable cities and society, 28,pp 297-306.

Abiwon, T. O. (2017). College level mentoring for underrepresented populations: Enhancing the transition into the corporate world.

Agrawal, A., Pandey, R. S., and Sharma, B. (2010). Water pollution with special reference to pesticide contamination in India. *Journal of Water Resource and Protection*, 2(05), 432.

Ajayi, O.O. (2000). Pesticide use practices, productivity and farmers' health: the case of cotton-rice systems in Cote d'Ivoire, West Africa.

Aktar, W., Sengupta, D., and Chowdhury, A. (2009). Impact of pesticides use in agriculture: their benefits and hazards. Interdisciplinary toxicology, 2(1), pp 1-12.

Alabi, O., Banwo, O.O., and Alabi, S. O. (2006).Crop Pest Management and food security in Nigerian agriculture.Archives of phytopathology and Plant Protection, 39(6), pp 457-464.

Anjum, R., Rahman, M., Masood, F., and Malik, A (2012). Bioremediation of pesticides from soil and wastewater. In *Environmental Protection Strategies for Sustainable Development* (pp.295-328). Springer, Dordrecht.

Asogwa, A. O., and L. N. Dongo, (2009). Problems Associated with Pesticides Usage and Application in Nigeria Cocoa Production; A Review African Journal of Agricultural Research 4(8): pp 675 – 683.

Barnes,K. K., Kolpin, D. W., Meyer, M. T., Thurman, E. M., Furlong, E. T., Zaugg, S. D., and Barber, L. B. (2002). Water-quality data for pharmaceuticals, hormones, and other organic wastewater contaminants in US streams, 1999-2000. US Geological Survey Open File Report, pp 2, 94.

Beseler, C. L., Stallones, L., Hoppin, J.A., 2008. "Depression and pesticide exposures among private pesticide applicators enrolled in the Agricultural Health Study" Environ., 116 (12): pp 1713-1719. doi:10.1289/eph.11091.

Busse, M. D., Ratcliff, A. W., Shestak, C.J., and Powers, R.F. (2001). Glyphosate toxicity and and the effects of long-term vegetable control on soil microbial communities. *Soil biology and biochemistry*, 33(12-13), 1777-1789.

Castro, S., Vinocur, M., Permigiani, M., Halle, C., Taurian, T., and Fabra, A. (1997). Interaction of the fungicide mancozeb and Rhizobium sp. in pure culture and under field conditions. Biology and fertility of soils, 25(2), pp 147-151.

Chitra G.A., Muraleedharan V. R., Swaminathan T., Veeraaghavan D.(2008). Use of pesticide and its impact on health of farmers in South India, 12(3):pp 228-33.

Coronado G. D., Thompson B., Strong L., Griffith W. C., Islas I. (2004).Agricultural task and exposure to organophosphate pesticides among farm workers. Environ. Health Persp. 112: pp 142-147.

Cui,L., Sun, L., Yang, D., Yan, X., and Yuan, H. (2012). Effects of cycloxaprid, a novel cis-nitromethylene neonicotinoid insecticide, on the feeding behavior of Sitobion avenae. Pest management science, 68(11), 1484-1491.

Dada, E.O., Daramola, A.O., and Ogoke, B.N (2002).Residual Pesticides and Trace/Toxic Metal Concentrations in Ready-to-eat Kolanuts (*Colanitida*).

Desalu, O. O. Busari, O. A., and Adeoti, A. O., (2014). Respiratory Symptoms among Crop Farmers Exposed to Agricultural Pesticide in Three Rural Communities in South Western Nigeria: A Preliminary Study. Annals of Medical and Health Science Research. 4(4): pp 662–666. Akobundu, I. O. (1987). Weed Science in the Tropics: Principle and Practices. John Wiley and Sons New York.522 pp.

Dhameja, S.K (2006). Environmental Science (3rd Edition); Delhi, S.K. Kataria and Sons, pp 64- 65.

Don- Pedro, K.N (2009). Man and the environmental Crisis (1st Edition); Lagos, University of Lagos Press, pp 311 – 336.

FAO, (2000).Assessing Soil Contamination: A Reference Manual.FAO Pesticide Disposal Series.Food and Agriculture Organization of the United Nations, Rome.

Frampton, G.K., Jansch, S., Scott-Fordsmand, J. J., Rombke, J., and Van den Brink, P. J. (2006). Effects of pesticides on soil invertebrates in laboratory studies: a review and analysis using species sensitivity distributions. Environmental Toxicology and Chemistry, 25 (9), pp 2480-2489.

Frankenberger WT, Tabatabai MA, Jr, Tabatabai MA. Factors affecting L-asparaginase activity in soils. Biol. Fert. Soils. 1991;11:1, 5.

Hord, N.G., Tang, Y., and Bryan, N.S. (2009). Food sources of nitrates and nitrites: the physiologic context for potential health benefits. The American Journal of clinical nutrition, 90(1), 1-10

Ibitayo O.O. (2006). Egyptian Farmers' Attitudes and Behaviours Regarding Agricultural Pesticides: Implication for Pesticide Risk Communication.Risk Anal: 26(1): pp 989-95

Jayaraj, R., Megha, P., and Sreedev, P. (2016). Organochlorine pesticides, their toxic effects on living organisms and their fate in the environment. *Interdisciplinary toxicology*, 9(3-4), 90-100

Kamel, F., Hoppin, J. A. (2004). "Association of pesticide exposure with neurologic dysfunction and disease", Environ. Health Perspect 112 (9): pp 950-8.

Katz, K. D., and Brooks, D. E. (2015). Organophosphate toxicity. Medscape reference available at https://emedicine.medscape.com/article/167726-overview.

Kishi, M., Pan, Y. A., Crump, J. G., and Sanes, J. R. (2005). Mammalian SAD kinases are required for neuronal polarization. Science, 307(5711), pp 929-932.

Martens, D. A., and Bremner, J. M. (1993). Influence of herbicides on transformations of urea nitrogen in soil. Journal of Environmental Science and Health Part B, 28(4), pp 77-395.

Matanmi B.M., Oladipo F.O., Adefalu L.L., Olabanji O.P., Yusuf S.Y and Abdulkareem, T.Z.(2015) Effect of the Use of Agrochemicals Among Arable Farmers In Oyo State, Nigeria.

Minimum Standard General Studiesprogrammesfor Universities, Polytechnics and Colleges of Education byOkeke, G.C. (ed), pp 47 – 59.

Ndaghu, A. A., Bunu, G. M., and Dire, B. (2014). Perception of health hazards associated with agro-chemicals use among arable crop farmers' in Mubi Agricultural Zone, Adamawa State, Nigeria. Int J Agric Ext Rural Dev Stud [Internet], 4(2), pp 17-24.

Ngidlo, R. T. (2013). Impacts of pesticides and fertilizers on soil, tail water and groundwater in three vegetable producing areas in the Cordillera Region, Northern Philippines. Am J Exp Agric, 3(4), pp 780-793.

Ogunwale, A. B. (2005). A Case Study of Small-Scale Farmers participation in Nigerian Agricultural Development Programmes: Oyo and Osun State Agricultural Development Programmes. *Journal of Rural Development,* 28(1), pp 85-96.

Oji-Okoro, I. (2011). Analysis of the contribution of agricultural sector on the Nigerian economic development. World review of business research, 1(1), pp 191-200.

Okeke, G.C. (1993). “Pesticides and the Environment”. In Science and Society (Vol. 1): A

Okwoche, V. A., Obinne, C. P. O., and Onugba, J. A. (2011). ZAdoptation of Herbicides and Fertilizers Among Rural Farmers of Zone B Area of Kogi State Agricultural Development Project, Kogi State, Nigeria. *Asian Journal of Agricultural Sciences*, 3(5), pp 389-392.

Olufemi, Pitan (2009). Introduction to Public Health Pest Management (1stEdition); Ibadan, Book Wright, Nigeria Publishers, pp 1, 20, 21, 160 – 180.

Rani, M., Shanker, U., and Jassal,V.(2017). Recent strategies for removal and degradation of persistent and toxic organochlorine pesticides using nanoparticles: a review. Journal of environmental management, 190, 208-222.

Remans, R., Beebe, S., Blair, M., Manrique, G., Tovar, E., Rao, I., and Vanderleyden, J. (2008). Physiological and genetic analysis of root responsiveness to auxin-producing plant growth-promoting bacteria in common bean (Phaseolus vulgaris L.). Plant and soil, 302(1-2), 149-161.

Richter, R., and Schlapfer, D. (2002). Geo-atmospheric processing of airborne imaging spectrometry data. Part 2: atmospheric/topographic correction. *International Journal of Remote Sensing*, 23(13), pp 2631-2649.

Santos, A., and Flores, M. (1995). Effects of glyphosate on nitrogen fixation of free-living heterophytic bacteria. Letters in Applied Microbiology, 20(6), pp 349-352.

Sarwar, M. (2015). The killer chemicals as controller of agriculture inspect pests: The conventional insecticides. International Journal of Chemical and Biomolecular Science, 1(3), 141-147.

Shaibu, I. (2008) NAFDAC bans 30 agrochemical productsAvailable atwww.allafrica.com. Accessed on Monday, 19th February, 2019.

Singha, S., Pandeyb, S. A., and Singhb, K. K. (2018). Use Abuse and Environmental Impacts of Pesticides: A Pleminary. International Journal of Environmental Science, 7(2), 75-78.

Smith, R.L. and Smith, T.M (1998). Elements of Ecology (4th Edition); California, Addison Wesley Longman Inc. pp 9, 10, 144, 235 – 240.

Tayebi, B., and Ahangar, A. G. (2014). The influence of heavy metals on the development and activity of soil microorganisms. *International journal of Plant, Animal and Environmental Sciences*, 4, 74-85.

Tijani, A. A. (2006). Pesticide use practices and safety issues: the case of cocoa farmers in Ondo State, Nigeria. Journal of Human Ecology, 19(3), pp 183-190.

Vig, K., Megharaj, M., Sethunathan, N., and Naidu, R. (2003). Bioavailabilty and toxicity of cadmium to microorganisms and their activities in soil: a review. Advances in Environmental Research, 8(1), 121-135.

Ware, G. W., and Whitacre, D. M. (2004). An introduction to insecticides.The pesticide Book. *Willoughby, ohio: Meister pub.*

World Health Organization (2000). The WHO recommended classification of pesticide by Hazard and guidelines to classification. Geneva.

Zhang, WenJun, Fubin Jiang, and JianFeng Ou. Global pesticide consumption and pollution:with China as a focus. Proceedings of the *International Academy of Ecology and Environmental Sciences*, 1(2), 125.

SUSTAINABLE URBAN ROAD LANDSCAPE PLANNING IN LOKOJA, NIGERIA

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Abstract
The significance of landscape planning in the structure and beautification of urban roads cannot be overemphasized. As a matter of emphasis, no city can survive without the landscape elements because the beauty and appearance of any city is often dependent on the quality and quantity of its landscape. This paper therefore investigates the level of landscape planning development in Lokoja city within the context of road transportation with a view to suggesting measures that can be employed in its restructuring to attain a sustainable city development. The study was conducted using questionnaires and field observation in the collection of data, while descriptive statistics such as frequency counts and percentage were employed in data analysis. The findings reveal that 59.8% of the respondents affirmed that level of landscape planning and development within the city environment is grossly inadequate while the few landscape elements that could enhance the aesthetic look of the city have dilapidated. To ensure that the city attains sustainable growth. It is therefore recommended that, establishment of Landscape Development Control in the State Ministry of Environment and Housing for the implementation of strategic plans for developing the environment and enhancing urban transportation, introduction of enforcement agents to guard against habitual destruction of landscape elements in the city centre, and sensitization of the public to the importance of landscape planning for achieving sustainable city development.

Keywords: *Landscape; planning; Urban; Road transportation; Sustainable city.*

INTRODUCTION

All through the past century, the world's population had been rapidly assembling in urban areas. The urban population in the world was approximately 2.4 billion in 1995, a figure that is expected to double by 2025 (Antrop, 2000). Increasing population and urbanization are acknowledged as some of the most complex processes globally (Luis et al., 2007). Massive urbanization started during the nineteenth century industrial revolution; however, the decline of nature during the twentieth century increased public awareness to the necessity of introducing natural assets and components in urban context (Pregill and Volkmann, 1999).

Urban growth has put great pressure on natural resources and on the environment, threatening to compromise urban quality of life. Cities have never been self-sufficient as they demand a complex set of importing and exporting arrangements for people, food, waste products and goods produced(Mazza & Rydin, 1997). However, the metabolism of modern cities, that is, the import of large amounts of energy, materials, water, food, and other resource inputs essential for supporting urban populations, and the export of waste products, has reached levels that threaten the environment on a global scale (Rees, 1997). The amount of land consumed by urban growth and development far exceeds the rate of population growth, which leads to the loss of sensitivehabitat, destruction of productive farmland and forestlands and high economic and infrastructural costs (Beatley, 2000). Urban growth has led to the loss of farmland and areas classified as 'natural while most of the urban green space has declined (Oloruntoba, 2010). This occurs as a result of inadequate urban landscape planning which could help to replace or replicate natural surroundings lost to city growth.

Urban landscape planning denotes the process of shaping, modifying and creating an attractive outdoor scene in order to effectively express the functional and supportive attributes of the public domains within an urban environment (Fadamiro, 2001). Public domain represents the collective shared spaces (streets, roads, markets, parks, playground and other open spaces) through which human beings carry out most of their day to day activities in the urban environment. Landscape itself is defined as the physical expression of land use by man (Oloruntoba 2010). It is also a cultural concept, sensory response, perceived, learned and recalled by the individual as he places himself in his surroundingsor a sensory response overlain by time not only within the life time of the individual but the lifetime of his culture (Fadamiro, 2001).
Landscape planning and design for sustainable city development requires the professionalism of the authors and conceivers of the built environment who are expected to use their skills to build sustainable cities that are aesthetically pleasing for living, working and moving (Oloruntoba, 2010). In connection with the above, it opined that landscape planning strives to solve the problems relating to the use expected of the proposed area or location, climate, type of landscape prevalent on the region and topography. Moreover, landscape planning covers all decisions about materials, elements and arrangements within designated areas, thus the establishment of connection or relation between building site, space and environment (Fadamiro, 2004).

Oloruntoba (2010) observed that landscaping of any area is highly dependent on available water, types of bedrock, existing plants species, buildings or scenes of architectural and historical interest, all which should be used to the best advantage. Similarly, Fadamiro and Adam (2004) suggest that the constant improvements in the landscape qualities of outdoor environments in different neighbourhoods have a direct relationship to residents perceived quality of living; such improvement can be done through vegetal landscaping which is appropriate for the tropics. The cost and effectiveness of this practice depend on the characteristics of the materials, the climate, ecological adaptability of the materials imposed on the cost and people’s commitment to landscaping which is achieved through the uses of indigenous or native plants (Oloruntoba, 2010).
The landscapes of urban roads/streets showcase the beauty of the city, with the elements that make up the streetscape being the corridors for vehicles and pedestrians, buildings, open spaces, street trees, street flowers and street furniture. These elements impact the way the city looks and feels – the design and feel of the streets, the shape of the buildings flanking the streets, the quality of adjoining open spaces, the installation of street furniture and relationship between these elements – all these create a series of outdoor activity areas, leading to the production of quality experience of the urban environment that make up the city image (Ekan, 2007).

The interrelationship of the above elements provides opportunities for street/road activities. In most cases, such opportunities may be constrained by functional demand imposed by the movement and service of streets. However, the city’s streets/roads must fulfil their roles. Itis not only important that the movement of vehicles be organized with safety and efficiency, but the walkways and street spaces must be safe and contribute to the visual and social quality of the city. Wang, Wang & Hong (2014) opined that roads play a vital role in shaping the landscape of the city and the function of roads is no longer limited to transportation, but also includes safety, convenience, aesthetics etc. In order to meet the needs of urban road landscape which is "on the wheels", it is necessary to integrate the various elements of the urban road landscape and facilitate people to perceive cities on roads.

Lokoja is the capital city of Kogi State and has a population of 195,261 (NPC, 2006). It serves as an intervening city between Lagos and Abuja (FCT). It is favourably located within the tropical region of the country. The city is fortunate to possess vital factors for the growth of essential and economic trees that can beautify the environment, subdue the heat of the dry season, control erosion, and serve as wind breakers. Unfortunately, tree planting has been rendered almost impossible because of human factors such as construction and building, inadequate development planning control, ignorance of people about the importance of city landscape and lack of official encouragement of the people through practical example. In actual fact, most of the government offices and institutions are deficient of trees, whereas tree planting and other landscaping element apart from the pleasant aesthetic, control soil erosion and provide calming shades during dry and hot seasons. This paper aims to show how the urban road landscape of Lokoja may be restructured to attain sustainable city development. The specific objectives are to: (i) identify various road landscape elements and their efficiency in Lokoja; (ii) assess the functions of road landscape elements in the study area; and (iii) examine the factors militating against the effectiveness of road landscape elements in Lokoja.

Land use refers to the various ways in which land serves to provide man with his needs and wants; which can be for the purposes of recreation, agriculture, transportation, mineral sources and water resources development (Oladeji, 2002; Umunnakwe & Nnaji, 2011). Fadamiro (2001) emphasizes that many studies carried out in some urban centres confirm the influence of people on the maintenance and conservation of the environment. The essence of landscape planning in a city or town is to ensure adequate quality of life that will showcase the aesthetic qualities of the environment where man lives. Moreover, Umunnakwe and Nnaji (2001) noted that the „quality of life‟ concept as applied to the urban environment is usually understood in two ways: the first concerns the environment and involves the pattern of inequitable advantages and opportunities that affect each citizen through accessibility to services, facilities and amenities. The second relates to the natural environment in urban spaces. This approach holds that such factors as air, water and soil quality and the amount of green space available affect the ways we live (Senecal, 2002). As stressed by Fadamiro (2001), the general objectives of landscape planning is to ensure clean and orderly appearance of grounds, structures and facility, and to protect the health, safety and convenient circulation (movement) of the people within the urban centre using landscaping materials. In a research conducted by Anozie (1994) in selected major towns in Imo State, Nigeria and reviewed by Fadamiro (2001), the pace of urban growth and its pressure on open spaces, existing infrastructures and roads and the resulting generation of solid waste now constitute a major concern.

Research has also shown that the rapid growth of urban centers has generated management problems, such as encroachment of open spaces and roads, environmental and health issues including waste management, water supply, housing and water pollution (Fadmiro, 2001; Umunnakwe and Nnaji 2011). Shonibare (1996) had earlier noted that the encroachment of open spaces and road sides by market and service industries is one of the major environmental management problems facing Nigerian urban cities such as Akure. This finding is similar to that of Alabi (2009) with regard to Lokoja, which reported that most of the open spaces and roads in the city had been encroached upon by the people for commercial activities or other uses. Lokoja, being an emerging metropolis, had begun to show the characteristics of urbanization with inadequate consideration for the landscape and open space development. Green belts were continually being built up largely due to pressure from increasing population and in most cases political and economic conditions (Alabi, 2007). Recently in Lokoja, areas originally planned as open spaces were being systematically replaced deliberately by other land uses. Multidimensional economic

and transportation activities had all been merged into one sphere (Alabi, 2009). This scenario results to high demand and competition of several land uses, with problems such as blockage of sewers, congestion along major routes, construction on prime agricultural lands and wet lands, and inadequate setbacks to buildings, particularly those built along transportation routes. The spread of commercial activities through the town without provision of adequate parking space due to the loss of reserved open spaces as well as haphazard development over available land invariably result into traffic congestion (Olorunfemi, 2013). Fadamiro and Atolagbe (2006) attributed this to a paucity of three elements: pursuit of landscape planning, urban planning and design, and management in promoting land use development in Nigeria.
Sustainable city is a development approach that is currently receiving much attention in the world and has been advocated by many international organizations such as the World Bank and the United Nations (Aboagye & Collins, 2013). The ideal of sustainable city came out of Brundtland Commission (WCED, 1987) where sustainable development was conceptualized to mean "development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Several authors have defined sustainable development in different ways. Some see it as the use of environmental resources in prolongation of existence (Wright, 2008; Singh, 2009; Kanagasabai, 2010; Joseph, 2009; Jay & Scott, 2011; Harris, 2006; Gabriela & Ronnie, 2009; Ashana & Ashana, 2010; Ibimilua, 2014). This thought has been transferred to achieving sustainability in several dimensions of the world. Antrop (2006) defined sustainable city as a city that strives to achieve quality living standards in various components of the city such as economic, social, ecological, cultural, political, and institutional aspect without leaving a burden on future generations. Zheng (2005) gave broad characteristics of sustainable cities to include features such as maintenance of balance among resources, promotion of social progress, economic use of resources, ecological security, free flow of resources between inner and outer urban system, and in all satisfying the needs of urban development at present and at the same time meeting the city's future needs. Characteristic features such as a compactness, mixed land-uses, high density, diversity in activities, and sustainable transport system have also been highlighted to support sustainable urban development (Jabareen, 2006; Dumreicher, Levine, & Yanarella, 2000).

Landscape planning could be regarded as an environmental approach to the realization of sustainable development (Ibimilua, 2014). Road landscape in the context of sustainable development cannot be over emphasized. This is because it adds to the aesthetic qualities of roads by providing shield and green environment for the people through planting of trees, shrubs and soft grasses. However, perception of roads is not only related to these material entities but also human beings. Wang et al. (2014) opined that urban road landscape is a visual concept in a narrow sense, and its elements can be divided into natural and artificial factors. Natural factors include mountain, terrain, water, vegetation, weather conditions etc. Artificial factors generally include the road itself, buildings, structures, historical rudiment, customs, and facilities along roads. In the pursuit of the sustainable urban transport agenda, emphasis is most often given to public transport systems and measures that favour cycling and walking (Jabareen, 2006; Kenworthy, 2006). No wonder, the 2012 world conference on sustainable development, Rio+20, emphasized the need for various sustainable development agendas to focus much attention on road safety (Watkins, 2012; Aboagye and Collins, 2013). This is because road networks support the majority of transport modes in the world with several development activities depending on them; unfortunately, thousands of lives are lost each year through road accidents. This makes it imperative for various countries and cities of the world to embark upon regular road care and beautification to keep their road networks in good shape and to enhance the welfare of the general public by minimizing casualties on roads, thereby ensuring efficient movement of people and goods, improving social equity, health, promoting cultural heritage, and productivity of goods and services (Aboagye & Collins, 2013).

Road, according to Wang et al. (2014), can be divided into two types: roads for living and roads for transportation. People's activities and their ways of travelling on these two types of roads vary, hence the way they understand road landscape and their requirements are diverse. In terms of roads for transportation, people usually use them for motorized travel, and they move quickly in cars, causing the fast movement of their sights, and a weakening of their recognition ability. Close-up view is instantly observed by people of some objects which are farther and more stable. The landscape design of roads for transportation should therefore pay more attention to the viewing effect from intermediate and long distance and the scale of such road landscape should be enlarged to ensure that people can identify and appreciate these landscape elements under moving vision. Regarding roads for living, it is more complicated, because they are used for diverse purposes, including motorized travel, non-motor vehicle travel, walking, and so on. The driving speed on such roads are much slower and has less impact on people's vision, thus the landscape of those roads can be designed under the principle of the low speed or static view. People's feelings of the landscape are comparatively more attractive when walking, and the ways they appreciate the landscape are not in a single perspective, but with diverse perceptions. As a result, the landscape design of roads for living should pay attention not only to the design of shapes and profiles, but also to the design of details, in order to bring gorgeous landscape experience and improve the visibility of road landscape.

MATERIALS AND METHODS

The Study Area

Lokoja, the study area, is located on longitude 06^0 57'E-06^0 63'E and latitude $07^0$74'N-$07^0$79'N. It is approximately 162 kilometers from Abuja, Nigeria's Federal Capital Territory; 65 kilometers from Kabba and 52 kilometers from Okene. It was a local government headquarters before it became the capital of Kogi State in 1991, since then the level of physical, economic and population growth has increased. This geometric growth in term of development of the area has led to the influx of people to the city for the purpose of employment and other related activities. As a matter of fact, Lokoja is highly favoured by nature as the location of the meeting point of Rivers Niger and Benue, a factor which has attracted people to the area, most especially those who engaging in fish farming activities. The available road landscape elements in Lokoja include trees/shrubs, grass, pavements, street lights, fountains, sculpture and historical artifacts. All these elements are put in place to produce an aesthetically pleasing environment.

The urban planning problems in Lokoja are similar to those of other big cities in Nigeria such as Lagos, Ibadan, Port-Harcourt, Kaduna etc. with regards to their non-habitability and environmental problems as reported by Fadamiro (2001). According to Fadamiro (2001), the scale of these problems ranged from traffic congestion, slum settlement through open spaces and roadside encroachment to the poor management which is now beyond the coping ability of the respective government.

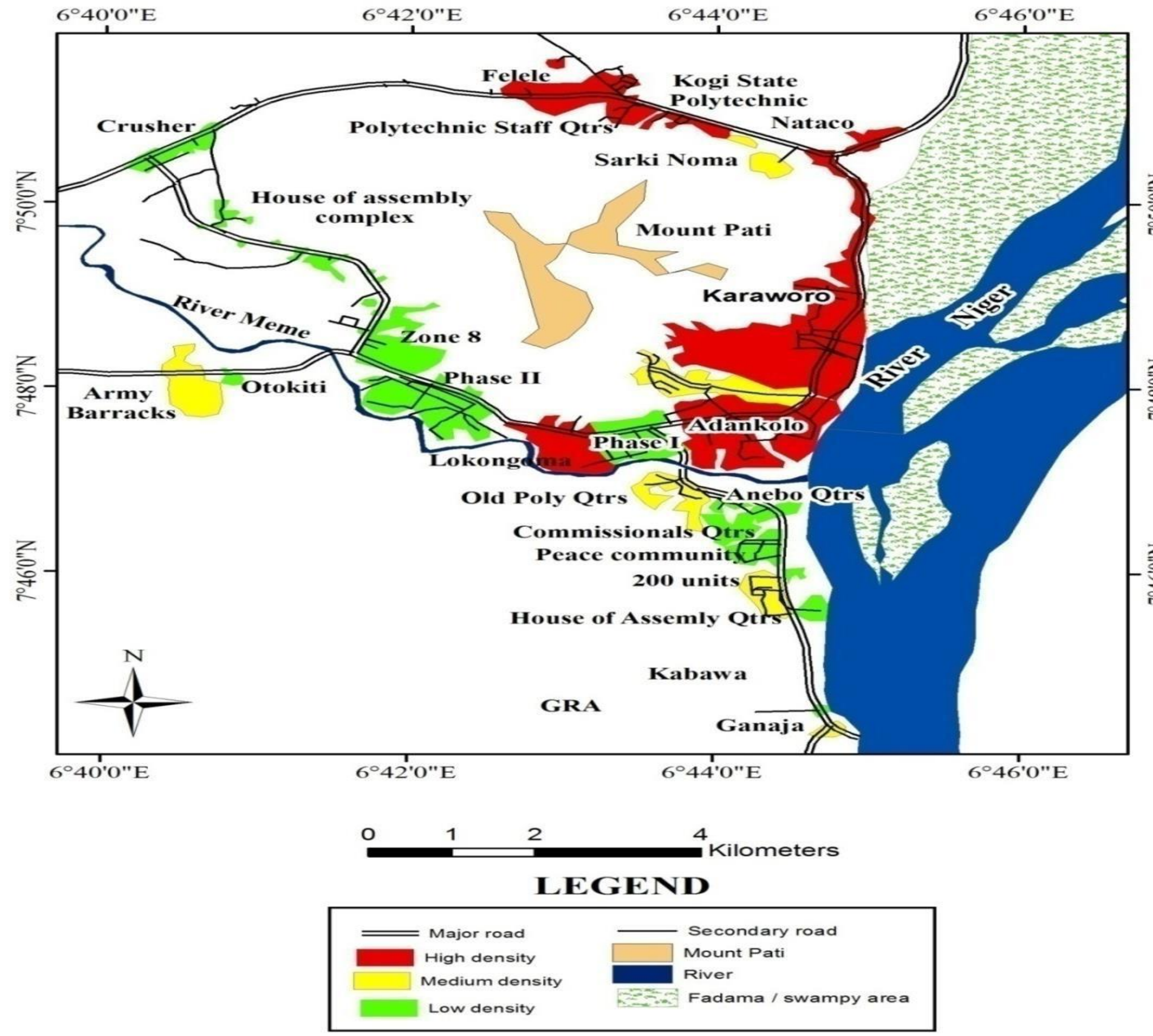


Figure 1: Map of Lokoja showing the road and built up areas.
Source: Kogi State Ministry of Land and Environment, Lokoja, 2018

Data Collection and Analysis

The sources of data for this research include both the primary and secondary data. To determine the sample size for the study, a count of buildings along the major roads of study was carried out, to get a total of 2086 buildings from which 10% buildings (209) was systematically sampled. Each building represents a major research population and the owners stand as respondents for the study. 10% of the total sampled was selected by systematic sampling technique, taking every 11th building (Table 1). The research instrument used was a well-structured questionnaire in which the variables were structured in question form and responses sought from the respondents in pre-coded alternatives. Six research assistants were trained by the authors to administer the questionnaire through face-to-face interaction with the respondents (the building owners). They were instructed to read and interpret the questions to the respondents. The analysis of the sample size of the buildings as numbered along the selected roads is shown in the table below.

Table1: Selected Roads

Name of theRoad	No of Buildings	10% sampled	Percent
Ganaja-Lokongoma Road	500	50	23.9
Old market Felele/New Market Road	1261	126	60.3
LGS-Post Office Road	70	7	3.4
IBB-MM Road	255	26	12.4
Total	**2086**	**209**	**100**

Source: Authors Field work, 2018.

RESULTS AND DISCUSSION

Available Road Landscape Elements and its Efficiency in Lokoja

It is unfortunate that the purpose of designing and placing of these elements in Lokoja has been defeated as many respondents (59.8%) affirmed that the available road landscape elements are inefficient (see Figure 2). For instance most of the trees/shrubs planted for the beatification of the city have withered away while the fountains and street lights have deteriorated. This supports Olorunfemi (2013) which reported that most of the open spaces within the city had been converted to other uses without taking into cognizance the consequences of such changes of use for the city. This can be attributed to the poor monitoring exercise of the Physical Planning Authority in the city. As noted by Fadamiro (1998) most private spaces intended for urban beautification are neglected, thus, rendering the landscape elements inefficient.Due to the proximity of the buildings to the road side, virtually all of them had been converted and used for commercial purposes, generating enormous human and vehicular traffic to the area, and =therefore encumbering the landscape elements along the roads.

Inefficient-59.8%
Fairly Efficient-22.0%
Efficient-12.9%
Very-Efficient-5.3%

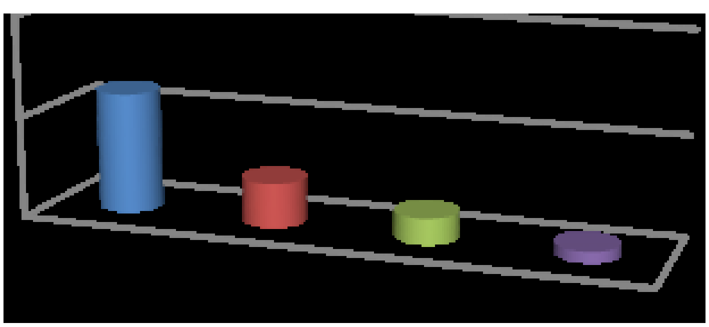
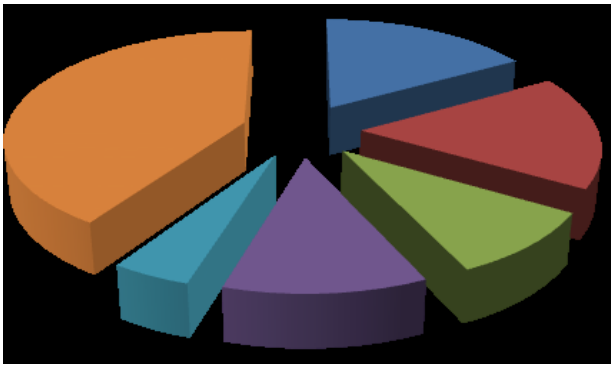


Figure 2: Road landscape Elements efficiency
Source: Author field work, 2018



Aesthetics-40%
Provision of Fresh Airto the Environment16.7%
Provision of Shade forPedestrians-16.7%
Protection fromEnvironmental Agents-11.5%

Figure 3: Road Landscapes Functions
Source: Authors" Field work, 2018.

Plate1: Dilapidated Road Landscape at New Ibro Motor Park, Lokoja.

I. Road Landscape Functions

The importance of landscape to the environment cannot be overstated, most especially its contribution to the improvement of aesthetics. Fadamiro (2004) had observed that in a well-landscaped area, users such as customers at a shopping centre, workers in an industry andthe students on campus are all soothed and refreshed by the well-planned landscape. Businessmen have discovered that customers gravitate toward a drive-in or service station under the shade of a tree; just as well-designed roads with adequate and functional landscapes attract and keep people around because of the shade and fresh air they enjoy. The functions of urban road landscapes identified in this study include aesthetics, provision of fresh air to the environment, provision of shade for pedestrians, protection from environmental agents, and property value.

About 40% (see Figure 3) of the respondents agreed that road landscaping could serve all the functions identified. However, while aesthetics and provision of fresh air were regarded as the most important functions, increase in property value was rated as the least important. This may be due to the low level of awareness of people about how good landscape could enhance the property value in the environments.

II. **Factors Preventing the Effectiveness of Road Landscape Elements in Lokoja**

The inefficiency of the road landscape elements reported by respondents in the Lokoja city has been traced to the following factors: lack of public awareness about the importance of road landscape, inadequate enforcement of laws protecting road landscape element and poormonitoring. Thirty-eight-point two percent (38.2%) of the respondents opined that a combination of all the factors stated above cause road landscape elements to dilapidate and become inefficient (Table 2).

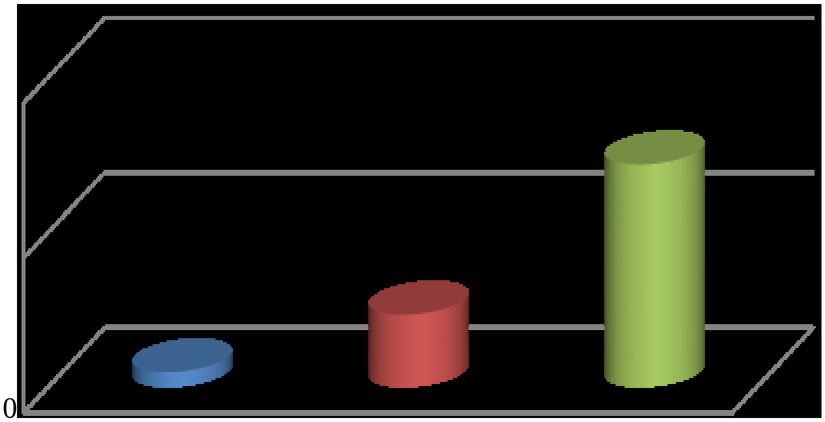
Table 2: Factors preventing the effectiveness of road landscape elements in Lokoja.

S/N	Factor	Frequency	Percent
1.	Inadequate public awareness about the importance of road landscape	30	14.4
2.	Inadequate law enforcement for protecting road landscape elements	39	18.7
3.	Poor monitoring	60	28.2
4.	All of the Above	80	38.2
	Total	**209**	**100**

Source: Authors" Field work, 2018.

III. **Need for Road Landscape Control to Achieve City Sustainability**

The need for road landscape restructuring in the context of sustainable city development is paramount. It adds to the aesthetics of roads by providing shield and green environment for the people through planting of trees, shrubs and soft grasses. The contribution of the natural and artificial elements of the urban road landscape identified by Wang et al. (2014) to aesthetics suggests the need to restructure them to achieve sustainable cities. This was supported by a significant majority (72%) of the respondents in the study area since they will not only add to the aesthetics of the city but will also help in the control of climate. Tree planting could help deflect winds and shield people from the inclemency of the tropical sun. Street lights help to reduce the incidence of road accidents at night, illuminate traffic signs and assist in reducing the incidence of crime especially at night in the city centers. Broken down vehicles on the road are noticeable from a distance with the presence of street light. Okoko (2006) had identified the importance of street lights to include enhancement of safety for all street users by aiding accidents reduction in the night; provision of security particularly for pedestrians during the night hours and facilitating the lighting levels along the footways while aiding the journey of both the public and private transport users. Apinya (2010) opined that there is the need for urban planning and landscape improvement which will in turn promote public transportation by providing convenient linkage; encourage non-motorized transportation with pedestrian linkage priority, improve crosswalk and street furniture; encourage job-housing balance of surrounding land use; improve visual perception and distinct identity and promote public green space that supports urban activities such as pocket parks, sidewalk cafes and shops.



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NO-17%, Not Sure-43%, Yes-72%.

Figure 4: Need for Road Landscape Control to achieve Sustainable City
Source: Authors‟ Field work, 2018.

CONCLUSION AND RECOMMENDATIONS

The study has revealed the need for restructuring urban road landscapes particularly in Lokoja the capital city of Kogi State, Nigeria. Landscape planning is a necessity for sustainable urban road transportation system and needs to be entrenched in the structure of land use pattern and planning in the country for the purpose of achieving aesthetically pleasing environments in terms of walking, living and accommodation. In achieving these, it is paramount that statutory policies be instituted, as this will improve the awareness and management prospects of the concerned agencies and the people.

Findings revealed that road landscape functions include; provision of fresh air to the environment and shade for pedestrians, protection from environmental agents and enhancement of property value. Based on this, government should encourage tree planting right from the inception of road construction to the end. This will help in controlling climate and other environmental degradation while boosting the green nature of the city. Community participation should also be encouraged in the provision of road landscape elements within each street of the city. By so doing, government will be able to educate the people about the importance of landscape in the environment and get them involved in the planning and design through the implementation to management stages.

In conclusion, government should empower the local authority in collaboration with other enforcement agencies or street task force to enforce regulations on protection of road landscape element. Enforcement will support broader objectives by ensuring a higher turnover of users and a more efficient and equitable use of the limited resources. This method will help to guard against sabotage of road landscape elements in urban areas, particularly in Lokoja where it has been discovered that inadequate law enforcement toward sustainable road landscape element remains one of the factors militating against the effectiveness of road landscape elements.

Recommendations

In view of the above, the following policy issues are recommended.

Landscape Monitoring Control Department in the Ministry of Environment and Housing to control and monitor the implementation of strategic plans that will be of benefit to the people within their immediate environments should be instituted by the Government. Such plans should include tree planting, provision of walkways, street lights, fountains, open spaces and other monument elements that aid city’s beautification and road users‟ activities. The department/agency should have responsibility for development control to forestall any illegal projects or development that can impair the landscape structure of the city.

Adequate attention should be paid to city illumination right from the major walkways of the urban roads to the lesser arteries and slow-speed streets as well as the pedestrian streets. There should be adequate and well-designed street furniture like street benches, bus stop shelters, street light etc. All these will go a long way in facilitating urban movement and enhance road users" activities.

REFERENCES

Aboagye, F., & Collins, A. M (2013). Enhancing urban roads maintenance in Ghana: Implications for sustainable urban development. *Civil and Environmental Research, 3* (12), 63-75.

Alabi M. O. (2007). A study of the physical expansion of Lokoja town, using geo-information techniques. *Confluence*Journal *of Environmental Studies, 2*(1), 48-52.

Alabi, M.O. (2009). Revitalizing urban public open spaces, through vegetative enclaves in Lokoja, Nigeria. *Journal of Geography and Regional Planning, 2*(3), 51-54.

Anozie, U.C. (1994). *Environmental Sanitation and Contro*l. Published by Imo State, Publishing company Owerri, Nigeria.

Antrop, M. (2000). Changing patterns in the urbanized countryside of Western Europe. *Landscape Ecology*, *15*,257–270.

Antrop, M. (2006). Sustainable landscapes: Contradiction, fiction or utopia? *Landscape and Urban Planning*, 4 (*753)*: 187–197.

Apinya, L. (2010). *Innovative landscape urban planning for Bangkok sustainable transportation development: Three study models of Bangkok.* Retrieved on 15th January, 2016 from www.arch.kmutt.ac.th/.../6.%apinya% IFLA2010%20full%20paper.com.

Ashana, D. K., & Asthana, M. (2010). *A textbook of environmental studies*. New Delhi: S. Chand and Company Ltd.

Beatley, T. (2000). *Green urbanism: Learning from European cities.* Washington, DC: Island Press.

Dumreicher, H., Levine, R. S., & Yanarella, E. J. (2000). The appropriate scale for "low energy": Theory and practice at the Westbahnhof. In: Koen, S., & Yannas, S. (eds.), *Architecture, city, environment: Proceedings of PLEA*, 359-63. London: James & James.

Ekan, E. (2007). *Streetscape character and the appearance of Nigerian cities: A case study of Uyo Urban.* In O. B. Ekpo, E. E. Etim & I. D. Obot (Eds.) Physical development of urban Nigeria: Emerging trends and challenges. Ikot Ekpene: Development Universal Consortia.

Fadamiro J.A. & Atolagbe, A.M.O. (2006). Urban environmental sustainability: A challenge to effective landscaping in Nigeria. *Dimension Teknik Arsitektur*, *34*(1*)*, 44-51.

Fadamiro J.A. (1998). *Landscape design and the environment*. Akure: Alfad Publications Limited.

Fadamiro, J.A. (1997). Housing development and environmental degradation: An intervention by landscape architecture. Paper presented at Housing in Nigeria Conference, Department of Architecture, OAU, Ile-Ife (July 1997)

Fadamiro, J.A (1995). The relevance of the architect in the rural health development. *AARCHES Journal*, 1(2): 1-5.

Fadamiro, J.A (2001). Landscape planning and urban roads in Akure, Nigeria. *International Journal of Transportation Studies*, *1*(1)*, 86*-91.

Fadamiro, J.A., & Adam, J.J. (2004). Environmental quality and landscape. A comparative analysis of public and private housing estates in Lagos, Nigeria. *Science Focus*: *An International Journal of Biological and Physical Science*, *19,* 48-56.

Falade, J.B (1985). *Nigeria's urban open spaces: An inquiry into their evolution, planning and landscape qualities.*Unpublished PhD dissertation. Department of Architecture, University of Edinburgh.

Gabriela, K., & Ronnie, L. (2009). *Environmental Governance: Power and knowledge in a local-global world*. London: Routledge.

Harris, J. M. (2006) *Environmental and natural resources economics: A contemporary approach.* New York: Houghton Mifflin Company.

Ibimilua, A. F. (2014). Key issues on landscape planning in the context of environmental sustainability. *European Scientific Journal*, *10(*2),143-156.

Jabareen, Y. F. (2006). Sustainable urban forms: Their typologies, models and concepts. *Journal of Planning, Education and Research, 26*, 38-52.

Jay, W., & Scott, B. (2011). *Essential environment: The science behind the stories*. Glenview: Pearson.

Joseph, B. (2009). *Environmental studies.* New Delhi: Tata, McGraw Hill.

Kanagasabai, S. (2010), *Textbook on environmental studies*. New Delhi: PHI Learning Private Limited.

Luis, L., Raúl, S., & Thomas, P. (2007). Urban parks and sustainable city planning - The case of Portimão,Portugal. *WSEAS Transactions on Environment and Development, 10*(3), 171-180.

Mazza, L., & Rydin, Y. (1997). Urban sustainability: Discourses, networks and policy tools. *Progress in Planning, 47*(1), 1-74.

National Population Census (2006). Comprehensive result of 2006 population census. Retrieved on October 15th,2015, from www.google.com

Okoko E.E. (2006). *Urban transportation planning and modelling.* Akure: Millennium Publishers.

Oladeji, O.S., (2002). Preliminary assessment of the environmental impacts of land use patterns on groundwaterquality. *Global Journal of Environmental Sciences, 1,* 35-42.

Olanrewaju, D.O. (1990). Spatial distribution of urban deprivation in Akure, Ondo State, Nigeria. Unpublished PhD Thesis University of Sheffield, United Kingdom.

Olorunfemi S.O. (2013). *Assessment of on-street parking in Lokoja, Nigeria.* Unpublished Master" Thesis, Department of Urban and Regional Planning, Federal University of Technology, Akure, Nigeria.

Pregill, P., & Volkman, N. (1999). *Landscapes in history – Design and planning in the Eastern and Westerntraditions.* John Wiley & Sons.

Rees, W. E. (1997). Urban ecosystems: The human dimension. *Urban Ecosystems, 1,* 63-75.

Sagris, V. (2006). Are European cities becoming dispersed? A comparative analysis of 15 European urban areas. *Landscape and Urban Planning, 77*: 111–130.

Senecal, G. (2000). Urban spaces and quality of life: Moving beyond normal approaches. http://policyresearch.Gc.ca/page.Asp. Retrieved on 10th October, 2015.

Shonibare, O. (1996). *The management of open space in Nigerian urban cities*. Unpublished National Diploma Project, Department of Architecture, Ondo State Polytechnic, Owo Ondo State, Nigeria.

Singh, H. R. (2009). *Environmental biology*. New Delhi: S. Chand and Company Ltd.

Umunnakwe, E. J., & Nnaji, A.O. (2011). Influence of land use patterns on Otamiri River, Owerri and urban quality of life. *Pakistan Journal of Nutrition 10* (11): 1053-1057.

Wang, Z., Wang, X., & Hong, L. (2014). The design of imaginable urban road landscape. *International Journal ofCivil, Architectural, Structural and Construction Engineering* 8 (4) 339-410.

Watkins, K. (2012). *Safe and sustainable roads: The case for a sustainable development goal.* Retrieved February10th, 2015 from http://www.makeroadssafe...._Transport_Goal_report.pdf

World Commission on Environment and Development [WCED] (1987). *Our common future*. Oxford, England: Oxford University Press.

Wright, R. T. (2008).*Environmental science: Toward a sustainable future***.** New Delhi: PHI Learning.

Zheng F. (2005). *Theory and practices of sustainable city*. Beijing: Renmin Press.

DETERMINANTS OF VISITORS' CHOICE PREFERENCE FOR UNIVERSITY OF IBADAN ZOOLOGICAL GARDEN AND AGODI PARKS AND GARDEN: KEY TO SUSTAINABLE TOURISM.

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Abstract
Factors influencing visitors' choice preference for University of Ibadan Zoological Garden and Agodi Parks and Garden were explored in this study. Data were obtained through the use of well-structured questionnaires administered to the visitors. A total of three hundred and eight four visitors (384) were sampled. Descriptive Statistic and T- test were used for data analysis. Results revealed that majority of the visitors were females, youth, singles and most visitors were educated. Repeat visitors were more and visitation during the festive period was highest. Learning and sightseeing had the highest weighted mean of 82.07, and hence the highest influence on visitors destination choice preference at the University of Ibadan. Tourist destination respect for the natural environment(weighted mean =31.40) and opportunity for rest and relaxation (weighted mean = 31.20)were the major motives for visiting Agodi Parks and Garden. Motivating factors that influence visitors' destination choice preference to UI Zoo and Agodi Parks and Garden were significantly different. The empirical examination of factors influencing visitors' choice preference will assist tourist site manager to identify the attributes that are to be promoted so as to match tourist motivations.
Keyword*: Motivation, Preference, Choice, Garden, Visitors*

INTRODUCTION

A destination can be viewed as a uniquely complex product of the tourism industry comprising, among other factors, an area's climate, infrastructure and superstructure, services, and natural and cultural attributes. Despite this complexity, it is nevertheless a product. Beerli and Mortin (2004) pointed out that tourist destinations must be conceived as brands that have to be managed from a strategic point of view. Buhalis (2000) regarded destination as a defined geographical region which is understood by its visitors as a unique entity, with a political and legislative framework for tourism marketing and planning; destinations offer an amalgam of tourism products and services, which are subsumed under the brand name of the destination.

According to Dellaert *et al*, (1998), tourists' decisions are complex multi-faceted decisions in which the choices for different elements are interrelated and evolve in a decision process over time, and most studies of tourists' travel choice address tourist destination choice as the key element in the travel decision-making process. The decision-making process is influenced by a number of psychological (internal) and non-psychological (external) variables, and consists of a number of different stages that are marked by specific actions. Furthermore, travel motivation is a multi-motive dimensional. Tourists often have more than one motive for choosing a certain destination, for example, people can choose one destination with a motive of relaxation in a pleasant safe place combined with visiting a local historical heritage (Prebensen, 2007). Motivation is also a dynamic and flexible variable. The design of a motivation list must be flexible enough to incorporate individual changes across the life-span and consider the effects of broad cultural force on tourist motivation (Pearce *et al* 2005). For example, a person may change his travel preferences as he moves through the family life cycle from a single-career person to a more family-oriented person, his motives for choosing destinations may be changed accordingly. The reasons behind choosing a travel destination have been an important area of study in tourism literature for decades (Quan and Wang, 2004). It is assumed that tourists would like to maximize satisfaction while choosing between a range of destinations, goods and services (Tribe, 2004). There are many factors that influence tourists when they need to make a decision about their holiday and destination.

According to Goodall (1991), motivations initiate actions and guide satisfactory behavior but more precise filters of choices are exercised by decision makers ‘preferences. Personal preferences, like motivations, may be both intrinsic, reflecting individual likes and dislikes, and extrinsic, or socially conditioned. Pearce (2005) stated that preferences are more specific than motivations, and are revealed by where travelers go and what travelers do. Crompton (1979) noted that it is possible to describe the who, when, and how, of tourism together with the social and economic characteristics of tourists; but does not answer the most interesting question of all tourist behavior-why. Thusthe broad objective of the study is to determine the factors influencing visitors’ destination choice preference to University of Ibadan Zoological Garden and Agodi Parks and Garden.

MATERIALS AND METHODS

Study Area

Agodi Parks and Garden

Agodi Gardens, created in 1967 and formerly known as Agodi Zoological and Botanical Garden, was a major recreational centre in Ibadan city, and managed solely by the Western Region until the creation of Oyo State in 1976. It is an *ex-situ* conservation site on a wetland and it occupies about 13 acres (approximately 5.3 hectares) of land. The geographical coordinates are Latitude 7º24‘25.01‘N and Longitude 3º53‘57.35‘‘E with an elevation 0f 191m above the sea level (Olubode, 2013). The tropical climatic of Ibadan in which then garden is located provides a moderate and optimal weather for the Garden. Agodi Garden is positioned North-East of Oyo State Secretariat, South-West of the University Teaching Hospital, and North-West of the Premier Hotels. The Garden has a river called Dandaru River which runs through it (Omonona, 2015).

University of Ibadan Zoological Garden

The University of Ibadan Zoological Garden was found in 1948 with the Department of Zoology. It was first a menagerie, where few animals were kept until it was upgraded to a full fledge zoological garden in 1974. As a major point of attraction for tourist to the University, the zoo has received millions of tourists from its time of creation with a wide array of exotic species from different ecological zones of Nigeria and beyond. It lies between latitude 7^{0}26’57’.6”N and longitude 3^{0}53’69’.9”E. It covers a 3.5km^{2} land area with vegetation mostly of trees and some grasses on a flat terrain. There is a stream which runs through the zoo creating a natural drainage.

Founded in 1948, the university of Ibadan Zoological garden portrays a balanced natural ecological relationship of various animals, ranging from strange domestic species wide variety of wild species (Olukole, 2009).

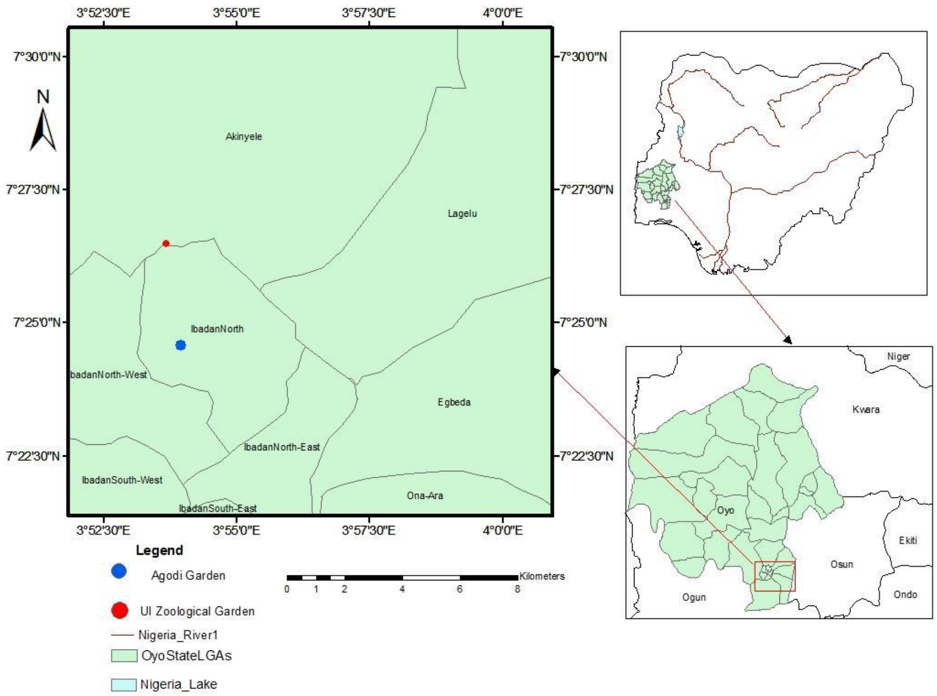

Figure 1: Location of UI Zoo and Agodi Parks and garden.

Source: Field Survey, 2017.

Procedure for Data Collection

Participants in the study were visitors to University of Ibadan Zoological Garden and Agodi Parks and Garden. Random sampling techniques was used in order to give every visitorequal rights of expressing themselves. The questionnaires were administered to visitors who were willing to participate in the study. A total of three hundred and eighty four (384) visitors were sampled (276 questionnaires at University of Ibadan Zoological Garden and 108 questionnaires at Agodi Park and Garden) using Kriecje and Morgan (1970) sample size determination. Both descriptive (tables, charts, means) and inferential (T-test) statistics were used for data analysis.Each variable highlighting the factors influencing visitors' destination choice preference was used to calculate the Weighted Mean (X) or mean of a group data. The Gross Arithmetic Mean (GAM) was applied to the entire calculated mean under each of the factors. The GAM result was used as baseline for determining the cut-off mark to accept or reject the variable as described by (Adetola *et al*, 2016).

RESULTS AND DISCUSSION

Socio demographic Characteristics of Respondents

Table 1 revealed that majority (53.91%) of Visitors to UI Zoo and Agodi Parks and Garden were female, 67.7% were single, ages of respondent had 55.2% for 20-39 years and 24.7% and 20.1% respondents fall within ages less than 19 and above 40years respectively. All respondents are Nigerian, 84.4% are Christians, highest percentage had tertiary education (44.3%) and majority were students (54.2%). Respondents without income earning were 40.40%, 31% earned between ₦20,000-59,000 and 7.6% earn more than ₦100,000.

Table 1: Socio-demographic Characteristics of Visitors to UI Zoo and Agodi Parks and Garden

VARIABLES	FREQUENCY (N=384)	PERCENTAGE (%)
GENDER		
Male	177	46.1
Female	207	53.91
MARITAL STATUS		
Married	119	31.0
Single	260	67.7
Divorced	5	1.3
Age		
Less than 19	95	24.7
20-39	212	55.2
40 and above	77	20.1
Nationality		
Nigeria	384	100
EDUCATIONAL STATUS		
No Formal Education	13	3.4
Primary	37	9.6
Secondary	145	37.8
Tertiary	170	44.3
Adult/Vocational	19	5.0
OCCUPATION		
Students	208	54.2
Civil servants	100	26.0
Trade/commerce	51	13.3
Agriculture	15	4.0
Artisan	6	1.6
Retired	4	1.0
RELIGION		
Christianity	324	84.4
Islam	60	15.6
MONTHLY INCOME (₦)		
No income	155	40.4
Below 19,000	51	13.3
20,000-39,000	62	16.2
40,000-59,000	57	14.8
60,000-79,000	18	4.9
80,000-99,000	12	3.1
100,000 and above	29	7.6

Source: Field Survey, 2017.

Visit Characteristics of Respondents

Figure 1 show that repeat visitors to the sites were 56.50% and first time visitors were 43.50%.Highest percentage (40.1%) visit during the festive periods, 29.40%, 16.20% and 14.30% are occasional, quarterly and once in a month visitors respectively (Figure 2). Highest percentage (24. 70%) visit with their family members as shown in Figure 3.

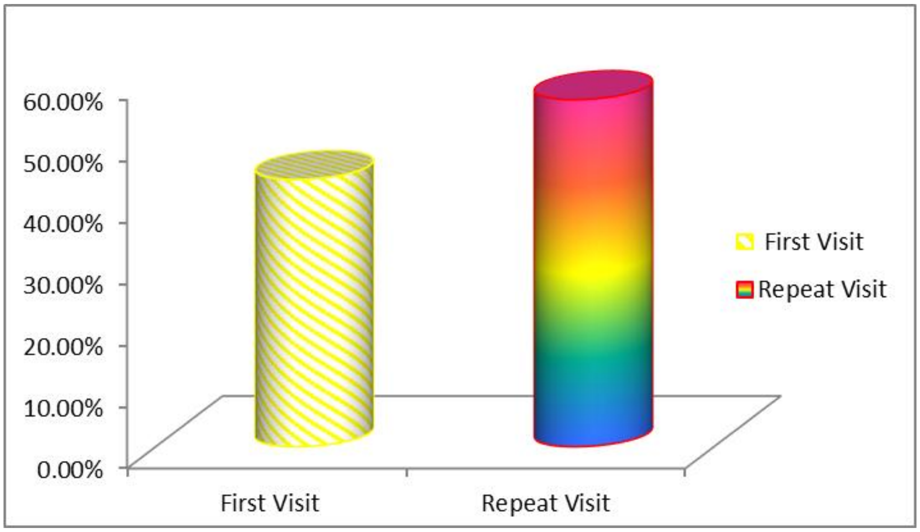

Figure 1: Visitation Pattern of Visitors to U.I and Agodi Parks and Garden

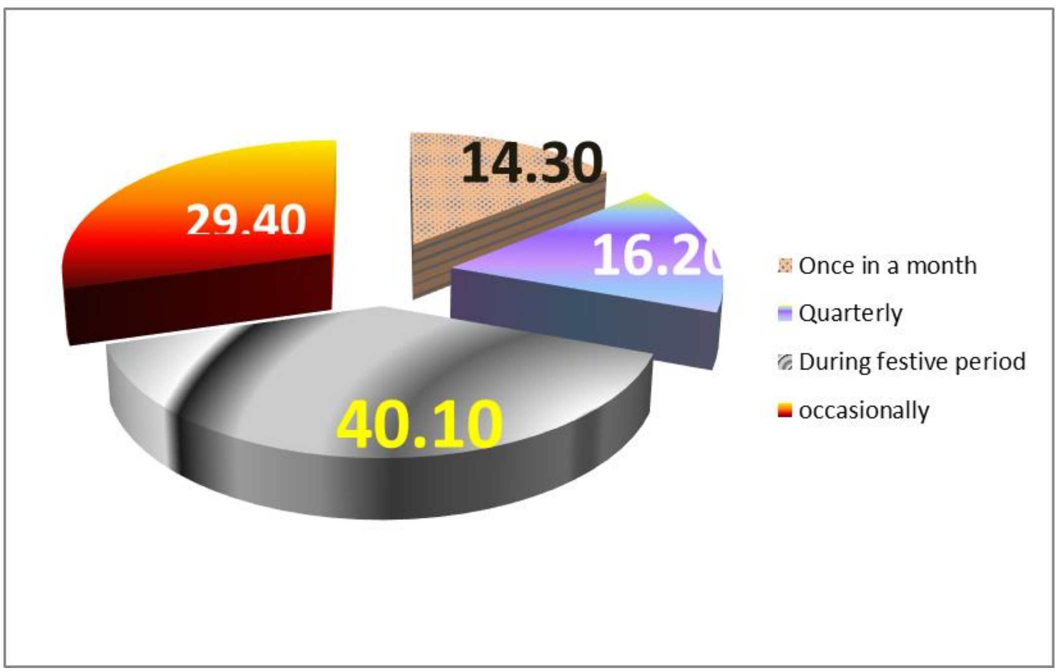

Figure 2: Visitors' Frequency of Visit to U.I and Agodi Parks and Garden

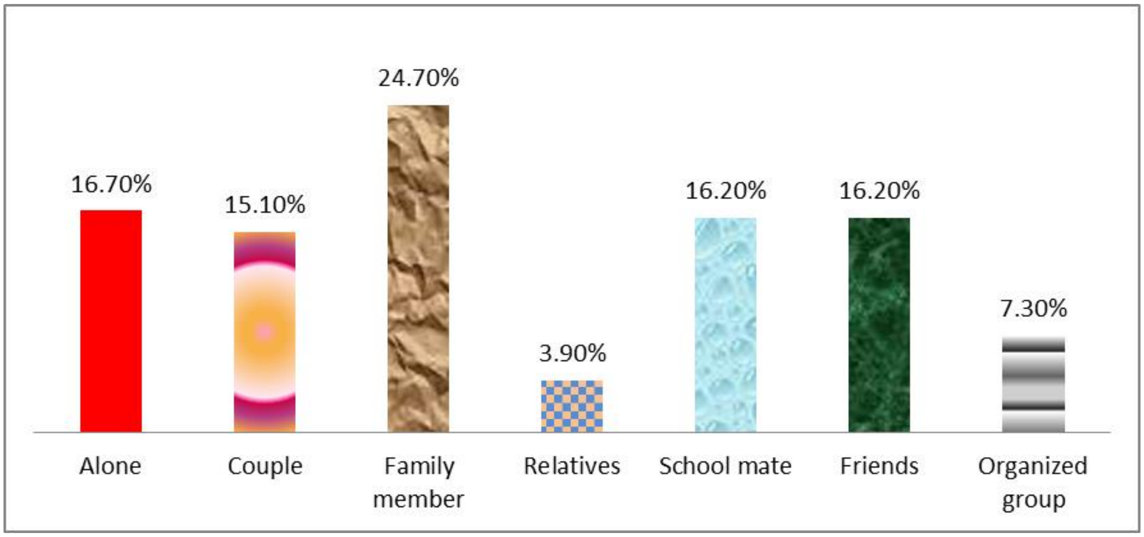

Figure 3: Visitors Group Characteristics to U.I ZOO and Agodi Parks and Garden

Visitors Motivation Factors

Table 2 presents the weights for the motivation factors in the University of Ibadan Zoological Garden. Learning and sightseeing had the highest weighted mean of (82.07), and hence the highest influence on visitors destination choice preference; next to it was tourist destination respect the natural environment (80.87) and motivation for visiting friends/ relatives (72.87) was the least.

Table 3 shows the weights for each criterion in Agodi Parks and Garden, tourist destination respect the natural environment had the highest weighted mean (31.40), which was followed by rest and relaxation (31.20) while escape from pressure of daily life (27.00) was the least motivation.However, the independent sample test in table 4 show that the motivating factors that influence visitors' destination choice preference to UI Zoo and Agodi Parks and Garden were significantly different.

Table 2: Motivating Factors that Influence visitors to University of Ibadan Zoological Garden

Factors	SD	A	U	D	SD	Total sum of score	Weighted mean(X)	Rank	Remark
Rest and relaxation	116	122	20	12	6	1158	77.20	9	Accept
Improve Health and fitness	108	108	38	15	7	1123	74.20	10	Reject
Visiting friends/relatives	97	114	29	29	7	1093	72.87	17	Reject
Meeting new people	105	110	23	28	10	1100	73.33	12	Reject
Escape from pressure of life daily life	100	99	42	27	8	1084	72.27	18	Reject
Self-actualization	93	117	40	19	7	1098	73.20	13	Reject
sight seeing	160	94	13	7	2	1231	82.07	1	Accept
Novelty seeking	105	105	48	14	4	1121	74.73	15	Reject
Adventure seeking	144	97	23	9	3	1198	79.87	5	Accept
Learning	164	90	12	5	5	1231	82.07	2	Accept
Transportation facilities	95	129	31	17	4	1122	74.80	11	Reject
Good shopping	86	124	41	20	5	1094	72.93	16	Reject
Art and craft appreciation	102	112	44	15	3	1123	74.87	14	Reject
I think most people have a positive opinion about this tourist destination	118	131	21	5	1	1188	79.20	6	Accept
The staff at this tourist destination are friendly towards the guests and always put guest first	114	120	37	4	1	1170	78.00	8	Accept
This tourist destination has a unique image	115	138	16	6	1	1188	79.20	7	Accept
think this tourist destination is popular	133	120	16	4	3	1204	80.27	4	Accept
this tourist destination respect the natural environment	131	128	13	3	1	1213	80.87	3	Accept
GAM (Gross Arithmetic Mean= 76.81)									

SA= Strongly Agree, A= Agree, U= Undecided, D= Disagree, SD= Strongly Disagree;
Source: Field survey, 2017.

Table 3: Motivating Factors that Influence visitors to Agodi Parks and Garden

Factors	SD	A	U	D	SD	Total sum of score	Weighted mean(X)	Rank	Remark
Rest and relaxation	52	44	8	4	0	468	31.20	2	Accept
Improve Health and fitness	36	53	14	3	2	442	29.47	5	Accept
Visiting friends/relatives	36	46	13	9	4	425	28.33	15	Reject
Meeting new people	32	56	14	4	2	436	29.07	10	Reject
Escape from pressure of life daily life	28	46	18	11	3	405	27.00	17	Reject
Self-actualization	28	53	18	6	3	421	28.07	13	Reject
sight seeing	35	56	10	4	3	413	27.53	16	Reject
Novelty seeking	28	48	20	9	3	442	29.47	6	Accept
Adventure seeking	38	50	14	4	2	443	29.53	4	Accept
Learning	40	47	15	4	2	440	29.33	7	Accept
Transportation facilities	38	44	23	2	1	440	29.33	8	Accept
Good shopping	33	42	21	9	3	417	27.80	14	Reject
Art and craft appreciation	28	48	15	11	6	405	27.00	18	Reject
I think most people have a positive opinion about this tourist destination	29	58	14	6	1	432	28.80	12	Reject
The staff at this tourist destination are friendly towards the guests and always put guest first	26	63	14	4	1	433	28.87	11	Reject
This tourist destination has a unique image	32	56	16	3	1	439	29.27	9	Accept
Think this tourist destination is popular	39	58	5	5	1	453	30.20	3	Accept
This tourist destination respect the natural environment	47	54	6	1	0	471	31.30	1	Accept
GAM (Gross Arithmetic Mean= 28.98)									

SA= Strongly Agree, A= Agree, U= Undecided, D= Disagree, SD= Strongly Disagree;
Source: Field survey, 2017.

Table 4: Test of Significance of the motivating factors between visitors to University of Ibadan zoological garden and Agodi parks and garden.

Variables	Values
UI Zoological Garden	76.81 ± 3.42
Agodi Parks and Garden	28.98 ± 1.24
T. value	55.86
Sig.	0.000*
Significant at $P<0.05$	

RESULTS AND DISCUSSION

Major finding from the result shows that majority of visitors were female. This is consistent with finding of Neves (2007) in Asia Trail Smithsonian National Zoological Park which reported that (62%) of the visitors were female, World Association of Zoos and aquarium reported that 50.3% of visitors to zoos were female. Association of zoos and aquarium (AZA, 2014) also reported that were 65% of female that visit zoos. Karanikola *et al*, (2014) in zoo of Thessaloniki, Greece reported that there were more female (50.9%) that visit the zoo but is inconsistent with the finding by Duta, (2005) in Peshweudyan Zoo, India which reported that majority (64%) of the visitors were males. The majority of survey participants were in the age range of 20-39. This was true at both the University of Ibadan zoological garden and Agodi Parks and garden. This is consistent with the findings Association of Zoos and Aquarium. AZA (2014) reported that 57% of the visitors were within the age group of 21-35 years. Duta (2005) in Peshweudyan zoo, India reported that 60% of the visitors were within the age group of 25-45 years old. The study also shows that 67.7% of the visitors were single; this is inconsistent with the finding of Jordan and Plessis (2014) in National Zoological Garden, South Africa which reported that 42% of the visitors to zoos were married. Karanikola *et al.*, (2014) in zoo of Thessaloniki, Greece reported that 64% were married. In addition, Students have the largest percentage of the visitors 54.2%, and have no income earning this is in agreement with the findings of Adetola *et al.*, (2016) which reported that 52.1% of visitors to University of Ibadan Zoological garden were students and inconsistent with finding of Karanikola *et al.*, (2014) that reported that 60% of the visitors were employed. The study also shows that all the respondents were Nigerians; this is consistent with the finding of Shani, (2012) in Central Florida zoo, USA that reported that 66.9% of visitors were domestic visitors from United State of America and 33.1% were foreign visitors. Most of the visitors were highly educated attaining to tertiary level of education. This is consistent with the findings of Knezevic *et al.*, (2016) in Zagreb zoo, Crotia which reported that 52% of the visitors to the zoo were educated attaining to tertiary level of education and its equivalents.

It is observed that most of the visitors were repeat visitors (56.5%) which is inconsistent with the findings of Couch (2013) in Potter Park Zoo, USA that reported 53% of the visitors as first time visitors. Findings agrees with Neves, (2007) in Asia Trail Smithsonian National Park which had 77% of the visitors as repeat visitors. Lancaster (2013) in Dartmoor Zoo, England and in Paignton‘s zoo in England reported 57% and 86% of the visitors as repeat visitors respectively, Couch (2013) in Detroilt Zoo reported 80% as repeat visitors. The visitation pattern increases during festive period in both destinations and family members was the major visit company.

The motivation factors that influence visitors' destination choice preference to University of Ibadan and Agodi Parks and Garden werelearning, sightseeing, respect for the natural environment, rest and relaxation amongst others. This supports the assertion onthe pull factor that pulls an individual toward a destination due to a region-specific lure, or perceived attractiveness of a destination (Lam and Hsu, 2006). Moreover, there is significant difference in the factors that influence visitors' destination choice preferences to University of Ibadan zoological Garden and Agodi Parks and Garden.

CONCLUSION

It is evident from this study that majority of the visitors were female, mostly students, young and educated. Majority were repeat visitors which suggest that they enjoyed their previous visits to the destinations. Major motivations that influenced visitors' choice of these destinations werelearning, sightseeing, respect for the natural environment, rest and relaxation. Findings from this studywill assist destination marketers to better understand how tourists and potential tourists view and choose their destinations. The empirical examination of tourist motivation will help to identify the attributes that are to be promoted so as to match tourist motivations.

REFERENCES

Adetola, B.O. Adenuga A. J. and Morenikeji, O. (2016). Willingness to pay for captive wildlife tourism at the University of Ibadan Zoological Garden, Nigeria.*Journal of Research in Forestry, Wildlife and Environment Vol. 8(2)*:58-72.

Association of Zoos and A quarium, AZA, (2014). *Zoo and Aquarium statistics*; Annual survey report 2014 Publications, 150p.

Beerli, A., and Martin, J. D. (2004). Factors influencing destination image. *Annals of tourism research*, *31*(3), 657-681.

Buhalis, D. (2000). Marketing the competitive destination of the future. *Tourism management*, *21*(1), 97-116.

Couch, A.S. (2013). Zoo visitor satisfaction with animal visibility, Masters of Science Thesis submitted to Mitchigan State University, 92p.

Crompton, J. L. (1979). Motivations for pleasure vacation. *Annals of tourism research*, *6*(4), 408-424.

Dellaert, B. G., Ettema, D. F., and Lindh, C. (1998). Multi-faceted tourist travel decisions: a constraint-based conceptual framework to describe tourists' sequential choices of travel components. *Tourism Management*, *19*(4), 313-320.

Dutta, T. (2005). Visitor profile at Peshwe Zoo, Maharashtra. *ZOOS'PRINT*, *20*(8).

Goodall, C. (1991). Procrustes methods in the statistical analysis of shape. *Journal of the Royal Statistical Society. Series B (Methodological)*, 285-339.

Jordan,Y and Plessis. G.M. (2014). Motivators to visit the National Zoological Gardens of South Africa, *Africa Journal of Hospitality, Tourism and Leisure* 3(1): 4-15.

Karanikola, P., Tampakis, S., Tsantopous, G. and Digbasani, C. (2014). The public zoo as recreation and environmental education area; Visitor's perceptions and management implications. WSEAS Transactions on Environment and Development, 10(1): 2-10.

Knežević M., Žučko I and Ljuština M. (2016). Who is visiting the Zagreb Zoo: Visitors Characteristics and Motivation. Sociologijaiprostor, 54 (2016) 205 (2): 169-184.

Lam,T. and Hsu, C. H. (2006). Predicting behavioral intention of choosing a travel destination. *Tourism Management*, *27*(4), 589-599.

Lancaster, S, (2013). A study evaluating what best inspires visitors' behaviors and attitude changes in zoos, with a small botanical garden comparison: addressing zoos educational and Subsequent Conservation Values. *The Plymouth Student Scientist* 6 (1): 289-331.

Neves, C.M.P. (2007). Museum Visitation as a Leisure Time Choice: A Background Report to the Smithsonian Board of Regents. Smithsonian institution Publications, 28p.

Olubode S.O. (2013). Field Survey Department of Crop Protection and Environmental Biology, Faculty of Agriculture and Forestry. University of Ibadan. Unpublished Record.

Olukole, T. O. (2009). GIS Database and Wildlife-based Tourism: The Case of the University of Ibadan Zoo, Nigeria.*Tourism Recreation Research*, *34*(2), 213-217.

Omonona, A. O. (2015). Development of Agodi Park and Garden: Challenges and the Way Forward. Production Agriculture and Technology, 11(10): 117-129.

Pearce, P. L., and Lee, U. I. (2005). Developing the travel career approach to tourist motivation. *Journal of travel research*,*43*(3), 226-237.

Prebensen, N. K. (2007). A grammar of motives for understanding individual toursitbehaviour. Doctor Dissertation, Retrieved from http://dhl.handlenet/2330/1481Quan, S., and Wang, N. (2004). Towards a structural model of the tourist experience: An illustration from food experiences in tourism. *Tourism management*, *25*(3), 297-305.

Shani, A. (2012). A quantitative investigation of tourists' ethical attitudes toward animal-based attractions, *Original scientific paper*, 60(2): 139-158.

Tribe, J. (2004). Knowing about tourism. *Qualitative research in tourism. Ontologies, epistemologies and methodologies*, 46-62.

THE RELEVANCE OF INDIGENOUS KNOWLEDGE IN MANAGING OLD OYO NATIONAL PARK'S NATURAL RESOURCES

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Abstract
Old Oyo National Park (OONP) is a protected area in Nigeria, endowed with fauna and flora resources. There are indications that the park has suffered indiscriminate and uncontrolled human activities which include fishing, hunting, livestock grazing, bush burning, and neglect of various cultural endowments. This study investigated the indigenous knowledge of the residents in the support-zone communities, on resource management in the park. In-depth interviews were conducted among fifteen purposively selected resource-users. Each interview was transcribed and analyzed thematically. The findings showed that traditional belief systems have strong elements of conservation techniques that can be adopted for effective conservation of natural resources because all the participants opined that Traditional Protected Areas were sacred places protected from human activities. We therefore suggest that there is need for the traditional belief systems and cultural practices that promoted the management, preservation and conservation of natural resources to be re-visited.

Keywords: *Indigenous knowledge, Natural resources, Old Oyo National Park, Traditional Protected Areas*

INTRODUCTION

Indigenous knowledge systems (IKS) have been defined as community-based knowledge systems, which have been developed by the community in managing everyday life (Bisong and Andrew-Essien, 2010). IKS include knowledge about people, places, plants, animals, and traditional beliefs associated with a particular community (Finneti, 2011). The relevance of IKS for natural resources management has been well established in literature.As opined by Sasaki *et al*., (2010), traditional beliefs, cultural mores and practices play a crucial role in the successful conservation of the environment and specific organisms, especially, in the developing countries. Taboos, and a system of classification of natural resources are part of the indigenous knowledge used in the conservation of natural resources in the pre-colonial era. A taboo, according to Jary and Jary (1995), refers to any ritual prohibition on certain activities used to protect or safeguard certain resources against possible damage by human interference.

The erosion of tradition is characteristic of developing countries, where there is increased exploitation of the biodiversity, and this is threatening approximately one-third of species worldwide (Renias and Remigios, 2013). IKS, particularly in the African context, have long been ignored and maligned by outsiders (Matsika, 2012). Bisong and Andrew-Essien (2010) as well as Jemitias and Philip (2013) opined that many academics and development professionals are yet to appreciate the value of IKS for sustainable development and socio-economic transformation of society. Therefore, Africans are expected to align their IKS with the modern reality in creating solutions to environmental problems (Were, 2011) because increasing human demands for resources has weakened the capacity of the earth's natural systems, as evidenced in collapsing fisheries, shrinking forests, eroding soils, and disappearing species (Andrea and Lucius, 2013).

Despite the fact that many benefits are derived from the natural environment, human activities continuously degrade the environment. Oladeji *et al.*, 2012) reported that there are indications that Old Oyo National Park (OONP) has suffered indiscriminate and uncontrolled human activities which include fishing, hunting, logging, mining, livestock grazing and bush burning. Therefore, this high rates of exploitation and perceived neglect of various cultural endowments in OONP should be strategically addressed for the purpose of continuous existence of the Park. The question could be asked thus: Could conservation programmes shift attention to the relevance of IKS in the management of natural resources in OONP? This study was guided by the following objectives:

(i) examine the roles of traditional belief system in natural resource management in Old Oyo National Park.

(ii) assess the extent in which social change has affected the indigenous methods of natural resource conservation.

MATERIALS AND METHODS

The participants in this study comprised of local residents in five (5) randomly selected host communities (Adetoro, 2008; Ajayi, 2014) within 10km radius of Old Oyo National Park (OONP). OONP is geographically located between latitude 8°07´and 9°04´N; longitude 3°35” and4°21´E. Politically, it lies in Oyo State in the Southwest of Nigeria and it is a mixed heritage site with outstanding natural and cultural values (Oladeji, *et al.*, 2012). Apart from the different plants, birds and aquatic creatures found in the park, visitors also sight animals like the western hartebeest, antelopes, duikers, kobs, bush hog, rock hyraces, baboons and variety of monkeys (Ige, 2013). The Park has five (5) ranges namely: Oyo-Ile, Sepeteri, Marguba, Tede and Yemeso. The participants were farmers, hunters, Herdsmen, traditional religious priests and charcoal/firewood traders because they were the major resource-users in that destination. The qualitative data collection was done by interviewing fifteen (15) purposively selected participants about indigenous knowledge on resource management in the study area. Each interview session was tape-recorded with permission of the participants. This was later transcribed and analysed thematically.

RESULTS AND DISCUSSION

Traditional Protected Areas in OONP include:

Agbaku cave

Agbaku means “taking another person’s death”. They discovered that whenever their enemies pursued them to this cave, their enemies would face and kill one another. It was also a hideout for the people of old Oyo because it could accommodate more than a thousand people at a time (Plate 1).

Antete shrine

The shrine is located at Ikoyi–Ile. In the olden days, if the people were expecting a war, the priest would offer sacrifice at the shrine. After some days, the pot would be full of honey bees. These bees always assisted their warriors to fight their enemies by stinging them to death (Plate 2).

Plate 1: Agbaku cave

Plate 2: Antete shrine

Ibuya pool

Ibuya means ‘where the mother resides’. This was the centre for annual festival (usually in July) for some traditional worshippers at Sepeteri. During those days, one of the priests used to carry hot ‘egbo’ (produced from maize) to the goddess in the pool. After seven days, the priest would return back with hot ‘egbo’ sent by the goddess. During this period, people used to experience different miracles like healings, pregnancies, etc. The head of the priests is called Oniyakun of Sepeteri land. He is from Ile Iyakun family. This festival is still celebrated till date but in a different form (Plate 3).

Plate 3: Ibuya pool

Plate 4: Python cave

Plate 5: Water reservoir

Python cave

According to local history lore, the pythons in this cave, gave the old Oyo people helping hands during the wars(Plate 4).

Water Reservoir

This site was a bit swampy. So, it was dredged through the instruction of the king for the purpose of water collection during the rainy season, forming a reservoir. This collected water would then be used as a water supply during the dry season (Plate 5).

The Role of traditional belief system in Natural Resource Management

African traditional belief systems have strong elements of conservation techniques that can be adopted for effective conservation of natural resources and the protection of the environment (Philip *et al*., 2014). This is possible because these traditional belief systems ascribed certain sacredness to some parts of the environment, which was seen as the abode of the gods. Humans were strictly prohibited from exploiting resources in such places.

Traditional Protected Areas refers to sacred groves, burial sites and sacred hills. Plants and animals found in these sacred places were protected from human activities because only the priests were allowed to enter these places for specific purposes. (Traditional religion priest, Aba Oyo community). It was a taboo for anyone to fish at Ibuya because it was the abode of the goddess who gave our forefathers different miracles (Hunter, Alobac ommunity). Our forefathers believed that the gods who helped them defeat their enemies dwelt in that rock. That was the reason they always run there whenever there was war, hence, the name agbaku (Traditional religion priest, Banni community).

Traditional belief systems and practices are consistent with current conservation practices. For instance, there were forest guards who were responsible for arresting trespassers, which is similar to the park rangers in protected areas.

Why do most local communities have reference for their natural resources?

Our environment is our life because we get everything we need – food, water, herbs for our health- from the natural resources in our environment. If we treat it well, we are only treating our lives well. Therefore, we need to protect them for future generations (Farmer, Ajebamidele community). The protection of the natural environment is very important to indigenous people since they derive benefits from the environment. No one can separate humans and natural resources. Without natural resources, there can be no human being on the earth (Herdsman, Budo Lube).

Take for instance, why should we disrespect the pythons in that cave that always helped our forefathers in those days to fight against their enemies. It was forbidden for our people to eat python. The government, through their policies that neglect indigenous people, has taken the sacred place from us (Hunter, Banni community). In the case of the above scenario, residents of that community had seen pythons as their totem which discouraged its hunting. This agrees with the opinion of Jemitias and Philip (2013), that totemism encouraged selective rather than indiscriminate hunting, thereby preserving any endangered species from possible extinction .

Our ancestors had lived in this area for many generations; they were the rightful owners and overseers on the use of natural resources in this area. We don't want our heritage which was handed overtous by our ancestors to be destroyed. Therefore, there must be collaboration between the residents and the managers of this park over ownership, management, and use of the natural resources in this park (Hunter, Ajebamidele community).

This opinion agrees with the observation of Ajayi *et al*., (2017) that the resources in OONP are seen as common property by the local residents which they have depended on as their means of livelihood.

Why is it that people are no longer protecting the environmental resources?

Nowadays, there is rapid decrease in natural resources because traditional beliefs have been neglected and unless attention is shifted to IKS, there will not be any change (Charcoal trader, Aba Oyo community)

This agrees with the view of Anoliefo *et al*., (2003) that the abandonment of traditional cultural practices is doing great harm to natural environmental structures. Furthermore, Ajayi *et al*., (2017) opined that the residents have developed negative attitudes towards the existence of the OONP because of restrictions imposed on them.

The traditional institutions had played vital roles in ensuring that defaulters were punished. Our traditional institutions have been looked down upon these days. Our traditional institutions should be empowered as local options for sustainable management of natural resources in this locality(Traditional religion priest, Aloba community). This follows the suggestion of Philip *et al*., (2014) that there was need for pursuance of more feasible and sustainable approaches for natural resource management if the drastic loss of biological ecosystem and cultural diversity is to be curtailed.

In the olden days, people had respect for the environment. There were rules to protect animals. For instance, our fathers told us that during hunting exercise, we should only target the dominant animal in the group of animals and we must not kill pregnant animals. We were taught the rudiments of hunting. But these days, things have changed (Hunter, Budo Lube community).

This confirms the observation of Anoliefo *et al*., (2003) that preservation of the environment has an inextricable link to the culture of the rural communities.

CONCLUSION

Majority of the interviewees said that they do not want the park to be destroyed. They were of the opinion that since traditional belief system had in the past, contributed immensely in the conservation and management of environmental resources, there is need to revive some of the belief systems and cultural practices of indigenous communities where they were once practiced.

REFERENCES

Adetoro, A. (2008). Peoples' Perceptions of the Old Oyo National Park, Nigeria. Germane Issues in Park Management. *Environmental Research*, 2: 182–86.

Ajayi, O. T., Ayodele, I. A. and Ojo, S. O. (2017). Conflict Resolution on Natural Resources Management in Old Oyo National Park: Residents' Perspectives. *Nig. J. Wildlife Management*, 1(1): 124 – 127

Ajayi, Y. P. (2014). Knowledge of Risk Factors and Health Implications of Obesity among Women of Reproductive age in Ibadan South-West Local Government Area, Nigeria. MSc thesis. University of Ibadan. 109pp

Andrea, B. S. and Lucius, F. H. (2013). Attitudes and Perceptions of Local Residents and Tourists toward the Protected Area of Retezat National Park, Romania. *International Journal of Humanities and Social Science* 3(4):18-34.

Anoliefo, G.O., Isikhuemhen O.S. and Ochije, N.R. (2003). Environmental implications of the erosion of cultural taboo practices in Awka-South Local Government Area of Anambra State, Nigeria. *Journal of Agricultural and Environmental Ethics* 16:281-296.

Bisong, F. and Andrew-Essien, E. (2010). "Indigenous knowledge systems for promoting community conservation education in a Nigerian protected area". *International Journal of Biology* 2(2): 149-157.

Finneti, C. (2011). "Traditional knowledge and the patent system: Two worlds apart". *World Patent Information* 33(1): 58-66.

Jary, D. and Jary, J. (1995). *Collins Dictionary of Sociology*, Harper Collins Publishers, Glasgow.

Jemitias, M. and Philip, M. (2013). "Indigenous knowledge systems and their implications for sustainable development in Zimbabwe" Journal *of Sustainable Development in Africa* 15 (5): 90-106.

Matsika, C. (2012). *Traditional African Education: Its Significance to Current Education Practices with Special Reference to Zimbabwe*, Mambo Press, Gweru

Oladeji, S. O., Agbelusi, E. A. and Ajiboye, A.S. (2012). "Assessment of Aesthetic Values of Old Oyo National Park." *American Journal of Tourism Management* 1: 36–48

Philip A., Arkum T. and Samuel, Z. (2014). Behind the Myth: Indigenous Knowledge and Belief Systems in Natural Resource Conservation in North East Ghana. *International Journal of Environmental Protection and Policy* 2(3): 104-112

Renias, N. and Remigios V. (2013). Indigenous knowledge systems and the conservation of natural resources in the Shangwe community in Gokwe district, Zimbabwe. *International Journal of Asian Social Science* 3(1):20-28

Sasaki, K., Sasaki Y. and Fox, S. (2010). Endangered traditional beliefs in Japan: Influences on snake conservation. *Herpetological Conservation and Biology* 5(3): 474-485

Were, J. (2011). "Innovation through knowledge networks: The African experience". United Nations Economic and Social Council.

ASSESSMENT OF WILLINGNESS –TO –PAY FOR WETLANDS PROTECTION IN ONDO STATE, NIGERIA

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Abstract
Wetlands perform numerous functions that provide services. The harvesting of these services has resulted in excessive depletion of wetlands. Participation of the wetland users in sustainable management of the resource is therefore crucial in mitigating the problem of wetland degradation. In line with this fact, this study assessed the willingness-to-pay (WTP) for wetland protection in Ondo State, Nigeria. The study specifically computed respondents' WTP for the protection of the wetlands and identified the factors influencing WTP. A multi-stage sampling procedure was used to select 124 respondents living around wetlands. Data collected were analyzed with descriptive statistics, Contingent Valuation Method (CVM), and Binary Probit Regression Model (BPRM).The results showed that 64.5% of the respondents interviewed was male, average age was 60 years while the average household size was 6. All the respondents accessed the wetlands for agricultural and fishing purposes. Majority (52.0%) of the respondents rated wetland service as water reservoir to be of great importance. Fifty-three percent (53.0%) of the respondents was willing to pay for the protection of the wetlands and the average amount indicated was ₦1038.68 per month. The BPRM result showed that gender, household size, distance to wetlands and annual income had significant influence on the WTP for the protection of the wetlands.

Keywords: *Wetlands, Protection, management, willingness-to-pay, community, Nigeria.*

INTRODUCTION

Wetland resources are global assets of enormous value to present and future generations, since they are vital to humanity's economic and social development (Shrestha, 2011). Wetlands are important ecosystems that serve as habitat to plants and animals while also providing biological resources to support the livelihood of the people who depend on them (Pramod *et al.*, 2015). Nigeria is one of the countries in the world that is richly endowed with both coastal and inland wetlands (Abocho, 2014). These wetlands play a very important role in the sustenance of both the surface and groundwater resources of Nigeria (Nwankwoala, 2012). In addition, they play an extremely important role in alleviating pollution of water resources caused by human activities (Kong, Kai, and Ning, 2014).

As stated by Marla and Jeanne(2014), wetlands provide a multitude of important services for the society. They contribute to the health of the planet and human well-being by ensuring food supply, regulating the atmosphere and providing raw materials for industry and medicine. Many natural products found in the economy including shellfish, cranberries and timber, come from wetlands. Wetlands provide valuable open space and create wonderful recreational opportunities. They provide tremendous economic benefits such as water supply, grounds for fisheries and agriculture, etc. through the maintenance of water tables and nutrient retention in floodplains; timber production; energy resources such as peat and plant matter; wildlife resources; transport; and recreation and tourism opportunities (Ajibola and Awodiran, 2013).

Historically, services provided by wetlands have not been monetarily valued and therefore are unaccounted for in the market system as a cost of production. The value of their loss or their benefits to production or society have also not been monetarily quantified. Since many policy and development decisions are based on monetary benefit-cost analysis, the value of wetland services (as non-commodities) has not been taken into consideration in policy and development discussions and as a result, wetlands have been significantly degraded and destroyed (Springate-Baginski *et al.*, 2009; Russi, *et al*., 2013).

However, wetlands can be sustainably exploited if the dynamics of the local institutions that influence accumulation and consumption of livelihood assets are well understood and harnessed appropriately (Mwakubo and Obare, 2009; Gren *etal.*, 1994). According to Folke (1991) as cited by Olarewaju *et al*, .(2011), the life support systems that are inherent within the wetland ecosystems can provide a wide range of valuable functions to society if they are used in a sustainable manner, for example, by incorporating the primary users in the management of the wetlands within the context of societal livelihoods and local institutions. Community participation plays vital role in the development of capacity for the management and utilization of their resources in sustainable way (Shrestha, 2011).

Wetland resources are widely used by the local communities for their sustenance and economic well-being. In such case, local participation is an effective tool for establishing an ecologically balanced use of available land and water resources. The participation of the wetland users is crucial for extenuating the problems related to wetland degradation (Shrestha, 2011). Sustainable wetland management has received most attention within the role of community participation and the value of wetlands is sustained only if managed and utilized with sound knowledge and cooperation between/among communities (Shrestha, 2011).

Rural peoples' willingness-to-pay (WTP) for the protection and sustenance of the wetlands around them is crucial as it connotes their intention to participate in management of natural resources. It therefore necessary to understand factors that affect people's WTP in order to identify effective policy instruments that can be put in place to motivate community peoples' participation in natural resource management and to ensure success of such policies. In view of this, the study was carried out to achieve the following objectives, which are to:

- describe the socio-economic characteristics of the people residing near the wetlands in the study area;
- identify the direct and indirect benefits accessed by the respondents;
- analyze respondents' perceptions of the importance of direct and indirect benefits provided by wetlands;
- compute respondents' WTP for wetland protection; and
- identify the factors influencing WTP for wetland protection .

MATERIALS AND METHODS

The study was carried out in Ondo State, Nigeria. Ondo State lies between latitude 5^0 45' and 8^0 15' North and longitude 4^0 45' and 6^0 East, this means that the State lies entirely in the tropics. The State is bounded in the North-West by Ekiti State, West-Central by Osun State, South-East by Ogun State, South-East by Delta State and in the South by Atlantic Ocean. The climate is tropical with two distinct seasons, the rainy season, (April-October) and dry season (November – March) with slight variations from year to year. The annual rainfall varies from 1,150mm in the northern parts to 2,000mm in the southern area, the State generally enjoys luxuriant vegetation. The vegetation consist of coastal forest and mangrove swamp forest in the south, moist lowland forest, and the forest savannah in the north. The study used primary data only. The data were collected using an interview schedule administered on the residents around the wetlands in the study area. A multi-stage sampling procedure was employed to select respondents for the study. The first stage involved purposive selection of the two Local Government Areas (LGAs) that falls within the wetlands of Ondo State. These LGAs were Ilaje and Ese-Odo. The second stage involved random selection of two communities in each of the two LGAs. The communities selected from Ilaje LGA were Ugbo and Igbokoda, while that of Ese-Odo were Igbekebo and Sabomi. The last stage involved a random selection of 35 respondents from each community. A total of 150 respondents was selected and interviewed but only data from 124 respondents were found adequate to enter the analysis. Data collected were analyzed using descriptive statistics Contingent Valuation Method (CVM) and Binary Probit Regression Model (BPRM).

The descriptive statistics was used to summarize the socio-economic characteristics of the respondents while the 5-point Likert scale was used to analyze the perceptions of the respondents on the importance of the benefits of wetlands in the study area. The 5-point Likert scale ranged from very important (5) important (4) Undecided (3) unimportant (2) to very unimportant (1).The perception statements include the following; “the wetland should be protected because it is useful for agriculture”, the wetland should be protected because it is useful for fishing and so on. The scores of the Likert scale were 5, 4, 3, 2, and 1 for very important through very unimportant respectively. The mean score of each perception statement was estimated. Following a mean score of less than 2.50, between 2.50 and 3.50 and that above 3.50 were taken to be “unimportant”, “undecided” and “important” respectively. CVM is a nonmarket-valuation method that is used to value specific changes from the status quo. According to Hoevenagel(1994),the CVM is a survey method in which respondents are asked how much they are willing to pay for the use or conservation of natural goods, where their preferences are assumed to be contingent upon alternative goods that are offered in a hypothetical market. This model is appropriate for valuing environmental goods or the proxies that have no market data but yet such goods affect the welfare of the respondents. A major strength of CVM is that it can be applied to different valuation situations since it does not rely on actual market or observed behaviour (Pearce and Moran, 1994; Emerton and Bos, 2004).

Probit is a probability regression that takes care of two cases of the same dependent variable which can be assigned the code “0” and “1”. Probit regression was selected in order to capture the cases of willingness and non-willingness of respondents to pay for the protection of wetlands. It was used to analyze the factors influencing WTP for the protection of wet lands. Following Wooldridge (2001) the WTP is assumed to be generated by a linear latent model given as

$$y_i^* = x_i\theta + e_i \quad \text{......} \quad 1$$

Instead of observing y_i^*, only a binary variable indicating the sign of y_i^* is observed:

$$y_i^* = \begin{cases} 1 \text{ if } y_i^* > 0 \\ 0 \text{ if } y_i^* \leq 0 \end{cases} \qquad \text{……} \quad 2$$

So $y_i = 1[y_i^* > 0]$ …………………………………………………………………………… 3

The distribution of y_i is easily obtained given x_i as follows:

$P(y_i = 1|x_i) = P(y_i^* > 0|x_i) = P(x_i\theta + e_i > 0|x_i)$………………………………………………… 4

y = willingness to pay (willing to pay = 1; not willing to pay = 0)
X_i = is a vector of attributes determining respondents' WTPfor wetlands protection, where
X_1 = Age (in years).
X_2 = Sex (male = 1; female = 0).
X_3 = Household size (in number).
X_4 = Years of formal education.
X_5 = Information on the importance of conserving water resources (yes = 1; no = 0).
X_6 = Distance to the wetland (kilometers).
X_7 = Usage of land around wetland (Agricultural purpose = 1; otherwise = 0)
X_8 = Annual household income (in Naira).

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

The socio-economic characteristics of the respondents are presented in Table 1. The table showed that majority (64.5%) of the respondents was male. Also, majority (33.1%) of the respondents was between 51 and 60 years with the average age being approximately 53 years. The results in the Table 1 revealed that a larger proportion (66.9%) of the respondents had household members of between 6 and 10 persons with an average of 6 persons per household. In terms of formal education, 35.5% of the respondents had primary school education. Considering the major occupation engaged in by the respondents, 29.1% of the respondents was engaged in fishing and many (61.3%) earned between ₦10,000 and ₦50,000 per month. The average income was about ₦59,000 monthly (Table 1). The table also revealed that 54.0% of the respondents had land near the wetlands, and 84.7% used the land for agricultural purpose. In response to whether respondents been provided any information on protection of wetlands at one point or the other, majority (65.3%) answered this in the affirmative.

Table 1: Socioeconomic characteristics of the respondents (n = 124)

Characteristics	Frequency	Percentage (%)	Mean	St Dev.	Minimum	Maximum
Gender						
Male	80	64.5	-	-	-	-
Female	44	35.5				
Age (years)						
≤ 40	26	20.9	52.84	7.95	35	76
41-50	19	15.3				
51-60	41	33.1				
≥ 61	38	30.7				
Household Size						
≤ 5	41	33.1	6.13	1.20	4	9
6 – 10	83	66.9				
Educational level						
No formal	16	12.9	-	-	-	-
Primary	44	35.5				
Secondary	31	25.0				
Tertiary	33	26.6				
Major occupation						
Civil servant	31	25.0	-	-	-	-
Fishing	36	29.1				
Farming	34	27.4				
Artisans	21	16.9				
Off-farm	2	1.6				
Monthly income (₦)						
10,000 – 50,000	76	61.3	59,010.00	57,526.00	15,000	500,000
50,001– 100,000	37	29.8				
> 100,000	11	8.9				
Land ownership near the wetlands						
Yes	67	54.0	-	-	-	-
No	57	46.0				
Usage of the land						
Agriculture	105	84.7				
Non - Agriculture	19	15.3				
Information on wetland protection						
Yes	81	65.3	-	-	-	-
No	43	34.7				

Source: Data Survey (2017).

Benefit Derived from the Wetland by Respondents

Table 2 presents the result on both direct and indirect benefits accessed by the respondents from the wetlands. It was revealed from the table that 100.0% apiece of the respondents used wetlands for agricultural production and fishing, respectively. Furthermore, most (98.0% and 73.0%) of the respondents got water and medicinal plants from wetlands. The wetlands were also used as a source of transport as attested by 91.0% of the respondents. The table also revealed that 71.0% of the respondents indirectly used the wetland as a tourist center while 90.0% indirectly accessed it in form of water reservoir.

Table 2: Benefits derived from the Wetlands by Respondents (n = 124)

Benefits Derived	Benefit (%)
Direct	
Agricultural Production	100.0
Fishing	100.0
Water	98.0
Timber	28.0
Fuel wood	16.0
Medicinal plant	73.0
Transport	91.0
Sand/mud Mining	54.0
Reed grass	15.0
Indirect	
Tourism	71.0
Scientific studies	49.0
Water reservoir	90.0
Protection of endangered species of animal and plant	26.0
Flood control	34.0

Source: Data Survey (2017).

Perceptions of Respondents on the Importance of the Indirect Benefit of the Wetland

Considering the benefit of wetlands, the perceptions of the respondents were sought on how important the wetlands can provide some selected benefits to the community. The result on their perception is as presented in Table 3. It showed from the table that most (31.0%) of the respondents perceived that it is important for the wetland to serve as a tourist center, 36.0% which constituted the majority was neutral on the usefulness of the wetland for scientific study. Furthermore, a large proportion (52.0%) perceived the benefit of the wetland as a water reservoir to be very important while 37.0% considered the wetland as abode of protection for endangered species to be very unimportant. In the same vein, 32.0% of the respondents saw the wetland to be a flood control point to be unimportant and very unimportant, respectively.

This sub-section has no meaning to me at all. It is no doubt a good sub-section to add in this manuscript since it fulfills one of the set objectives but it is poorly presented. It is better to present the section on both direct and indirect benefits. It is the summary results of the analyzed Likert-scale data that should be presented here not the raw data which has no meaning.

Table 3: Perception of Respondents on the Importance of Benefits of the Wetland (n = 124)

Benefits	Very important (%)	Important (%)	Undecided (%)	Unimportant (%)	Very unimportant (%)	Mean score	Decision
Direct							
The wetland should be protected because of it is useful for agriculture.	79.8	20.2	-	-	-	4.71	Important
The wetland should be protected because of its usefulness for fishing.	66.1	33.9	-	-	-	4.54	Important
The wetland should be protected for water supply	83.9	8.9	0.80	-	6.4	4.65	Important
The wetland should be protected for availability of Timber.	1.6	17.7	28.2	28.2	24.3	2.46	Unimportant
The wetland should be protected for availability of fuel wood.	0.80	8.1	13.7	48.4	29.0	2.04	Unimportant
The wetland should be protected for availability of medicinal plant.	11.3	32.3	29.8	15.3	11.3	3.19	Undecided
The wetland should be protected for availability of reeds.	-	-	13.7	16.9	69.4	1.45	Unimportant
The wetland should be protected as source of transport.	34.7	42.7	12.1	7.3	3.2	4.00	Important
The wetland should be protected for availability of sand/mud.	8.1	28.2	17.7	13.7	32.3	2.63	Undecided
Indirect Benefit							
The wetland should be protected because of tourism.	10.6	30.6	28.2	16.9	13.7	3.06	Undecided
The wetland should be protected for scientific studies.	5.6	7.3	36.3	21.8	29.0	2.39	Unimportant
The wetland should be protected for serving as a water reservoir.	51.6	33.1	11.3	0.8	3.2	4.31	Important
The wetland should be protected for being home to endanger species of plants and animals.	4.0	13.7	19.4	25.8	37.1	2.22	Unimportant
The wetland should be protected for serving as flood control point.	4.8	5.6	25.0	32.3	32.3	2.20	Unimportant

Source: Data Survey (2017)

Distribution of Respondents according to their Willingness-to-Pay

Figure 1 showed the result of respondents' WTP for the protection of the wetlands around them. From the figure, it showed that most (53.0%) of the respondents was willing to pay an amount of money while 47.0% was not willing to pay anything.

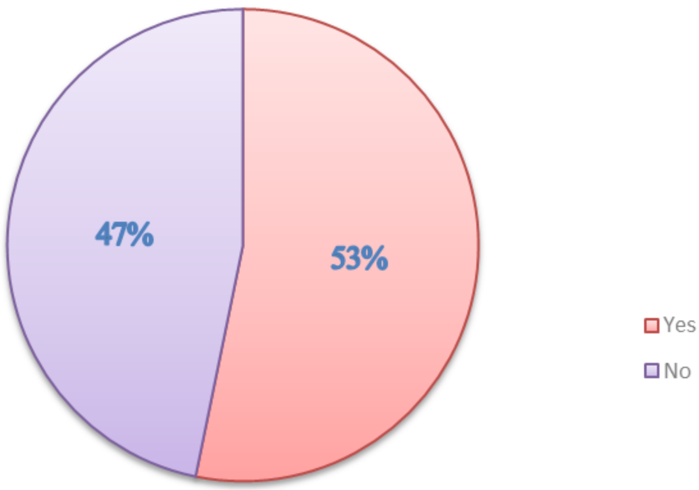

Figure 1: Distribution of Respondents according to their Willingness-to-Pay

Source: Data Survey (2017)

Distribution of Respondents according to Exact Amount they are Willing to Payper Month

The distribution of 66respondents according to the exact amount they are willing to pay is presented in Table 4. The table showed that25.8% was willing to pay₦ 500 and 36.4% was willing to pay as much as ₦1000. Only 1.5% apiece was ready to pay ₦3000 and ₦4000, respectively. The mean amount the66 respondents were willing to pay was ₦1038.68 per month.

Table 4: Distribution of Respondents by the Amounts they are Willing to Pay per Month

Amount (₦)	**Frequency**	**Percentage**
500	17	25.8
650	3	4.5
750	6	9.1
1000	24	36.4
1250	7	10.6
1500	5	7.6
2000	2	3.0
3000	1	1.5
4000	1	1.5
Total	**66**	**100.0**
Mean	1038.68	

Source: Data Survey (2017)

Factors Influencing Respondents' Willingness-to-Pay

The estimated results and marginal effects of the BPRM are presented in Table 5. The result revealed that age, years of formal education, information on wetland protection, and usage of land around the wetland had no significant influence on respondents' WTP for the protection of the wetlands. Sex, household size, distance to wetlands and annual income of respondents had significant influence on respondents' WTP for the protection of the wetlands at 5%, 10%, 5% and 1% levels respectively. The positive coefficient of sex suggested that being a male increases the likelihood to pay for protection of the wetlands than being a female. The marginal effect showed that WTP increased by 31.19% for being a male than being a female. This may be that male used the wetland for more productive activities that contribute immensely to their livelihood than their female counterpart, therefore, the wetland must continue to exist for them to harness this benefit continually. In the same vein, the farther the respondents' abode to the wetland, the more the WTP for protection of wetlands and *vice versa*. The marginal effect indicated that for every kilometer increase in distance to the wetland, WTP increased by 0.52%. Household size had a negative influence on WTP which implied that respondents with higher numbers of household members were less likely to pay for the protection of the wetlands than those with few members. Reason for this may be that, when the number of household members increases the consumption expenditure will likely increase, so there will be less money to pay for environmental goods. This result is in line with the marginal effect, a unit increase in household size will reduced the WTP by 7.75%. Annual income of respondents had a positive influence on WTP which indicated that the higher the annual income of the respondents, the higher the probability that they will be willing to pay for wetland protection. The reason for this may be that substantial proportion of the household income is sourced from the wetland, therefore the preservation of the wetland becomes more beneficial to the respondents. Also according to the theory of demand, the willingness to pay for goods depends on consumer income, with an increase in income, the purchasing power of the consumer increases because he is in a position to buy more goods; consequently, the consumer's demand for goods increases. This result is consistent with most empirical results such as Mohamed, *et al.*, 2012.

Table 5: Probit Model Estimation of Factors Influencing Respondents' Willingness to Pay

Explanatory Variable	Coefficient	P>/z/	Marginal effect
Age	0.03358 (0.0216)	0.120	0.0090 (0.0055)
Sex	1.1699** (0.4583)	0.011	0.3119 (0.1091)
Household size	- 0.2908* (0.1602)	0.069	- 0.0775 (0.0408)
Years of formal education	0.0240 (0.1030)	0.816	0.0064 (0.0274)
Distance to wetland	0.0195** (0.0090)	0.030	0.0052 (0.0022)
Information on wetland	0.2207 (0.2822)	0.434	0.0588 (0.0745)
Usage of land	0.2566 (0.2322)	0.269	0.0684 (0.0609)
Annual income	1.86e-06*** (6.36e-07)	0.003	4.97e-07 (1.48e-07)
Constant	- 3.4962 (1.7008)	0.040	
No. of observation	124		
Prob. > χ^2	0.000		
Pseudo R^2	0.3104		
Log likelihood	- 47.6741		

Standard errors are in parentheses * significant at 10%, ** significant at 5% *** significant at 1%

Source: computed from Data Survey (2017)

CONCLUSION

This study provided an in-depth insight into community people's payment decision towards protection of wetlands in Ondo State, Nigeria. The results showed that gender, household size, distance to wetland and annual income of respondents significantly influenced WTP. This establishes the fact that some respondents' socio-economic characteristics are important determinants of WTP for wetland protection.

Since majority of the respondents was aware of the need and was willing to pay for the protection of wetland, there is the need for a concrete step to be taken to enact a favourable wetland protection policy and ensure that such policies are well implemented.

Furthermore, the result of the BPRM showed that the higher the annual income of the respondents, the more probability that they will be willing to pay to protect the wetlands. In that case, government should ensure that a policy that ensures increment in income and purchasing power of the people are pursued and implemented effectively to encourage communities living around wetlands to participate in their protection.

REFERENCES

Abocho, M. (2014). *Conserving Nigeria's Wetlands For Improved Food Production.* Retrieved May 17, 2018, from PM News: www.pmnewsnigeria.com/2014/02/11/conserving-nigerias-wetlands-for-improved-food-production/ pp. or P.

Ajibola, M. O. and Awodiran, O. O. (2013). Assessment of Wetland Valuation Processes for Compensation in the Niger Delta, Nigeria. *Ethiopian Journal of Environmental Studies and Management, 6*(4), 398 - 403.

Bostian, M. and Herlihy, A. (2014). Valuing Tradeoffs between Agricultural Production and Wetland Condition in the U.S. Mid-Atlantic region. *Ecology Economics, 105*, 284–291.

Emerton, L. and Bos, E. (2004). *Value: Counting Ecosystems as an Economic Part of Water Infrastructure.* Gland: IUCN

Folke, C. (1991). Socio-economic Dependence on the Life-Supporting Environment. In C. Folke, and T. Kabeger, *Linking the Natural Environment and the Economy: Essays from the Ecogroup,* pp. 77–94. Kluwer, Dordrecht.

Gren, I. M., Folke, C., Turner, K.,and Bateman, I. (1994). Primary and Secondary Values of Wetland Ecosystem. *Environmental and Resource Economics, 4*(1), 55 - 74. doi:10.1007/BF00691932.

Hoevenagel, R. (1994). *The contingent valuation method: scope.* Amsterdam: Institute for Environmental

Kong, F., Kai, X., and Ning, Z. (2014). Determinants of Farmers' Willingness to Pay and Its Level for Ecological Compensation of Poyang Lake Wetland, China: A Household-Level Survey. *Sustainability, 6*, 6714-6728. doi:10.3390/su6106714.

Marla, J. S. and Jeanne, C. (2014). *Ecosystem Service Valuation For Wetland Restoration: What It Is, How To Do It, and Best Practice Recommendations.* The U.S. Environmental Protection Agency, Wetlands Division, pp. 70

Mwakubo, M. A. & Obare, G. A. (2009). Vulnerability, Livelihood Assets and Institutional Dynamics in the Management of Wetlands in Lake Victoria Watershed Basin. *Wetland Ecology and Management, 17*, 613 - 626.

Nwankwoala, H. (2012). Case Studies on Coastal Wetlands and Water Resources in Nigeria. *European Journal of Sustainable Development*, 1(2), 113 - 126.

Olarewaju, T. O., Shittu, A. M., Olubanjo, O. and Dipeolu, A. (2011). Perceived Benefits of Selected Wetlands in South-West Nigeria. In Theme of the Conference. Federal University of Agriculture, Abeokuta, Nigeria pp

Pearce, D., and Moran, D. (1994). *The economic value of biodiversity*. London: Earthscan Publications, ISBN, pp. or P.

Pramod, L., Kishor, A., Krishna, P. P. and Lalit, K. (2015). An analysis of willingness to pay for community based conservation activities at the Ghodaghodi Lake Complex, Nepal. *International Journal of Biodiversity Science, Ecosystem Services and Management*, *11*(4), 341-348. doi: 10.1080/21513732.2015.1055338

Russi, D., ten Brink, P., Farmer, A., Badura, T., Coastes, D., Förster, J., and Davidson, N. (2013). *The Economics of Ecosystems and Biodiversity For Water and Wetlands.* London and Brussels: The Institute for European Environmental Policy

Shrestha, U. (2011). Community Participation in Wetland Conservation in Nepal. *The Journal of Agriculture and Environment, 12*, 140 -147.https://www.nepjol.info/index.php/AEJ/article/viewFile/7574/6157

Springate-Baginski, O., Allen, D. and Darwall, W. (2009). *An Integrated Wetland Assessment Toolkit:A Guide to Good Practice.* Gland,: IUCN Species Programme

PERCEIVED IMPACT OF CLIMATE CHANGE ON TOURISM PATRONAGE AT IKOGOSI WARM SPRING, NIGERIA

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Abstract

There are indications that impact of climate change is gradually affecting level of customer patronage in ecotourism industry. There is need for tourism managers at Ikogosi Warm Spring to pay much attention on tourist's perception and experiences of weather and activities undertaken during visit. This is a serious consideration for this study aimed at establishingthe level of awareness of the tourists on climate change phenomena, medium of awareness and their perception on the impact of climate change as it affects their visitation pattern and associated recreational activities. Purposive sampling technique was used to administer fifty copies of questionnaire to visitors while in-depth interview was conducted with the staff to validate the result. The data collected was analyzed descriptively. The results showed that most of the respondents were female (52%) with the highest age range between 18 and 25 years (28%). Marital status showed that 52% were single with76% having tertiary education. 96% of the respondents were aware of climate change while 76% of them established this change through personal experience. Increased rainfall, irregular rainfall pattern, increased sunlight and heat, heavy wind were indicators of change in the climate affecting their patronage to the tourism destination. It is therefore recommended that government should formulate policies to mitigate the effect of climate change on tourism destination so as to make the industry sustainable.

Keywords*: Climate Change, Tourism patronage, Perceived Impact*

INTRODUCTION

The tourism industry is a main contributor to worldwide economic advancement, especially as an employer in developing economies and regions where tourism commonly represents the main source of national income (Hall and Higham, 2005; Bigano *et al.,* 2007). However, tourism is obviously and closely dependent on and susceptible to climatic conditions (Gössling and Hall, 2006a, 2006b). The Stern Report on the Economics of Climate Change (2006) concluded that although small increases in temperature may benefit the economy at first, but if left unattended to, this could result in a 20% reduction in per capita consumption by the end of the century (Stern, 2006).

Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as "a change in the state of the climate that can be seen (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that continues for an extended period, typically decades or longer; and encompasses any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC, 2007).

The IPCC'S Third Assessment Report (2001) as cited by Okali and Ewah (2004) on vulnerability to climate change showed that some unique and threatened systems may be indelibly harmed by changes in climate beyond certain thresholds as every species has its threshold level to operate. Indicators of Nigeria's vulnerability as outlined by Okali and Ewah (2004): Many flora and fauna species are increasingly becoming extinct, tree density and floristic richness are reducing, new species of plants and animals scarcely showing up in the ecosystem, the disruption and decrease of the fruiting intensity of some trees, aberration in animal matings, changes in bird and animal migratory pattern (due to the need for new habitats or new food sources) and changes in fish spawning patterns, species of plants and animals. All these point to the fact that climate change will lead to failure of many systems including the tourism sector (particularly ecotourism) which may jeopardize tourism-dependent economies. Tourism managers, therefore need to be well informed to enable them to either take precautionary measures against the destructive effects or combat the effects by devising adaptive measures. This has necessitated the need for this research.

Study Area

The study area is the Ikogosi Warm Spring Resort, Ikogosi-Ekiti, Ekiti State, Nigeria. It is located in southwest Nigeria. It is situated between lofty, steep-sided and heavily wooded, north-south trending hills about 27.4 km east of Ilesha (Osun State), and about 10.5 km southeast of EfonAlaaye-Ekiti. It is located just north of the 7^0 35'N latitude and slightly west of the 5^0 00' E longitude. The study area experiences two seasons-rainy season (April- October) and the dry season (November-March). Temperature ranges between 21° and 28°C with high humidity.

Ikogosi is a destination for tourists from all over the world. To further promote the quality and visitation of this natural heritage, a well-furnished chalet was built to enhance the comfort of the visitors. Apart from this, hospitable facilities such as hotels and guest houses are available in the vicinity of the Resort. The Guest House is well-equipped with conference room, seminar hall and catering service for the satisfaction of the visitors. Also, a non-chemical swimming pool is provided for relaxation. This is an original natural beauty in Nigeria and as such, a haven for tourists (Hospitality Nigeria, 2010).

MATERIALS AND METHODS

This study made use of primary data which were collected through questionnaire and in-depth interview. The population for this study was the staff and visitors to the Ikogosi Warm Spring Resort. Purposive sampling approach was used to administer fifty structured questionnaire which made up of five point Likert scale questions ranging from strongly disagree, disagree, undecided, agree to strongly agree to visitors who had vast knowledge of climate change. The questionnaire covered information on visitors' demographic characteristics, their awareness on climate change as well as their perceived impact of climate change on tourism. The data obtained were presented descriptively using SPSS 21 (Statistical Package for Social Sciences) (IBMSPSS, 2013).

Data Analysis

A 5-point rating Likert scale (Strongly Disagree=1 to Strongly Agree=5) was used to analyse data obtained on perceived impact of climate change on tourism development. Weighted mean scores were computed andthe upper limit of data concerning the impacts is4.5-5.0 and the lower limit score <1.5. Descriptive statistics was expressed in tables on percentage and graphs.

Weighted mean (WM)= **Σwx/Σw**

Σ= the sum of.

w= the weights.

x= the value.

i.e.

Weighted Mean (WM) = fSDX1, fDX2, fUX3, fAX4, fSAX5 = Weighted Frequencies (WF)

Sum of Weighted Frequencies/Sum of Initial Frequencies=Weighted Mean (WM)

Decision rule; Strongly agree= 4.5-5.0, Agree= 3.5-4.4, Undecided=2.5-3.4, Disagree=1.5-2.4, Strongly disagree= <1.5

RESULTS AND DISCUSSION

Table 1 shows the socio-demographic characteristics of the respondents. Majority of the respondents are females (52%) while 48% are males, with 52% of the respondents being single. Majority of the respondents (28%) are within the prime ages of within 18 and 25 years. The prime age of these visitors suggests that they are economically viable to spend money on leisure and recreation as opined by Ogunbodede, (2012). Majority of the respondents (76%) also have tertiary education qualification which depicts that they are knowledgeable enough to understand climate change.

Table 1: Socio-Demographic characteristics of Respondents

VARIABLE	FREQUENCY	PERCENTAGE (%)
GENDER		
Male	24	48.0
Female	26	52.0
AGE		
18-25	14	28.0
26-30	10	20.0
31-40	11	22.0
41-50	5	10.0
above 50	10	20.0
MARITAL STATUS		
Single	26	52.0
Married	24	48.0
EDUCATIONAL BACKGROUND		
Primary	5	10.0
Secondary	7	14.0
Tertiary	38	76.0

Source: Field Survey, 2019

Awareness on Climate Change

When asked about their awareness on climate change, highest percentage of the respondent (96%) stated aware of climate change in which most of them have experienced it personally. Their awareness is consistent with findings from Oladeji *et al.*, (2018) which also showed majority of people being aware of climate change.

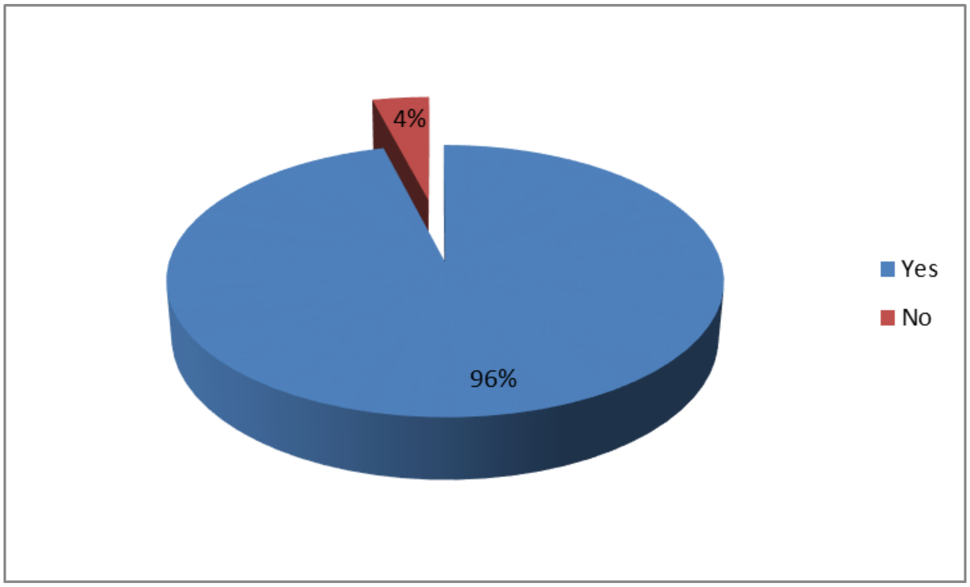

Figure 1: Distribution of Respondents by Awareness on Climate change
Source: Field Survey, 2019

Distribution of respondents by Media of climate change awareness

Figure 2 shows that 76% were aware through personal experience, 10% through television, 4% through friends and 10% through books.

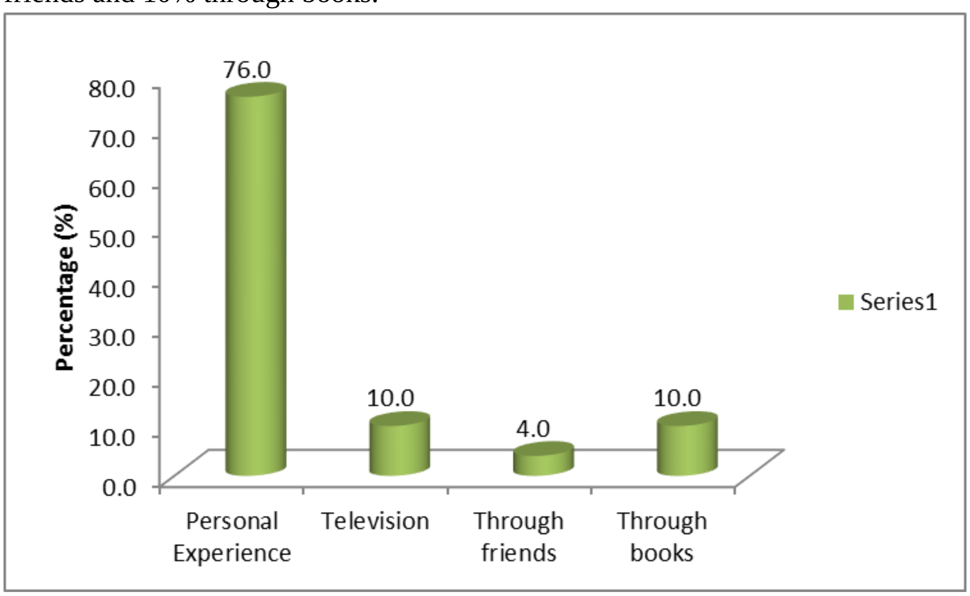

Figure 2: Medium of climate change awareness
Source: Field Survey, 2019

Table 2: Perceived impact of climate change on tourism patronage

Statements	SD	D	U	A	SA	Weighted sum	Weighted mean	Decision
Perceived Impact of intensive rainfall on tourism	-	-	9(18%)	9(18%)	32(64%)	223	4.46	SA
Perceived impact of increasing temperature (or heat) on tourism	-	-	9(18%)	24(48%)	17(%)	208	4.16	A
Perceived impact of Irregular Rainfall Pattern on tourism	7(14%)	5(10%)	5(10%)	23(46%)	10(20%)	174	3.48	A
Perceived impact of increasing sun intensity on tourism	-	-	5(10%)	13(26%)	32(64%)	227	4.54	SA
Perceived impact of Heavy Wind or storm on tourism	-	10(20%)	9(18%)	9(18%)	22(44%)	193	3.86	A

(Keys: SD- Strongly Disagree, D-Disagree, U-Undecided, A-Agree, SA-Strongly Agree)

Table 2 shows the perceived impact of climate change phenomena on tourists. The mean score shows that the respondents strongly agreed that they have been witnessing intensive rainfall which has affected their patronage in term of the time of visit to tourist site. This is consistent with findings from Ijeomah and Aiyeloja(2009) that increased rainfall which might lead to flooding affects tourist visitation and lead to shift in tourist destination. Interview with a staff of the site revealed that the site has witnessed intensive rainfall period that might last for a long time of the day with exceptional excessive cases of downpour at the Ikogosi warm Spring. In most cases heavy down pour is mostly experience at the site with sparse drops of rainfall in the adjoining community around. These staff claimed that in most cases tourists are discourage form visiting whenever the rainfall for a very long period of time. This assertion as revealed by the staff of the site further supports the claimed that based on weather-related changes tourists' travel routes , the timing of their travel and activity participation at destination are affected their influence their level of patronage (Becken *et al*., 2013).

The respondents also agreed that increased heat has been affecting tourism visit to the site. Uyarra *et al.*, (2005), opined that environmental features have significant influence on the visitor's destination choice and on the experience of visitors to the Caribbean islands of Bonaire and Barbados. In-depth interview with the staff also revealed increased heat period or extreme temperature change lead to decrease in the water level of the warm spring which is the major attraction at this site. This was observed to have resulted into reduction in the level of tourist patronage and shift in tourists' behavior towards the site. Interview further revealed loss of fauna species that used to be present at the site.

Most of the respondents (46%) also agreed that irregular rainfall pattern has affected tourism patronage at the site as tourists can no longer plan when to visit the site since rain might fall anytime without prior warning or notice. Irregular rainfall patterns could also affect cultural festivals being celebrated in the adjoining community. This largely alter the visitation pattern of tourists that are not only coming to experience the warm spring but also participate in the cultural festival during the period of their visit. Cultural festivals are observed to be originally planned and celebrated in the communities when there would be no risk of rainfall to disrupt the activities. Ijeomah and Aiyeloja (2009) opined that seasons established by rainfall affects cultural tourism because of date of festivals that are already fixed by past generations based on their indigenous knowledge of rainfall pattern.

In-depth interview with the staff revealed that increased sunlight has damaged some of the wooden structures at the site making the site less attractive to tourists. Majority of the respondents (64%) also strongly agreed to the risk of increased sunlight intensity on tourism development. This has caused a reduction in the volume of water at the site over the years. This is supported by Uchegbu (2011) that Rivers that were known to be permanent in the 1960s have now turned into seasonal rivers and are drying up.

The respondents also agreed that heavy wind is affecting tourism at Ikogosi. This corroborates findings from in-depth interview with the site staff who revealed that heavy wind has destroyed and reduced the vegetation at the site, making the site less attractive to tourists. This is consistent with projection from IPCC (2007) which concluded that changes in a number of weather extremes are probable as a result of projected climate change, including: higher maximum temperature and more hot days over nearly all land areas, greater tropical storm intensity and peak winds, more intense precipitation events over many land areas, and longer and more severe droughts in many mid-latitude continental interiors.

CONCLUSION

This study has successfully determined the perceived impacts of climate change on tourism development at the study area and therefore concludes that majority of the respondents are aware of climate change while most have witnessed increased rainfall, irregular rainfall pattern, increased sunlight, increased heat and heavy wind as evident forms of climate change. It is therefore important for government and tourism destination to formulate mitigation policies for the sustainability of the tourism sector.

REFERENCES

Becken, Susanne, Wilson and Jude (2013). The impacts of weather on tourist travel Tourism Geographies, Volume 15, Issue 4, 2013, Pages 620-639. http://www.tandfonline.com with the open URL of your article.

Bigano, A., Hamilton, J.M. and Tol, R.S.J. (2007). The Impact of Climate Change on Domestic and International Tourism: A Simulation Study, *The Integrated Assessment Journal 7:25-49.*

Gössling, S. and Hall, M. (2006a). Tourism and Global Environmental Change: Ecological, Social, Economic and Political Interrelationships, Routledge, New York.

Gössling, S. and Hall, M. (2006b). Uncertainties in Predicting Tourism Flows under Scenarios of Climate Change, Climate Change 79, 163-173.

Hall, M.C. and Higham, J. (2005). Tourism, Recreation and Climate Change, in: Hall, M.C. and Higham, J. (eds.) Tourism, Recreation and Climate Change, Channel View Publications, Clevedon, 3-28.

Hospitality Nigeria, (2010). Available: http://hospitalitynigeria.com/ikogosi_warm.php.

IBM Corp. Released (2013). IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

Ijeomah, H. M., and Aiyeloja, A. A. (2009). Impact of Climate Change on Sustainable Tourism Management in Plateau State, Nigeria. *Journal of Sustainable Development in Africa*, *11*(1), 23-34.

IPCC. (2007). Climate Change 2007: Synthesis Report. Geneva: Inter-Governmental Panel on Climate Change.
Ogunbodede E.F. (2012). Patronage Pattern of Tourists to Idanre Hills and its Implications for Tourism Development in Nigeria. *Journal of Environmental Research and Development. 6(3):908-915.*
Okali, D.U.U. and Ewah, O. (2004). Climate change and Nigeria: A guide for policy makers. A joint project of NEST Nigeria and GCSI, Canada under the Auspices of Canada –Nigeria Climate change capacity Development project, Canadian international Development Agency and Federal Ministry of Environment Abuja, Nigeria, 20pp.
Oladeji S. O, Adewuyi O. E. and Abiodun I. O. (2018). Traditional knowledge on Climate Change Mitigation and Adaptation Strategies in Akure North Local Government Area of Ondo State.
Stern, N. (2006), *The Economics of Climate Change: The Stern Review*, Cambridge University Press.
Uchegbu, S. (2011). The Impact of Climate Change on Tourism in Africa.
Uyarra, M., I. Côté, J.A. Gill, R. Tinch, D. Viner and A. Watkinson (2005). “Island-specific preferences of tourists for environmental features: implications of climate change for tourism-dependent states”, *Environmental Conservation, 32*(1): 11-19.

DEVELOPMENT OF RECREATIONAL OPEN SPACES FOR ECONOMIC WELLBEING IN SELECTED AREA OF LAGOS STATE

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Abstract

Increasing decline in the economic wellbeing of many ~~a~~ Nigerians has led to the advent of entrepreneurial outlets by which financial freedom can be achieved. While this is a good attempt, the role of the informal sector if left unsupervised would lead to more decay of the environment. This paper examines the roles people friendly landscape solutions could play in ensuring a conducive environment for living without adverse effects on the economic wellbeing of residents. A mixed methodological approach was applied which included review of relevant literature, while drawing from the wealth of information obtained through questionnaire administered on a section of the Jakande Estate, Amuwo Odofin in Lagos, Nigeria. It highlights challenges being faced by the estate management authorities, residents and professionals of the built environment as well as approaches employed in conquering them to profitable ends. The paper further shed light on the impact that the landscape design solutions such as recreational open spaces, can make on the estate through proper utilisation of these edifices as worthy vessels for economic wellbeing. It found that the level of education, income, and availability of the right infrastructure to propagate environment friendly activities will go a long way in servicing the needs of the people. It asserts that when well-funded, the gains from employing landscape and urban design would greatly improve societal productivity as this will impact positively on the work done by the built environment industry.

Keywords: *Entrepreneurial outlets, environment friendly, recreational open spaces, landscape design, people friendly.*

INTRODUCTION

Existence of parks and gardens are definitely not just a way to make cities look pretty but they are also instrumental for recreation to improve the lives and health of citizens and assist in tackling environmental issues like climate change while creating opportunities for employment. The economic wellbeing of many a Nigerian has led to the advent of entrepreneurial outlets by which financial freedom can be achieved due to the increasing decline experienced in that wise.

BACKGROUND OF THE STUDY

Several organisations have been involved in climate studies as well as sustainable built environment studies. Community Conservation and Development Initiatives, CCDI implemented a project under the Heinrich Böll *Stiftung's Climate resilient and inclusive Megacity Lagos program*, on the importance of open and public spaces for climate resilience, in a city being pressurised daily by the consequences of rapid urbanisation, (Adeleke, 2017). The project aimed at identifying open spaces in an area consisting mainly of swampy and sandy ground between the lagoon and the sea which underwent huge transformations in recent years. Remaining public spaces should be preserved as climate risk reduction areas open to the community for recreation, bus garages, places for safety and flood shelter which can be used as open markets. In addition, poor quality of the Nigeria urban environment has been attributed partly to the inadequate, misuse and mis-management of the urban open spaces. Fadamiro, (2002a; 2000c)opine that the aforementioned attributes exerted a major strain on the physical outlook of the environment and a negative effect on the welfare and productivity of the residents (Plate 1 and Plate 2).

The relentless and most determined campaign by the administration of the Akinwunmi Ambode led government of Lagos State to rid the city of roadside trade and long established markets made it necessary to look deeper into local planning and decision making processes. While this is a good attempt, the role of the informal sector if left unsupervised would lead to more decay of the environment. Hence the need to examine how people friendly landscape solutions would play a major role in ensuring a conducive environment for living without adverse effects on the economic wellbeing of residents.

Plate 1: Top view of a park in Lagos

Source:www.vanguardngr.com/category/homes-property

In separate studies, Olu-Sule (1990) and Akeju,
(2007) affirmed that government investment in housing in the third world is limited and wasted on expensive projects designed to woo electorates rather than directed to meet real needs for housing. This scenario has resulted in the deplorable situation in most existing public housing schemes, Nigerian being no exception. While decent housing is regarded as the right of every individual, a great proportion of the Nigerian population lives in substandard, deplorable and unsanitary residential environments. At the 2001 United Nation's estimated population of 12,100,000 people in metropolitan Lagos, the ratio of planned open spaces to the population is 81,000 people per hectare. In comparison, the international average is 600 people per hectare (Adejumo, 2003). These exacerbate by rural-urban migration, which in effect

proves to be a heavy burden on cities that are already plagued with rapid population growth and urbanization (Onibokun, 1982; Oni, 1988; and Olayiwola *et al.*, 2005).

Plate 2: A view of a park in Lagos commercially leased for use by a member of the public
Source:www.vanguardngr.com/category/homes-property

Most of the above (limited government spending, unplanned housing and spaces, rural-urban migration) thus leads one to the heart of the matter that residential estates can be the bedrock of true advancement of a people's wellbeing not only physically and psychologically but economically too. This is particularly true when we consider the wholesomeness of planned residential estates which are supposed to be all inclusive and self-servicing in many ramifications.

The correlation between employment generation and socio - economic wellbeing of citizens is so significant that almost all nations the world over take the issue of employment generation as a top priority in their agenda (Attah *et al.,* 2013).The provision 7of adequate infrastructure such as good roads, electricity, water, telecommunications, sewage and drainage are basic requirements that determine the socio-economic wellbeing of an area (Anofojie *et al.,* 2014). Statistics in Africa indicate that urban dwellings are generally overcrowded, lack elementary amenities and are surrounded by a deplorable urban landscape (Acquaye, 1985; Aduda, 2002; Olayiwola, Adeleye and Jiboye, 2006; Jiboye, 2009; NPC and ICF Macro, 2009).This is as a consequence of high population growth, which is associated with continual rural-urban migration and rapid urbanization, which manifests in homelessness, overcrowding and growth of slums (Olotuah, 2006; Lawanson, 2006).

It is on this premise that recreational open spaces which are a component of the urban landscape can thus be used as a means of providing much needed commercial relief to the economic wellbeing of people within that environment. The intent here is to find the place of landscape design as a solution to economic wellbeing either through government interventions, private individuals or a mix of the two, i.e. Public-Private Partnerships (PPP).With unemployment rate at 23.9 per cent and unemployed youth population put at 20.3 million, Nigeria generated about 4.5 million new entrants into the labour market annually. 2.2 million primary school leavers not proceeding to secondary school, one million secondary school leavers not proceeding to the tertiary level and 300,000 graduates finding no placement anywhere for productivity, and yearly graduate turnover at over 600,000 (Federal Office of Statistic, 2012). Thus, the knowledge that government at various levels have introduced various policies and programmes aimed at reducing this menace but to no avail further drives this quest. However, it is worthy to note that, informal sector contribution to economic development in the area of job creation has help to ameliorate the unemployment saga (Donald &Stephen 2010), as most of them operate the traditional method of production and services.

Job creation through the expansion of opportunities for productive and remunerative employment will go a long way to reduce the poverty level (Ishola, 2008). There will be fewer dependents and those employed will be able to assist the upcoming ones and the trickle down effects of the paid ones will reduce the vicious circle of poverty. There are many landscape design projects and extensive employment of urban agriculture whereby home gardens exist and horticulture can be practiced in recreation spaces. Their implementation would relieve the severe constraints faced by the poor and improve their conditions and thus help improve economic growth in the process.

The literature further revealed that this strategy is employed in a number of developed countries where you find recreational open spaces (ROS) that have elements of commerce such as games arcades, eateries, paid swimming, track and field activities to discover and harness new talents. Furthermore, the literature identified a strategy on roles to be played by the Federal, State and Local Governments as well as members of the public (Adejumo, 2003). They include strategies to be employed such as Developmental Philosophy, Developmental Foundation: the role of state government, Natural drainage basin, Land Acquisition for Park System, Urban Agriculture, Urban Fringe, State Role and Local Government Role.
Of particular interest to this study is the role of the local Government as proffered by Adejumo (2003) The 1999 Federal Republic of Nigeria constitution is explicit on the role of the third tier of Government. The Local Government is charged with the responsibility of establishing cemeteries, public recreational facilities and parks. (Federal Government of Nigeria Constitution 1999). The suggested functions include~~:~~

i. establishment of Local Park Agency in the mode of State Park Agency,
ii. initiates aesthetic improvement of local streets through street tree programme,
iii. determine choice of specific sites for public parks,
~~ii.~~iv. design, planning and execution of parks and recreational projects for the people and;

establishment of public participation mechanism as stated in the 1992 National Urban Development Policy." (Adejumo, 2003)

THE STUDY AREA

Lagos State, the smallest in terms of landmass in Nigeria, second most populated state after Kano, with a population of 9,013,534 (NPC, 2006) is the hub of commercial and industrial activities of the nation. Although essentially a Yoruba-speaking state, it acts as a socio-cultural melting pot that attracts both Nigerians and foreigners alike. Created on May 27, 1967 by virtue of State (Creation and Transitional

Provisions) Decree No. 14 of 1967, Lagos State lies in South-Western Nigeria, on the Atlantic coast in the Gulf of Guinea, west of the Niger River Delta located between Latitude6^{o} and 7^{o} North of the Equator and Longitude 3^{o} and 4^{o} East of the Greenwich Meridian (Figure 1).

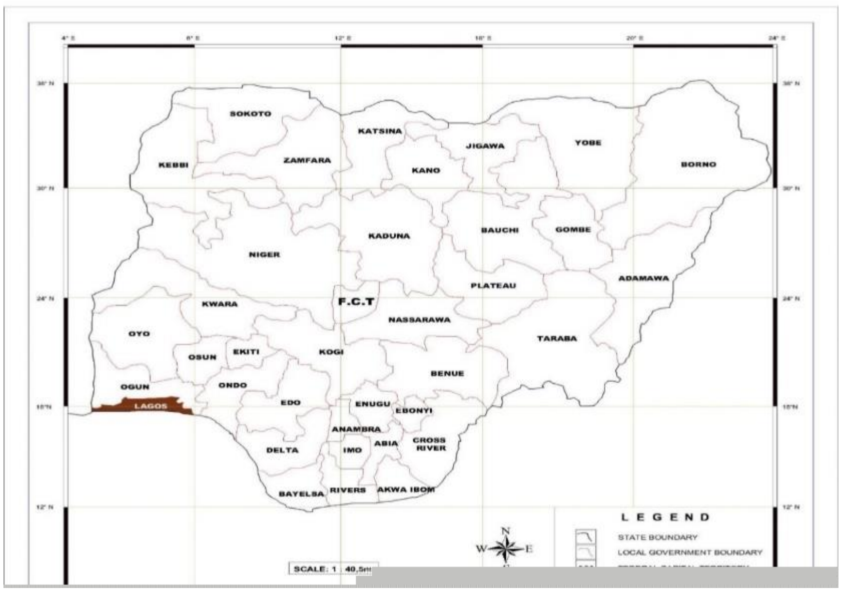

Figure 1: Map of Nigeria indicating Lagos State

Source: Department of Urban and Regional Planning, F.U.T. Akure, Ondo State (2017)

Amuwo-Odofin Local Government Area was one of the many local government areas created by the head of State, Gen. Sanni Abacha in 1996 It has a land mass of 153 square kilometres and the water area is 26.1 sq. km, which make up 179.1 sq. km. The population is very high. Government housing provision started in 1979 with the Civilian’s zeal to provide housing for all classes of people in Lagos State. The administration adopted a dynamic housing policy with LSDPC as the implementation agency. Hence, the 80s witnessed a rapid increase in the provision of housing for all classes of people in the state between 1981 and 1989 (Anofojie *et al.*, 2014).

Amuwo-Odofin (LSDPC) housing estates (AOHE) comprises five public residential estates namely, Amuwo-Odofin low-cost housing estate, popularly called Jakande Estate, Raji Rasaki Estate, Crystal housing Estate, Amuwo-Odofin terrace housing estate, and Canal View estate. The scheme is located at a distance of about 3.2 km east of Lagos along Lagos-Badagry Express Way, which forms the scheme’s southern boundary. The canal receives Festival Town's storm water forms the boundary between the scheme and Festival Town on the western side. On the east, the Apapa-Oshodi Express Way bound it. Okota, which is under Isolo Local Government Area, bounds the north (Anofojie *et al.,* 2014)

For the purpose of this study, only a description of the Jakande Estate which is the focus of the study is described thus: Amuwo-Odofin low-cost housing estate, (Jakande Estate) comprises 2,068 housing units of blocks of flats of 2-storeys 2-bedrooms and 3-bedrooms. It comprises 256 blocks of 2-bedroom flats and 232 blocks of 3-bedroom flats. It also contains single units of housing built by individuals, which are not accounted for in this study. Road networks serve buildings in the estate. There are primary and secondary schools, recreation spaces and football pitches. Open spaces were generously provided in all parts of the estate to protect the environment and for community uses such recreation and sports as well as for public meetings that were common in the traditional system in Nigeria(Anofojie *et al.,* 2014; LSDPC, 2017).

MATERIALS AND METHODS

The instruments for data collection were questionnaire, oral interview and personal/physical observation, consultation of relevant literatures and records from professionals and management agencies. These can be divided into two primary and secondary data. Prior to the commencement of the research, a reconnaissance survey was conducted to familarise with the research area and establish the exactitudes of the research instrument designed for the study.

a) The primary data were collected through administration of questionnaires, structured interviews with key informants and field observations. Two sets of questionnaire were administered, the first set to selected household heads in the estates, while the second was administered to the management (LSDPC).Study questionnaires were administered by the researcher and 8 specially trained Field Assistants (FAs). The structured questionnaires were used to collect quantitative information on participant's demographics, environmental attitude, participant's perception of the impact of the physical transformation of ROS and other components relevant to the study from the sample population. The systematic random sampling method was used to select one out of every forty housing units in each density. The eighty-three questionnaire elicited information relating to the present quality of life in the housing estates while respondents and management were directed to rate the estates from selected parameters or variables that bordered on economic wellbeing and landscape solutions to combating issues on matters arising

b) The Structured Interview guide was used to elicit detailed information from the professionals at the management agencies of each selected estate in the study area.

Several researchers (White et al., 2011; Lynch, 1986) agree that the use of observation and pictures in authenticating facts in many a research has been on for many years and has been employed by other researchers. Their studies confirmed that pictures taken at the site have the same effect on respondents as onsite experience as the correlation between the two was 60 percent greater.

ii. Secondary Data: They include academic journals, magazines, monographs, newspapers and other literatures relating to this study which were reviewed for existing documentation. Literature search areas included: urban growth and implications on land use management, land use transformation or conversion, evolution and strategies of recreation provision, recreational open spaces, city sustainability, urban agriculture, relationship between recreation and environmental attitudes. Other sources included the use of maps and necessary visual and pictographic materials which were sourced from relevant government offices and other related agencies in the review of literature, definition of terms and identifying tools for data analysis (Figure 2).

Figure 2: Map of Jakande Estate, Amuwo Odofin, Lagos State.

Source: Department of Urban and Regional Planning, F. U.T. Akure, Ondo State

RESULTS AND DISCUSSION

Pictures taken during the survey, shows the commercial activities being carried out at the ROS, thus buttressing the economic importance of these spaces. The results from the estate managers/professionals were juxtaposed with those of the respondents to suggest a link or emphasize the contrast between them. The result depicts the actual condition of infrastructure and buildings with particular emphasis on the recreational open spaces in the estates. Findings showed that the ROS have been serving commercial purposes in many instances (Plate 3).

Plate 3: A recreational open space (ROS) used for commercial and other activities at Jakande Estate, Amuwo-Odofin.

Plate 4: A neglected ROS adjoining buildings at Jakande Estate, Amuwo Odofin.
Source: Author's Fieldwork, 2016.

Data from residents established that public transportation ranked 2.48 (poor), landscaping ranked 2.38 (poor), while recreational facilities, housing units, water supply and power supply ranked least - 1.03, 1.23, -1.0 and 1.33 (very poor) respectively(Plate 4). The overall condition of infrastructure in the estates was rated poor (1.75 and 1.8 respectively). On the other hand, management rated public transportation 4.0 (good), while roads, drainages, sewage management, adequacy of housing units, water supply, power supply and recreational facilities were rated 1.0 (very poor) each(Table 1). Security was rated 3.0 (fair) by both categories of respondents, this is due to the presence of an active residents' association across the estate.

Table 1: Reasons for poor impact of ROS

Aggregate Opinion	Residents	Management
Public Transportation	2.48 (poor)	4.0 (good)
Landscaping Elements	2.38 (poor)	1.0(very poor)
Recreational Facilities	- 1.03 (very poor)	1.0 (very poor)
Housing Units	1.23 (very poor)	1.0 (very poor)
Security	3.0 (fair)	3.0 (fair)
Power Supply	1.33 (very poor)	1.0 (very poor)
Water Supply	1.03 (very poor)	1.0 (very poor)
Overall Infrastructure	1.75 (poor)	1.80 (poor)

Source: Field Work (2018)

The study also sought to ascertain what users of these parks felt was responsible for their dissatisfaction. The major reason for poor impact is perceived as poor maintenance and upkeep of parks (54.2 %), and insecurity/loss of serenity (18.1%). Some went as far as suggesting payment of a token to use the ROS. This opinion was expressed by 54% of respondents that were dissatisfied with the operation of parks in the estate. Another significant opinion expressed included the problem of non-availability of facilities (20.5%) while the last being the non-availability of ROS in approved areas (7.2%) (Table 2).

Table 2: Reasons for poor impact of ROS

Aggregate Opinion	Frequency (n)	Percentage (%)
Poor maintenance/upkeep/payment	45	54.2
Non availability of ROS in approved areas	6	7.2
Insecurity/loss of serenity	15	18.1
Non availability of Facilities	17	20.5
Total	**83**	**100.0**

Source: Field Work (2018)

On seeking solution to the issues raised as regards poor impact of the ROS, 39% of the respondents chose consistent maintenance, 29.6% picked privatisation of government owned ROS for sustainability while 18.9% picked improved security in parks as shown in Table 3. Other problems include development and maintenance of users responsive and market determined entrepreneurial themes introduced to existing ROS which are sustainable and related to the culture of the people. The findings of this study support those of Oladapo (2006), and Jiboye (2010), amongst others that retrogressive management factors constituted a foremost source of dissatisfaction to public housing residents in Nigeria. Further to this, the estate managers were observed to be slack in carrying out their assigned duties; hence, the maintenance of the estates was poor. It was also observed that infrastructure in the estates were not adequate and functional (See Table 1, and Plates 1, 2, and 3).

Table 3: Perception of Respondents on Solution

Aggregate Opinion	Frequency (n)	Percentage (%)
Privatisation of government owned ROS for sustainability	25	29.6
Improved maintenance	32	39
Improved security	16	18.9
Introduction of entrepreneurial themes	10	12.1

Total	83	100.0

Source: Field Work (2018)

All of these are indicators that the estate would benefit from the existence of more recreational open spaces which would employ people to provide the services that these would offer and thus reduce poverty through job creation. This supports the report by Adegboye (2012) which states that the management agencies shall enumerate and tag all trees within the state inclusive of those in private tenements, monitor and supervise trimmings and felling of trees within the state, advise on all matters to the greening programme of the state, cause funds for the maintenance of parks and gardens. The above is an avenue for both wealth and job creation and as such, the onus falls on the management and residents to come up with a scheme that would be sustainable and beneficial because it is imperative from the responses of users that privatization of parks will solve a lot of problems.

CONCLUSION AND RECOMMENDATION

In conclusion, this paper carried out field study through collection of primary and secondary data, analysis and presentation of the result descriptively in form of tables. It also reviewed literature on investigations on the development, maintenance attitudes, and perception of residents to the economic importance of ROS in the Jakande Estate, Amuwo Odofin in Lagos State. The standard for any residential estate should be one with an ideal population size, which relates to the provision of facilities, services, and the retention of identity. Hence, the provision of infrastructure in any estate should not only be adequate, meeting residents' needs but also functional in the selected estates. The paper found that these recreation spaces can play important roles in reducing economic hardship and improving the sustainability of towns the world over through people friendly landscape design solutions. The study established that this solution through the integration of various bodies that have been charged with the responsibility of parks development and maintenance, as well as those with the same passion, can team up to make sure parks are better managed as a private sector initiative within the framework of the existing master plan and will prove more efficient on the longrun.

It was recommended that the body of residents and relevant government agencies as well as the private sector should work hand in glove to fully harness the countless benefits these ROS in our built-up areas can offer. This can be achieved through formalizing the role of the informal sector in establishing ROS such that they can generate employment is important. In addition, the necessary government agencies (Local Government) in charge of the environment should also be contacted while NGOs that are aligned with such conservation related issues e.g. the Nigerian Environmental Conservation Organisation (NECOR) can be reached out to with respect to greening the environment.

REFERNCES

Acquaye, E. (1985). A Technological Review of Housing Problems in Developing Countries, in Onibokun, A. G. (ed.) Housing in Nigeria: A Book of Readings, NISER, Ibadan, pp. 41-48.

Adegboye, K. (2012). Lagos rolls out new law to preserve parks and walkways in www.vanguardngr.com/category/homes-property accessed on 10/19/2018

Adejumo, T. Developmental Strategy for Sustainable Public Open Space System in Metropolitan Lagos: The City in Nigeria. OAU, Ile-Ife, p112-120, 2003

Adeleke, K. (2017). Public Participation and Struggles for Sustainable Spaces in the Community accessed on 10/20/2018 at https://ng.boell.org/2017/02/22/public-participation-and-struggles-sustainable-spaces-community

Aduda, G. T. (2002) The Cost of Corruption in the Development and Management of the City in Nigeria, in Amole, D. et al (eds) The City in Nigeria: Perspectives, Issues, Challenges and Strategies, Proceedings of the National Conference organised by the Faculty of Environmental Design and Management, Obafemi Awolowo University, Ile-Ife, November 9-11, 2002.

Akeju, A. A. (2007) Challenges to Providing Affordable Housing in Nigeria, A paper presented at the Second Emerging Urban Africa International Conference on Housing Finance in Nigeria, held at Shehu Yar'dua Centre, Abuja, October 17:19, 2007.

Anofojie, A. E., Adeleye O. A., Kadiri, M. A.(2014). Housing Quality Assessment in Selected Public Residential Estates in Amuwo-Odofin L.G.A, Lagos, Nigeria in International Journal of Research in Earth & Environmental Sciences Sept. 2014. Vol. 2. No. 6; ISSN 2311-2484

Fadamiro, J. A. (2002a): Open Space Concept and Evaluation in the Medium Urban Environment, A case study of Akure, Nigeria. Journal of Environmental Technology, 1(1):79 – 90.

Fadamiro, J. A. (2002c): Landscaping and Open Space Relationship: A Strategy for an Effective and Sustainable Development of Urban Environment, African Journal of Social and Policy Studies, 2(1&2): 141-147.

Federal Government of Nigeria (2004). National Housing Policy for Nigeria, Government Printing Press

Federal Office of Statistic (2012). Social Statistics Report 2012. Government Printing Press

Federal Republic of Nigeria (1999). Constitution of the Federal Republic of Nigeria Fourth Schedule. Function of a Local Government Pp. 150-151

Ishola R. Akintoye (2008). Reducing unemployment through the informal sector: A case of Nigeria: European Journal of economics, finance and Administrative Science.

Jiboye, A. D. (2009) The Significance of Household Characteristics on Housing Quality inOsogbo, Nigeria, Journal of Geography Planning Science, Vol. 2, No. 2, pp. 1 10.

Lawanson, T. O. (2006) Challenges of Sustainability and Urban Development in Nigeria: Reviewing the Millennium Development Goals, Submitted for Publication in Africa Insight, April 2006.

Lynch, K. (1986). *The Image of the City.* Boston: The M.I.T. Press, USA. Manning, 2004

National Population Commission (NPC) (2006). Annual Reports 2006, NPC, Lagos.

National Population Commission (NPC) and ICF Micro (2009) Nigeria Demographic and Health Survey 2008: Key Findings, Calverton, Maryland, USA: NPC and ICF Macro.

Olayiwola, L. M., Adeleye, O. A. and Jiboye, A. D. (2006) Effect of Socio-Cultural Factors on Housing Quality in Osogbo, Nigeria, A Paper presented at the International Symposium on Construction in Developing Economies: New Issues and Challenges, Working Commission W107 Construction in Developing Countries, 18 – 20 January 2006, Santiago, Chile.

Olayiwola, L. M., Adeleye, O. A. and Ogunshakin, L. (2005) Public Housing Delivery Nigeria: Problems and Challenges, World Congress on Housing: Transforming Housing Environments through the Design, September 27-30 2005, Pretoria, South Africa.

Olotuah, A. O. (2006) Housing Quality in Suburban Areas: An Empirical Study of Oba-Ile, Nigeria, Dimensi Teknik Arsitektur, Vol. 34, No. 2, Dec. 2006, pp. 133-137.

Olu-Sule, R. A. (1990) Recent Slum Clearance in Lagos (Nigeria): Victims or Beneficiaries? GeoJournal, Vol. 22, No. 1, September, pp. 81-91.

Oni, A. S. (1988). An Appraisal of Planned Neighbourhoods in Nigeria: A Comparative Analysisof Surulere Housing Estate and Apapa G.R.A, Lagos, An21 unpublished M.Sc. Thesis, Department of Urban and Regional Planning, Obafemi Awolowo University, Ile-Ife.

Onibokun, A. G. (1982) Issues in Nigerian Housing, NISER, Ibadan.

White, H. L., Matheson, F. I., Moineddin, R., Dunn, J. R., Glazier, R. H. (2011). Neighbourhood deprivation and regional inequalities in self-reported health among Canadians: Are we equally at risk? Health and Place. 2011(1):361-69.

WILLINGNESS-TO-PAY FOR FOREST ECOSYSTEM SERVICES IN ONDO STATE, NIGERIA.

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Abstract
The study assessed the willingness-to-pay (WTP) for forest Ecosystem Services in Ondo State, Nigeria. A multi-stage sampling technique was employed to select 120 respondents. The collected data were analyzed using descriptive statistics, contingent valuation method and double-bounded logit model. The study revealed that the respondents were still in their active age with a mean age of 41 years. They had small family size of six members on the average. Some (20%) of the respondents did not have any year of formal education while most (82.5%) of the respondents are farmers and married. Some (46.7%) of the respondents had lived in the areas between 1- 10 years and the mean year of residence was 14. A larger proportion (57.5%) were aware of forest information and had high and favorable perception towards forest protection. The implication of this is that the respondents are likely to have positive disposition towards willingness to pay for forest protection. The double-bounded logit regression model showed that bid amount, age, occupation and information on forest protection were the socioeconomic characteristics that significantly influenced the respondents WTP for forest protection. This study concluded that the respondents are aware of the importance of forest Ecosystem Services to their livelihoods and are willing to pay for its protection. The study recommended that government should enact a policy that will place a token on the use of the forest as a measure to prevent over exploitation of Ecosystem Services.

Keywords: *Ecosystem, Protection, Forest, Reserves, Natural Resources.*

INTRODUCTION

Natural resources provide rural people with food, medicines, meat, honey, gums and resins, condiments and other goods that are exchanged or used for secondary processing, and contribute greatly to rural subsistence economies (Kaimowitz, 2003). More than 800 million people worldwide live in or near tropical forests and savannas and rely on these ecosystems for fuel, food, and income (Chomitz*et al.* 2007). Local ecosystems provide the main source of livelihood for many of the world's poor. Most of the rural poor in Sub-Saharan Africa rely for their livelihood and food security on highly climate-sensitive rain-fed subsistence or small-scale farming, pastoral herding and direct harvesting of natural services of ecosystems such as forests and wetlands (Intergovernmental Panel on Climate Change, 2007; Mitchel and Tanner, 2006; Leary *et. al.* 2005; Roach, 2005). An estimated 1.6 billion people are dependent to some degree on forests for their livelihoods, of which 350 million to a high degree for their subsistence or income (World Bank, 2004).In Sub-Saharan Africa, about 15 million people derive their cash income from forest-related enterprises such as fuel wood and charcoal sales, small-scale saw-milling, commercial hunting and handicraft. In addition, between 200,000 and 300,000 people are directly employed in the commercial timber industry (Jumbe *et al*., 2005). The economic value (i.e. benefits provided by goods and services to consumers) of market ecosystem services are reflected in their market prices and are well known by people. However, the value of non-market ecosystem services are not known without research (Field and Field, 2013; de Groot *et al.,* 2012).

Hence this study focused on rural people's perception on forest protection and their willingness to pay for forest Ecosystem Services.

The main objective of this study is to assess the willingness-to-pay for protection of forest ecosystem services by respondents in Ondo state, Nigeria. Specific objectives are to:

1. describe the socio-economic characteristics of the respondents in the study area;
2. assess the awareness and perception of the respondents towards forest protection;
3. estimate willingness of the respondents to pay for the protection of ecosystem services; and
4. identify factors influencing respondents' willingness-to-pay for the protection of forest ecosystem services.

MATERIALS AND METHODS

This study was carried out in Ondo State, Nigeria. The State covers a land area of 14,783 square kilometers with its administrative capital at Akure. The population of the State as revealed by the 2006 population census was 3,441,024. The State has eighteen Local Government Areas and is bounded in the North by Ekiti and Kogi States, in the East by Edo State, in the west by Osun and Ogun States and in the south by the Atlantic Ocean. Ondo state is located entirely within the tropics. Ondo State has a forest reserve covering a total area of about 3,200 sqkm. Some of the forest reserves in the State are Akure Ofosu forest reserve, (a globally accepted world protected area covers 394 km^2 (152 sq miles)); Ogbese, Ifon, Igbo – Olodumare, Osse river park, Okeluse forest reserve, Oluwa forest reserve and Idanre forest reserve.A multi-stage sampling technique was used in the selection of respondents. Stage one involved purposive selection of three Local Government Areas (LGAs) which were Akure South, Akure North and Idanre Local Government Areas. This selection was done due to the presence of forest resources in the LGAs. The second stage involved purposive selection of two communities around the forests in each of the LGAs. The final stage involved random selection of twenty respondents from each community. These aggregated to one hundred and twenty (120) respondents that were used for the study. A total of forty (40) respondents were chosen from each LGA. Data collected were analyzed using descriptive statistics, contingent valuation method and double- bounded logit. Descriptive statistics such as percentages and means tables were used to analyze objectives 1, and 2. Likert scale was used to analyze objective 2. In order to assess the awareness and perception of the respondents towards forest protection likert scale analysis was adopted in which a 5-point Likert scale ranging from strongly agree (5), agree (4), undecided (3), disagree (2) to strongly Disagree (1). This was used to classify the perceptions of the respondents into favourable, indifferent and unfavorable perceptions in line with Torimiro and Dionco - Adetayo (2004). Class boundaries of means were used to draw the inferences , the Class boundaries are: < 1.0 < 1.5 = strongly disagree; ≥ 1.5 < 2.5 = disagree; ≥2.5 < 3.5= undecided;≥ 3.5 < 4.5= agree and ≥4.5 ≤ 5.0 = strongly agree. CVM was used to estimate objective 3. The CVM is based on the concept of the willingness to pay a certain amount in order for the individual to maximize his/ her utility or willingness to accept compensation so as to improve his utility as a result of damage, or absence of the public good.

Willingness to pay (WTP) is the naira amount a consumer is willing to give up or pay in order to acquire a good or service. CVM was used to obtain WTP of the respondents. ₦10,000 was allotted as the initial bid, ₦5,000 as the lower bid and a higher bid of ₦15,000 per annum was offered. When offered a bid of ₦10,000, a higher bid of ₦15,000 was offered if the response is yes and in case of a no response to initial bid, a bid offer of ₦5,000 was given to the respondents. From CVM two dichotomous variables were observed, i. e. the answers to the first question and its follow-up answer. There were four possible outcomes of dichotomous choices, namely, 'YES YES' (YY), it means respondents said yes to the first and second bid, 'YES NO' (YN), it means respondents said yes to first bid and no to the second bid, 'NO YES' (NY) , it denotes respondents said no to the first bid and yes to the second bid and 'NO NO' (NN) means respondents said no to the first bid and no to second bid.

Double –bounded logit model was used to analyze objective 4. The model is explicitly stated as:

$$L_n \frac{WTP}{1-WTP} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon_i$$

Where;

X_1= Bid amount
X_2 = Age (Years)
X_3 = Household size
X_4 = Marital status
X_5 = Level of education
X_6 = Gender
X_7 = Main Occupation
X_8 = Information on forest protection
$\square_i$= Error term

RESULTS AND DISCUSSION

Description of Socio-economic Characteristics of the Respondents.

The results of the socio-economic characteristics showed that the average mean age of the respondents was 41.90 years. This showed that they were still in their productive age. The respondents were predominantly male with 70%. The average household size was 6. This implied that small household size was prevalent among the respondents. The study also showed that the main occupation of the respondents with the highest percentage in the study area was farming with 82.5%.

Table 1: Socio-economic Characteristics of the Respondents

Variables	Frequency	Percentage
Age		
≤ 20	1	0.8
21-30	27	22.5
31-40	40	33.3
41-50	29	24.2
51-60	29	24.2
>60	10	8.3
Total	**120**	**100.0**
Gender		
Male	84	70
Female	36	30
Total	**120**	**100.0**
Household size		
1-5	65	45.9
6-10	53	44.2
11-15	10	8.3
16-20	2	1.6
Total	**120**	**100**
Main Occupation		
Private employment	3	2.5
Self-employed	17	14.2
Farming	99	82.5
Clergy	1	0.8
Total	**120**	**100.0**
Awareness of forest information		
Aware	69	57.5
Not aware	51	42.5

Total	**120**	**100.0**

Source: Field Survey, 2017.

Respondents' Perception on Protection of Forest Ecosystem Services

The study revealed from the inferences drawn that the respondents strongly agreed that protection of Ecosystem Services is important with a mean score of 4.51. They also agreed to the fact that forest protection programme is necessary to sustain the forest.

Table 2: Perception of Respondents on protection of Forest Ecosystem Services

Perception Statement	Strongly agree		Agree		Undecided		Disagree		Strongly disagree		Mean score	Inferences based on mean class
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%		
Protection of forest Ecosystem Services is important	73	60.8	40	33.3	2	1.7	5	4.2	0	0	**4.51**	**Strongly Agree**
You have responsibility to protect the forest	53	44.2	43	35.8	4	3.3	13	10.8	7	5.8	**4.02**	**Agree**
Resource extraction fees are necessary to sustain the forest	39	32.5	44	36.7	4	3.3	21	17.5	12	10	**4.18**	**Agree**
Local people have the responsibility to protect the forest	40	33.3	59	49.2	6	5	9	7.5	6	5.0	**3.80**	**Agree**
Forest protection programme is necessary to sustain the forest in your area	61	50.8	46	38.3	3	2.5	9	7.5	1	0.8	**4.31**	**Agree**

Source: Field Survey, 2017

Estimation of Willingness-to-pay for Forest Ecosystem Services

Table 3 showed that 82.5% of the respondents were willing to pay. This therefore, implies that the majority of the respondents were willing to pay.While17.5% of the respondents were not willing to pay for the forest protection programme, Individuals, who refuse the proposed change, exhibit a zero WTP. Some zero bids reflect the true preferences, zero being the reservation price of individuals who are indifferent to the proposed change (Strazzera *et al*. 2003). However, some zero bids are protest bids, which refer to situations where respondents indicate that their WTP is zero, not because they have no value for the environmental good or service in question, but because they object to some aspects of the way the hypothetical market of the good is presented.

Table 3: Distribution of Respondents by Willingness-to-pay

Willingness to pay	Frequency	Percentage
Willing	99	82.5
Not willing	21	17.5
Total	**120**	**100**

Source: Field Survey, 2017.

Exact Amount willing to pay by the Respondents

The result in Table 4 summarized the exact amount respondents are willing to pay for the forest protection programme. Among 82.5% of the respondents who agreed that they are willing to pay, larger proportion 29.2% of the respondents were willing to pay the initial bid of ₦10, 000.00 while 10.8 % of the respondents agreed to pay ₦ 15,000.00 higher bid. Only 0.8% of the respondents was willing to contribute ₦25, 000.00.

The mean of the exact amount willing to pay is recorded as ₦7983.33. Considering the level of income in rural areas which exclusively comes from agriculture, the expressed mean WTP is low relative to the initial bid amount but reasonable given rural poor household income. This result is in consonance with the findings of Sylvie (2012).

Table 4: Distribution of Exact Amount Respondents Are Willing to Pay

Amount (₦)	Frequency	Percentage
0	22	18.3
1,000	2	1.7
1,500	1	0.8
2,000	8	6.7
2,500	1	0.8
3,000	3	2.5
5,000	21	17.5
10,000	35	29.2
12,000	1	0.8
15,000	13	10.8
20,000	12	10
25,000	1	0.8
Total	**120**	**100.0**
Mean	**7983.33**	

Source: Field Survey, 2017

Factors influencing willingness-to-pay for Protection of Forest Ecosystem Services

In assessing the factors affecting willingness to pay for forest ecosystem services by the respondents, four variables namely: Bid amount, age, occupation, and information on forest protection were significant. The bid amount poses a significant positive relationship on respondents' willingness to pay. This indicates that as the bid amount increases, the respondents' willingness to pay increases. This indicates from Table 5 that if the bid amount increases by 1 unit, the respondents' willingness to pay also increases by 0.0006. The bid amount was significant at 0.01 or 1% level of significance which implies that the bid amount highly affects the decision of the respondents. Age had a significantly negative effect on respondents' willingness- to- pay for forest Ecosystem Services. This indicates that the younger the respondent is, the more their willingness to pay for forest Ecosystem Services. This result is line with report of Grany*et. al.* (2014) and Chin-Huang Huang and Chiung-Hsia Wang (2015).Occupation of the respondents was significant at 5% and was positively related. The type of occupation they do affects their WTP. Since farming is the main occupation of the majority of the respondents, it may influence their willingness to pay in order to maintain the use of forest for their farming activities. Those who are farmers are more WTP than those in other occupation. This may be due to the fact that farming households are more aware of the benefits derivable from the forest and thus are more willing to pay to get an improvement in quality. This is consistent with the findings of Kesiena*et al.* (2016). Information on forest protection was significant at 1% and was positively related. The more accessible they are to information on forest protection the more they are willing to pay. If a respondent has information on forest protection he/ she will be willing to pay. This explained that people who have information about the importance of protecting the environment are more willing to pay than their counterparts. This conforms to the premise that people often pay for activities that they expect to get benefit from (Chen and Liaw, 2012).

Table 5: Regression Results of the Factors Influencing WTP

Variable	Estimates	Std. Error	P>/Z/
Bid amount	.0006004***	.0001657	0.000
Age	-.1003706**	.044864	0.025
Household size	.1053872	.1378987	0.445
Main occupation	2.051463**	.8195836	0.012
Marital status	.2211213	.6508164	0.734
Level of education	-.1385152	.296532	0.640
Information on forest protection	2.298681**	.931024	0.014

*** Significant @ 1%   ** Significant @ 5%

Source: Field Survey, 2017

CONCLUSION AND RECOMMENDATIONS

Considering the empirical results obtained from this study, it can be said that the study area is farmer dominated and most of the farmers were in their productive age. The study also concluded that majority of the respondents were willing to pay for protection of forest Ecosystem Services. The study showed that the respondents were aware of the importance of forest Ecosystem Services as observed in their willingness to pay for its protection. The likely factors that might be responsible for their willingness to pay statistically were highlighted as bid amount, occupation, age and information on forest protection.

Based on the findings of this study the following recommendations are made:

i. Government should enact a policy that will place a token on the use of forest within the study area.
ii. Despite people's willingness-to-pay for protection of ecosystem, government should check the unsustainable exploitation and utilization of its goods and services as well as its associated environmental challenges.

Government should adopt stakeholder approach in the forest management for the sustainable utilization of resources.

REFERENCES

Chen, W. and Liaw, S. (2012). What is the Value of Eco-tourism? An Evaluation of Forested Trails for Community Residents and Visitors. *Tourism Economics*, 18(4):871-885.

Chin-Huang, H. and Chiung-Hsia W. (2015).Estimating the Total Economic Value of Cultivated Flower Land in Taiwan Sustainability, (7): 4776.

Chomitz, K., Buys, P., De Luca, G., Thomas, T., and WertzKanounnikoff, S. (2007). At Loggerheads? Agricultural Expansion, Poverty Reduction and Environment in the Tropical Forests. World Bank, Washington DC. ISBN: 0-8213-6853-2.

De Groot, R., Brander, L., Van Der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., Mcvittie, A., Portela, R., Rodriguez, L., Ten Brink, P. and Van Beukering, P., (2012). Global Estimates of the Value Of Ecosystems and their services in Monetary Units. *Ecosystem Services*, 1(1): 50-61.

Field, B., and Field, M. (2013). Environmental Economics: An Introduction. McGraw-Hill, New York.

Grany M., Senyolo, E., Wale, and Gerald, F. (2014). Consumers' Willingness-To-Pay for Underutilized Vegetable Crops: The Case of African Leafy Vegetables in South Africa.

Intergovernmental Panel on Climate Change (2007). Fourth Assessment Report. ClimateChange 2007: Synthesis Report. Summary for Policymakers. Geneva, IntergovernmentalPanel on Climate Change. Cambridge University Press, Cambridge Uk.

Jumbe, C., Bwalya S. and Husselman M. (2005). Contribution of Dry Forests to Rural Livelihoods and the National Economy in Zambia. Department of Economics, University of Zambia.

Kaimowitz, D. (2003). Forest Law Enforcement and Rural Livelihoods International.*Forestry Review* 5(3).

Kesiena T. Ogeh, Jimoh,S., Ajewole O. (2016) Willingness to Pay For Environmental Service Functions of Mangrove Forest in Uzere, Delta State, Nigeria.16.

Leary, N., Adejuwon, J., Bailey, W., Barros, V., Caffera, M., Chinvanno, S., Conde, C.,De Comarmond, A., De Sherbinin, A., Downing, T., Eakin, H., Nyong, A., Opondo, M.,Osman, B., Payet, R., Pulhin, F., Pulhin, J., Ratnasiri, J., Sanjak, E., von Maltitz, G.,Wehbe, M., Yin, Y., and Ziervogel, G., (2005). For whom the Bell Tolls- vulnerability in aChanging Climate, a Synthesis from the AIACC project. Retrieved www.aiaccproject.org

Mitchell, T, and Tanner T. (2006). Adapting to Climate Change Challenges and Opportunities for the Development.

Roach R. (2005). Dried up, Drowned Out-Voices from the Developing World on a Changing Climate, Tearfund, 100 Church Road, Teddington, Middlesex, TWAA 8QE, United Kingdom.

Strazzera, E., Riccardo S. Pinuccia C., Guy D. and Kenneth G. (2003). Modeling Zero Values and Protest Responses in Contingent valuation surveys. *Applied Economics*, 35(2): 133-138.

Sylvie, N. (2012). An Assessment Of Farmers' Willingness to Pay for the Protection of Nyabarongo River System, Rwanda Unpublished M.Sc. Thesis Submitted to the Board of Postgraduate Studies, University Of Nairobi In Partial Fulfillment of the Requirements for the Degree of Master of Science in Agricultural and Applied Economics.

Torimiro, D. and Dionco-Adetayo, E. (2004). Perception of Nomadic Household on Children Involvement in Animal Rearing Industry among the Fulani Communities.*Stud. Tribes Tribal*, 2: 131-135.

World Bank (2004). Sustaining Forests: A development strategy. The World Bank, Washington D.C.

ENVIRONMENTAL MENACE OF PLASTIC WASTE IN NIGERIA: CHALLENGES, POLICIES AND TECHNOLOGICAL EFFORTS

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Abstract
Plastics are durable, lightweight and inexpensive materials, which moulds readily into a variety of products with wide range of applications. Over the last 60 years, production of plastics had witnessed remarkable increase and is proposed to be used in solving other global pressing problems. Increasing demand and usage of plastics, and its disposal has resulted in several environmental pollution burden on both land and water habitats threatening the safety and health of wildlife, aquatic life and humans. Economic growth, changing consumption and production patterns are resulting into rapid increase in generation of waste plastics globally. Increasing attention has been paid to plastic waste by policymakers, scientists and the media. Since plastics are non-biodegradable in nature, it is very difficult to eliminate the waste plastics. The problems in plastic waste management and disposing them in landfills and burning them severely affects the environment leading to pollution of air, water and soil. Mechanical recycling of low value waste plastics i.e. shredding or agglomeration of the plastics is primarily necessary in converting the waste plastics into a more useful form of recycled plastics using further recycling methods like extrusion, injection or other recycling methods. This paper highlights the menace of plastic pollution in Nigeria, opportunities in plastic recycling, government policies and technological efforts in the development of plastic recycling.

Keyword: *Plastics, waste management, recycling, policies, technological efforts.*

INTRODUCTION
The increasing quest for better quality of life is an unending goal for the people of this world. This has contributed to the increased consumption of goods and services, resulting in the generation of waste. Plastics have become an integral part of our lives, its wide use in various sectors and its ever-expanding applications has been of enormous benefits to the society. The amounts of plastics consumed annually have been growing steadily (Kumar, 2017; Kaza *et al.*, 2018).Being a versatile, light weight, strong and potentially transparent material, plastics are the drivers for its growth and ideal suitability for a variety of applications. Their low cost, excellent oxygen/moisture barrier properties, bio-inertness and light weight make them excellent packaging materials. Besides its wide use in packaging, automotive and industrial applications, they are extensively used in medical delivery systems, artificial implants and other healthcare applications, water desalination and removal of bacteria etc (Verma*et al.*, 2016; Okon, 2018)
Usage of plastics, in preservation and distribution of food, housing and appliances are too many to mention. Specially designed plastics, have been an integral part of the communication and electronics industry, especially in the manufacture of chips and compartments. They are also used in alternative energy systems such as fuel cells, batteries. (Babayemi *et al.*, 2018). Meanwhile, increasing plastic production and use in emerging economies looks set to continue, and waste management infrastructure

will have to develop accordingly (Uwaegbulam *et al.*, 2018). Unfortunately, the properties of plastic that make it so valuable also make its disposal problematic, such as its durability, light weight and low cost. In many cases plastics are thrown away after one use, especially packaging and sheeting, but because they are durable, they persist in the environment (Hopewell *et al.*, 2009)

However, as the use of plastic in modern society has increased, so too have the environmental impacts associated with its production and disposal. UNEP (2018) highlighted the environmental costs of plastic use in consumer World population, which surpassed 7 billion in 2011, is forecast to exceed 9 billion by2050. It is feared that the growing demand for resources will facilitate an increase in resource consumption and waste generation, contribute to deterioration of the natural environment and climate change, and impact future generations (Ogwo *et al.*, 2013). To solve poverty, hunger, and environmental problems and achieve sustainable development in diverse ways while dealing with this increase in world population, it is generally acknowledged that a multifaceted approach that integrates economic, social, and environmental aspects is needed as it could help to address some of the world's most pressing problems, such as climate change and food shortages. For example, plastics are used in the manufacture of rotors for wind turbines and tunnels made from polyethylene can help crops grow in otherwise unfavorable conditions (Oyake-Ombis *et al.*, 2015). As demand for materials with certain qualities increases, the plastics industry will aim to supply them.

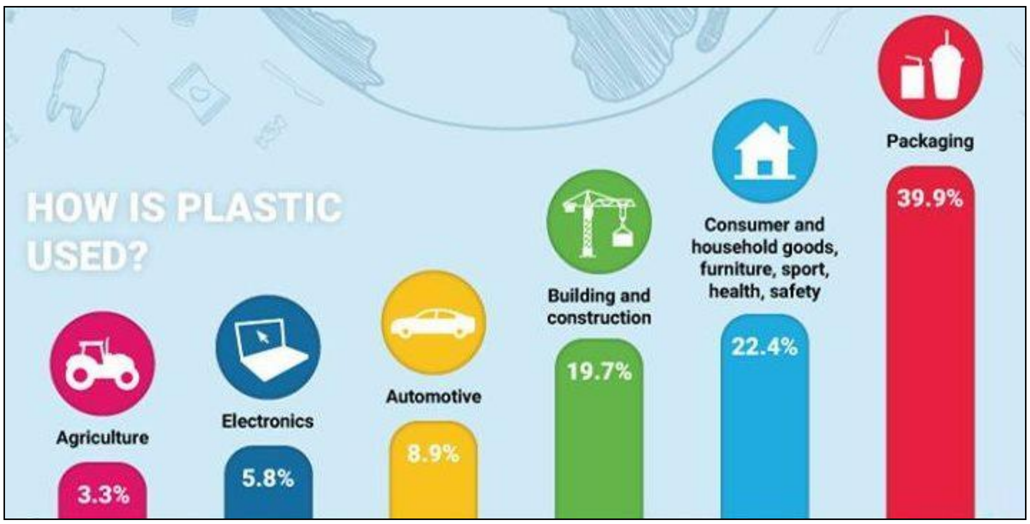

Figure 1: Global Plastic Usage. (J and K. Envis Hub, 2018)

Waste management has become a global predicament, requiring adequate attention in order to solve the world's resource and energy challenges. The World Environment Day celebration which begun in 1974, with the aim of raising awareness, supporting action and driving change towards environmental protection had its theme for 2018 as 'Beat Plastic Pollution'. Plastic pollution is a global, and raising concern. We have produced more plastic in the last 10 years than in the whole of the 20th century, and every piece of plastic ever produced still exists today(J and K Envis Hub, 2018). These environmental costs have prompted some to argue that plastics should be replaced with alternative materials, which may present fewer environmental challenges (Elias and Omojola, 2015). However, as the use of plastic in modern society has increased, so too have the environmental impacts associated with its production and disposal. UNEP (2018) highlighted the environmental costs of plastic use in consumer products, including emissions of greenhouse gases, air, land and water pollutants, depletion of water and the production of marine debris in the global oceans.

It is ultimately important to address plastics pollution, as it is highly pertinent for achievement of Sustainable Development Goals, with emphasis on goal six (Ensure access to water and sanitation for all), eleven, (Make cities inclusive, safe, resilient and Sustain- able), twelve (Ensure sustainable consumption and production patterns), and fourteen (Conserve and sustainably use the ocean, seas and marine re- sources).This paper aims at discussing the menace of plastic pollution highlighting the root-causes, financial implication, and impacts of plastic pollution on all ecosystems, aquatic and land- based, and throughout the plastic life cycle, showcasing existing policy approaches and instances of people-powered

MATERIALS AND METHODS

Forms of Plastics

Plastics are synthetic organic materials produced by polymerization.It molds easily under the application of pressure or heat. They are of high molecular mass and can be molded or extruded into desired shapes. Plastics are classified as thermoplastics and thermosets. Thermoplastics softens when heated and molded or shaped with pressure when in molten state and becomes hardened when cooled to retain the shape. Thermosets are unmeltable solids that decomposes on heating (Majka and Pielichowski, 2011). The life cycle of plastics begins from the extraction of ethylene from crude oil or natural gas to its disposal as waste after usage. Several substances, as well as polymers, are an addition in the production of plastics to improve performance and or reduce cost (Ikpe *et al.*, 2017). Plastics are of five major categories: Polyethylene (PE), Polyethylene terephthalate (PET), Polypropylene (PP), Polystyrene (PS), Polyvinylchloride (PVC) (Ayo *et al.*, 2018).

Production and Consumption

Over the past 50 years, there have been a global increase in the production of plastic, from 2 million metric tons in 1950 to 381 million metric tons in 2015, and is anticipated to double in the next 20 years (J and K Envis Hub, 2018). The total global production of plastics to date is estimated at 8,300 million metric tons (Royer *et al*, 2018), with 64 million metric tons produced in Europe alone. China is one of the large producers of plastics in the world, accounting for more than one quarter of the global production (Statistica, 2018). Implying that as more resources are being used to meet the increased demand of plastic, more plastic waste is being generated (UNEP, 2018). Annually, over 280 million tons of plastics is produced and almost 75% of the demand comes from four major sectors: packaging, construction, automotive and electrical or electronics. (Thevenon and Oliver, 2014). Its use has increased twentyfold in the past half-century and is expected to double again in the next 20 years (Ekeu-wei *et al.*, 2018).

Nigeria’s packaging industry has accounted for 12 percent of the $4billion recorded by Middle East and African markets in the last five years, according to a survey carried out by PCI Film Consulting (J and K Envis Hub, 2018). The total amount of plastics imported into Nigeria from 1996-2014 (including plastics from motor vehicles from 1980-2010) was estimated to be 23.4 million tons. Plastics produced in Nigeria are manufactured from imported raw materials or from recycled waste and therefore may not be counted as an additional contribution source to the volume of plastic in Nigeria. (Elias and Omojola, 2015)

The Nigerian plastics and packaging sector started with about 50 plastics companies in the 1960s and had grown to over 3,000 companies in 2013 witha production capacity of over 100,000 tons per year according to the National Agency for Food and Drug Administration and Control (NAFDAC) (Hanafi, 2018). The growing market for plastic products in Nigeria is a major driverof this development. With about 70% of raw materials imported (mainly from the Middle East, Europe and Asia) and only 30% produced locally, the Nigerian market has great potential for exporters of plastics in primary forms, positioning Nigeria as Africa's largest importer of plastics in primary forms (Odior *et al.*, 2012). The per capita consumption of plastics in Nigeria has grown by about 5% annually over the past ten years, from 4.0 kg in 2007 to 6.5 kg in 2017 and is estimated to be 7.5 kg in 2020 (Brandspur, 2017). Globally, plastic waste constitutes more than 60% of the total global municipal solid waste (MSW) of which 22% were recovered and 78% disposed of. (Ogwo *et al.*, 2013; Ayo *et al.*, 2018).

Impacts of Plastic Waste on the Environment

Plastic waste is a global problem, but with regional variability. Plastic waste has tremendous impact on the health of the ecosystem and humans. The unethical methods of disposal further aggravate the effects with the release of chemicals to the environment through burning or by escape of landfill leachates. The ingestion of plastic by fishes also cause internal ulcerations, disruption in the digestive tract of the fishes, and restrains buoyancy contro l(Verme *et al.*, 2016). Some of the major impacts of plastic waste on the environment are discussed below:

Effect on Marine Life

The global oceans are critical to sustaining the Earth’s natural life support systems. They are regarded as the lungs of our planet, providing most of the oxygen we breathe, they also contribute to the livelihoods, culture and well-being of communities around the world, and play a vital role in the global economy, providing food and a source of income for millions of people. Yet, with a fast-growing world population, the production of waste continues to increase faster than the efforts towards mitigating its impact on the oceans (Blettler *et al.*, 2018).

Statistica (2018) indicates that one million waste plastic bottles are churned out every minute across the world while five trillion plastic bags are generated yearly, about 10 million unit every minute. It is also estimated that at least eight million tons of plastic end up in the oceans every year (Darshan and Gururaja, 2017). The empirical prediction that by 2050, world’s ocean will have more plastic than fishes portends far-reaching dangers and calls for drastic measures to address the menace urgently.

In a statement released by African Development Bank, over 100,000 marine animals are killed by plastics and 83 percent of tap water are found to contain plastics particles (Hanafi, 2018). Plastic pollution is of particular concern in coastal areas of Nigeria. Plastic fragments will persist in the aquatic environment for decades or centuries, due to their high resistance to natural degradation processes. This waste gets into the ocean from land-based sources such as storm water discharges, combined sewer overflows, littering, industrial activities, and solid waste disposal and landfills (Blettler *et al.*, 2018)

The most visible and worrying impact of marine plastic pollution is the suffocation and entanglement of marine species, which includes seabirds, turtles, fishes, mussels, crustaceans and marine mammals. Also, of concern is accidental ingestion, which can be fatal. Entanglement can produce lacerations and causes infections as a result of abrasive or cutting action of the litter (SFEP (Science for Environment Policy) 2011). It also impairs the animals swimming, search for food and escape from predator. The effect of entanglement is largely underestimated, as most victims are undiscovered as they sink, eaten by predators or transported over long distances altering biodiversity and the equilibrium of native ecosystems

The venon and Oliver (2014) reported that some birds and marine species mistake plastic particles waste for potential prey items and select specific plastic shapes and colours, reducing their actual food uptake and causing lethal injury and death following blockage of the intestinal tract. The ingestion of plastic debris is also of concern to small invertebrate organisms with possible health implications for humans who consume seafood as the pollution as resulted in the prevalence of toxic metal in the food chain.The surfaces of floating plastics potentially accumulate toxic pollutant during their long residence time in polluted seawater, serving as a vector for toxic pollutants that accumulate in marine organisms.

Beyond the heroic efforts of beach clean-up volunteers, the challenge of reducing plastic pollution in the ocean requires a coordinated effort from all sectors of the society, including manufacturers, tourism, local authorities and governments, and all other users of coasts and oceans.

Plastics in Landfills

Landfills have contributed to nearly 20% of Green House Gases (GHG) followed by fossil fuels. (Verma *et al.*, 2016). In landfills, plastic degrades into its smaller components and leaches into the soil and the water table, ultimately making its way towards the food chain and causing massive health hazards. Leachates from landfills contains metals, such as lead, mercury, cadmium along with pesticides, pharmaceutical wastes, disinfectants, organic compounds and chemicals which contaminates the groundwater. A mixture of toxic substances and decaying organic material from a landfill site can also affect the structure and quality of the soil in the region, inhibiting sustainable agriculture practices, thus exerting a direct impact on biodiversity (Hakeem *et al.*, 2018).

Landfills are also the source of several greenhouse gases amongst which carbon dioxide and methane constitute 90% to 98%, respectively. Methane which is released as a result of the decomposition of organic matter. These gases, apart from been able to cause landfill fires due to their flammability, could also trap solar radiation, thereby leading to global warming (Hanafi, 2018; Okon, 2018).

In Nigeria, less than 12% of plastic waste is recycled. About 80% of plastic waste goes to landfills and dump sites (Babayemi *et al.*, 2018). Cities choose to dump solid waste in dump yards where waste is either buried or left in place. The common act of dumping is particularly due to the lack of awareness and the need for land to discard an enormous amount of wastes generated from households and surrounding areas.

Waste burning

Waste burning is a recurrent means to plastic disposal in municipals resulting in smog and poor air quality. The practice has been on the rise owing especially to ignorance, lack of awareness about the consequences, and poor prevalent waste collection infrastructure. The by-products of plastic combustion are airborne particulate emission (soot) and solid residue ash (black carbonaceous colour) which can travel thousands of kilometers, depending on prevailing atmospheric conditions and enter our food chain possess a high potential of causing health and environmental concerns (Hanafi, 2018; SFEP, 2011).

Burning plastic and other wastes releases dangerous substances such as heavy metals, Persistent Organic Pollutants, and other toxins into the air causing greenhouse effect and damage to the ozone layer. Dangerous pollutants like mercury, polychlorinated biphenyls, dioxins and furans which are released during burning accumulates in food crops, animals and fish endangering humans and wildlife. Toxins which are released when plastic waste is burnt with food waste, which can increase risk of heart disease, aggravate respiratory ailments, damages kidney, liver, nervous system, skin, causes cancer and possibly death (WECF, 2004; DESA, 2013).

Flood

Flood is an overflow of water that submerges dry lands, carrying materials uncontrollably from one location to another. Arguably, floods wreak havoc seasonally on Nigeria, especially in populated metropolitan cities where plastic bottles, plastic bags and other waste materials crammed drainage channels, thereby hindering free flow of water whenever it rains. Apart from the monumental losses it causes, flood is a potential source of water borne diseases such as cholera, typhoid and dysentery (Agamuthu *et al.*, 2015).

Environmental Policies and Technological Efforts

Establishment of Extended Producer Responsibility

Governments of different developed countries of the world have been legislating policies on plastics recycling waste management system to curb the menace of the increased waste plastics on their environment (Hovath *et al.*, 2018). Countries like Russia, Canada and Japan have devised different strategies that mandate individuals, households and business to dispose their waste responsibly for recycling, landfilling and incineration depending on the nature of the waste materials. They have also made policies that directly hold manufacturers responsible for the waste generated from their products. Chief among the policies is the Extended Producer Responsibility (EPR) which requires manufacturers to monitor the end life of their products to minimize environmental hazards (Gupt and Sahay, 2015). In 2015, the National Environmental Standard Regulations and Enforcement Agency of the Federal Ministry of Environment joined other countries to implement this policy in the beverage sector. The policy was enacted under the Producer Responsibility Organization (PRO) aimed at promoting clean environment, creating jobs along recycling value-chain and encouraging firms to design environmentally-friendly products (NESREA, 2018).

In response to the policy, some multinational food and beverage organization in Nigeria formed Food and Beverage Recycling Alliance (FBRA) as their Producer Responsibility Organization, with collaboration with state government to rid the state's waterways of plastic and packaging waste, a step in the initial phase of a long-term commitment to effective plastic waste management (Hanafi, 2018;Uwaegbulam*et al.*, 2018). In addition, efforts are been made towards public awareness campaigns and advocacy on appropriate packaging waste disposal systems. With effective EPR, there will be an increase in plastic recyclers. Geometric replicating the concept across every corners of the country. Regardless of the promising impact of the policy, limited effort is directed towards the enforcement of the policy (NESREA, 2018).

Development in Plastic Recycling Machine in Nigeria

Around the world, waste constitutes an environmental, health and sustainability burden which can be overcome through recycling (UNEP, 2011a). Darshan and Gururaja (2017) described plastic recycling as the operations involved in the recovering and reprocessing of waste plastic into useful products. In order to preserve our environment, there is a need for the development of sustainable means to manage plastic wastes generated from our local communities and industries, hence plastics recycling is of utmost important in waste management and for this to be sustainable, the recycling process must be cost-effective.

Plastics recycling in waste management is a collective effort which requires the involvement of every arm of the society which includes large industries, medium scale and at the local level also. Study and field survey showed minimal involvement of local recyclers in PET recycling as manual labour is being used for chopping plastic waste. This limits the volume of shredding and results in human fatigue, the cost and maintenance of existing machine is very expensive and not affordable for local operators (Ugoamadi and Ihesiulor, 2011; Okon, 2018).

The capital-intensive nature of recycling discouraged interested entrepreneurs, aside the cost of land for setting up a recycling center, it costs fifty million naira to acquire an imported plastic crushing machine (Hanafi, 2018). Most plastics recycling machine used in Nigeria are imported and costly, hence there is need to locally developed recycling machine for cheaper production. In view of this, only limited work has been done on the development of plastic recycling machines as discussed below:

Ugoamadi and Ihesiulor (2011) reported the design and fabrication of a plastic recycling machine using locally available materials, to recycle waste polythene bags, film sheets, PET bottles etc, by using a gearing system to transmit power and it was suggested that for improved efficiency, belt and pulley system should be employed. The recycling efficiency of the machine was 97% and its recycling capacity was 265 kg/hr. Odior *et al.* (2012) developed a polythene recycling machine from locally sourced materials. The heat used in softening the waste plastic to be shredded is generated by friction during the operation of the machine. The machine has a capacity of recycling 30 kg of polythene/nylon wastes per hour. Odusote*et al.* (2012) designed and developed a motorized polythene and water nylon sachet recycling machine. The developed machine achieved the shredding of polythene materials into flakes by softening the polythene using heat and then pass them through fixed and rotary blade assembly. The developed machine was able to produce 30-40 kg/hr of polythene shredded flakes in an hour.

Kusekar, *et al.*(2015) developed a pneumatically operated injection plastic molding machine and the die assembly was simulated using ANSYS software to determine the stress, strain and temperature distribution across the die. Farabiyi (2017) improved the existing design of the locally made machine which involves shredding, melting and extrusion units by adopting a belt and pulley transmission, which focused on the production of reel of thin plastic filament for the manufacturing of components using finite element modelling tool to simulate and analyze the machine members to ensure efficiency.Ikpe and Owunna (2017) developed a plastic crushing machine for commercial and industrial recycling. The machine has an average throughput capacity of 0.112kg/s with an efficiency of 82.2%.

Ayo *et al.*, (2017) developed a low-cost waste plastic shredding machine to shred larger plastic sizes at a very high speed. The average particle size shred of the machine is 13.3 mm, with a percentage shredded of 53.2% and 95% specifically for PVC type of plastic. The machine has an average throughput of 27.3 kg/hr and recovery efficiency of 95%. The machine is produced using locally sourced materials at an estimated cost of one hundred and forty thousand, seven hundred and fifty naira, making it affordable for small and medium recyclers. Okunola *et al.*, (2018) developed a shredding and washing machine for polyethylene terephthalate bottles pelletizer. The machine shredded PET bottles into a required grain size for effective functionality of the incorporated pelletizing machine, the machine has a maximum recycling efficiency of 93.73% and a shredding efficiency of 60.01%, producing particles of the desired size ($0.001m^2$). The machine has the capacity to shred 50-75kg of PET bottles per hour. It was produced using locally sourced materials at an estimated cost of seventy thousand naira, making it relatively affordable for plastic recycling entrepreneurs.

Opportunities in Plastic Recycling

Plastic waste and its devastating consequences are not peculiar to Nigeria, many countries have taken bold steps towards managing it. In order to preserve our environment, there is a need for the development of sustainable means to manage plastic wastes generated from our local communities and industries, hence making recycling of plastics an important aspect of waste management (DESA, 2013).

Consequentially,plasticwasterecyclingiseconomicallyviable,asitgeneratesresources,whichareinhighdemand. Plasticwasterecyclingalsohasagreatpotentialforresourceconservationandreduction in greenhouse gases(UNEP, 2011b). Reduces the volume of plastic waste getting to the oceans and landfills.

Energy required for plastic recycling is relatively less compared to the energy used in making new products from raw materials, as more energy is expending in extracting, refining and transporting and processing raw materials. Studies shows that plastic recycling had a multiplier effect of reducing cost of plastic production, the burden of sourcing foreign exchange to import virgin resin, raw materials used for manufacturing which gives leverage for the affordability of the people and creating employment (Onwuka and Udeh, 2015). With reduced cost of production, plastic products are produced at lower prices. (Hakeem, 2018). In addition, Recycling saves the funds spent on clearing drainage challenges, managing and clearing landfills, ocean cleanups.

Recycling benefits the economy by generating revenue and creation of new jobs. Nigeria Bureau of Statistics in 2017, revealed that out of active labour force of 85.08 million people in Nigeria, about 16 million people were unemployed. As a result of the overwhelming unemployment rate in the country, there has been much pressure on the government to provide empowerment and create enabling environment for people to explore small and medium enterprises (SMEs). New jobs and businesses could be created in collecting, processing, transporting and trading of recycled waste. Furthermore, Plastic recycling reduces the waste on landfills and oceans.

Plastic Waste to Energy Conversion

Waste to Energy processes have been recognized as an important player in establishing a sustainable management framework for plastic waste globally. In some developed countries, sustainable development policies aimed at reducing and recycling waste are also centered on electricity production (Chanashetty and Patil, 2015). Converting plastic wastes into energy can be achieved using two methods. First, power generation by direct combustion and fuel energy extraction (Adekomaya and Ojo, 2016). Wong *et al.*,

(2015) highlighted that plastics wastes can be converted into energy using thermal and catalytic pyrolysis, microwave-assisted pyrolysis and fluid catalytic cracking.

Fuel Oil from Plastic Waste

Fuel oil from plastic can also be instrumental in energy generation, considering the challenge of waste management and energy generation that Nigeria is currently facing coupled with the staggering oil revenue of the country (Olufemi and Olagboye, 2017). Energy potential of plastic wastes have been explored by several researchers and these have received full attention due to its recyclability and affordability (Oyake-Ombis*et al.*, 2015). Adekomaya and Ojo (2016) suggested that Lagos state and Rivers state, who are believed to be generating highest volume of plastic wastes in Nigeria should explore the use of plastics wastes for energy generation using processes such as thermal and catalytic pyrolysis, microwave-assisted pyrolysis and fluid catalytic cracking. With increasing demand for energy, Plastic waste can be used to produce fuel for domestic and industrial use (Chanashetty and Patil, 2015).Hakeem *et al.*, (2018) explored the catalytic pyrolysis of waste polypropylene using ahoko kaolin clay as catalyst. Optimum yield was obtained at a catalyst-to-plastic ratio of 1:3 with a yield of 79.85wt% for liquid product, which is characterized for its suitability as fuel. Olufemi and Olagboye (2017) produced fuel oil from polypropylene, low- and high-density polyethylene with negligible.

CONCLUSION AND RECOMMENDATIONS

Plastic waste may be a major world challenge due to its properties and wide applications, with millions of tons of it entering the country.Considering the impacts of this large amount of non-degradable waste to global and immediate environments, human health and safety, an elaborate analysis of the technological efforts and policies established in addressing this menace is essential in establishing a sustainable waste management centered towards reduction in production, reuse, recycling, conversion to energy and development of alternative materials. Appropriate policies and strategies are necessary to address chemical exposure caused by plastic, encouraging research in that path. Societal awareness of the severity of the problems of plastic usage and disposal, and adoption of alternatives should be encouraged. Plastic recycling technologies is considered the assured path to enhance environmental sustainability. Concerted efforts should be geared towards funding environmental sustainability research and technologies, encouraging recyclers, the adoption of alternative materials and recycling by-products, and the development of recycling infrastructures and policies in Nigeria.

Recommendations

In other to achieve a sustainable plastic recycling system in Nigeria. The government must be holistically involved by engaging a wide range of stakeholders in the decision-making to address the menace. For interested recyclers with capital issues, the government can fund the purchase of machinery and then monitor the operations, or fund a cooperative to support the business. Grants can also be made available through agencies to support land purchase.

Tax incentives should also be made available to encourage and attract entrepreneurs into the recycling business, seminars and workshops should be organized to educate people on the opportunities in the recycling sector and encourage like-minded people to establish recycling outfits, by enlightening the people to recognize that, recycling is not only a source of income but a support to the ecosystem. Recycling of plastic and other waste would boost the economic status of Nigeria.

Furthermore, technical assistance should be provided to micro and macro firms exploiting the challenge of plastic pollution. Wide range and intense sensitization should be carried out by government agencies and manufacturers on proper waste disposal methods, raising awareness on the harm caused by the indiscriminate disposal of plastic waste especially in run off and water bodies.
Recycling firms should be established in every states of the country funded by the State government in partnership with private organizations e.g Public Private Partnership (PPP)Public-private partnerships and voluntary participation should be encouraged. More importantly, Plastic collection points should be established across the country, as it was identified that plastic collection is a major challenge in recycling. Plastic collection and sorting should be assisted.

They must finance more research and development of alternative materials to plastic, involving study on the adoption of indigenous and traditional packaging materials () and the development of bioplastics. In addition, economic incentives are necessary to encourage the adoption of eco-friendly and alternative materials. Establishment of technological incubation. National Environmental Standards and Regulations Enforcement Agency (NESREA) and other involved agencies should be better empowered to ensure companies alignment to the terms of PROs. The success of the EPR requires the coordinated input from all sectors in the economy. Strict sanctions should also be introduced for non-compliance to the regulations.

REFERENCE

Adekomaya, O., and Ojo, K. (2016). Adaptation of Plastic Waste to Energy Development in Lagos: An Overview Assessment. Nigerian Journal of Technology, 35(4), 778. doi:10.4314/njt.v35i4.12

Agamuthu, P., Milow, P., Nurul, A. M., Nurhawa, A. R., Fauziah, S. H., (2015). Impact of Flood on Waste Generation and Composition in Kelantan. Malaysian Journal of Science 34 (2): 130-140

Ayo A. W., Olukunle O. J., Adelabu D. J., (2017). Development of a Waste Plastic Shredding Machine. Int J Waste Resour 7: 281. doi: 10.4172/22525211.1000281

Babayemi J. O., Ogundiran M. B., Weber R. and Osibanjo O. (2018). Initial Inventory of Plastics Imports in Nigeria as a Basis for More Sustainable Management Policies. Journal of Health & Pollution Vol. 8 (18)

Blettler C.M., Abrial E., Khan F. R., Sivri N., Espinola L.A., (2018). Freshwater plastic pollution: Recognizing research biases and identifying knowledge gaps, Water Research (2018), doi: 10.1016/j.watres.2018.06.015.

Brandspur (2017). Nigeria Plastic Production Q4 2017. [Available from: https://brandspurng.com/2017/11/07/nigeria-plastic-production-q4-2017/]

Chanashetty V. B. and B.M. Patil., (2015). Fuel from Plastic Waste. International Journal on Emerging Technologies (Special Issue on NCRIET-2015) 6(2): 121-128(2015)

Darshan R., and Gururaja S., (2017). Design and Fabrication of Crusher Machine for Plastic Wastes, International Journal of Mechanical and Production Engineering, 5(10): 55-58

Department of Economic and Social Affairs (DESA), (2013). Sustainable Development Challenges, World Economic and Social Survey 2013, E/2013/50/Rev. 1, United Nations, Newyork.

Ekeu-weiI. T., Azuma K. I. and Ogunmuyiwa F. B., (2018). Assessment of Environmental Impact of Solid Waste Dumpsites Using Remote Sensing.

Elias, P. and A. Omojola,, (2015). Case study: The challenges of climate change for Lagos, Nigeria. Current Opinion in Environmental Sustainability, 2015. 13(0): p. 74-78.

Gupt, Y. and Sahay, S. (2015). Review of extended producer responsibility: A case study approach. Waste Management & Research. 33. 595– 611. 10.1177/0734242X15592275.

Hakeem I. G., Aderuagba F. and Musa U., (2018). Catalytic Pyrolysis of waste polypropylene using Ahoko Kaolin from Nigeria. Applied Petrochemical research. https://doi.org/10.1007/s13203-018-0207-8

Hanafi A., (2018). Plastic pollution: Nigeria's untapped 'waste wealth' fuels environmental disaster, Punch Newspapers, pp 18-19 [Available from: https://punchng.com/plastic-pollution-nigerias-untapped-waste-wealth-fuels-environmental-disaster/]

Hopewell J., Dvorak R. and Kosior E. (2009). Plastics recycling: challenges and opportunities, Philosophical Transactions of The Royal Society. 364, pp 2115-21226

Hovath B., Mallinguh E., and Fogarassy C., (2018). Designing Business Solutions for Plastic Waste Management to Enhance Circular Transitions in Kenya. Sustainability, 10, 1664; doi:10.3390/su10051664

Igoni, A. H., Ayotamuno M. J., Ogaji S.O.T., and Probert S.D., (2007) Municipal solid-waste in Port Harcourt, Nigeria. Applied Energy. 84(6): p. 664-670.

Ikpe A. E. and Owunna I., (2017) Design of Used PET Bottles Crushing Machine for Small Scale Industrial Applications, International Journal of Engineering Technologies Vol.3(3): 233-241

J. and K. Envis Hub, (2018). Beat Plastic pollution, If you can't refuse it, reuse it. Environmental Day Special. Department Of Ecology, Environment And Remote Sensing, Volume 5 – Issue 2, ISSN 2455 – 8575, India

Kusekar, S. K., Morajkar, C. E., Kashid, S. N., Hipparakar, K. S., and Deshpande, V. S., (2015). Design and Development of Plastic Recycling Machine by using FEA. International Research Journal of Engineering Technology, 2(2): pp. 184-190.

Majka T. M. and Pielichowski K., (2011). Application of waste plastics for efficient flood protection systems. 1st World sustainability forum.

National Environmental Standards and Regulations Enforcement Agency (NESREA), (2018). Extended Producer Responsibility Programme is a Must, [Available from: http://www.nesrea.gov.ng/extended-producer-responsibility-programme-is-a-must/, May 23rd, 2018]

Odior, A. O., Oyawale, F. A., and Odusote, J. K. (2012). Development of a Polythene Recycling Machine from locally sourced materials. Industrial Engineering Letters, 2(6): pp. 42-46.

Odusote, J K, Muritala, A A, &Oyawale, F A (2012). Design and Fabrication of Polythene/Nylon Wastes Recycling Machine. Proceedings of CIVIL, 2012 at UNILORIN 4th Annual and 2nd International Conference of Civil Engineering, July, 2012, Ilorin, Nigeria: Unilorin Press.

Ogwo P. A., Obasi L. O., Okoroigwe D. S. and Dibia N. O., (2013). From Plastic Bag Wastes to Wealth: A Case Study of Abia State University, Nigeria. Journal of Environmental Management and Safety Vol. 4(1): 35 – 39

Okon, A. (2018). Food, beverage recyclers, Lagos collaborate on plastic waste management, Punch Newspapers, pp 18-19, [Available from: https://punchng.com/food-beverage-recyclers-lagos-collaborate-on-plastic-waste-management/]

Okunola O. I., Oyebade D. A. and Olanrewaju O. O., (2018). Development of Shredding and Washing Machine for Polyethylene Terephthalate (PET) Bottles Pelletizer. International Journal of Engineering Science and Application. Vol. 3, No. 4, pp 106-112,

Olufemi A. S. and Olagboye S. A., (2017). Thermal conversion of waste plastics into fuel oil. International Journal of Petrochemical Science & Engineering;2(8):252–257

Onwuka I. O. and Udeh S. N., (2015). Environmental Sustainability and Job Creation – A Critical Symbiosis for Growth in Nigeria. International Journal of Innovative Environmental Studies Research 3(4):1-12

Oyake-Ombis, L., van Vliet B. J., and Mol A. P., (2015). Managing plastic waste in East Africa: Niche innovations in plastic production and solid waste. Habitat International, 2015. 48(0): p. 188-197.

Royer S. J., Ferron S., Wilson S. T., Karl D. M., (2018), Production of methane and ethylene from plastic in the environment. PLoS ONE 13(8): e0200574. https://doi.org/10.1371/journal.pone.0200574

Statistica (2018). Production of plastics worldwide from 1950 to 2017 (in million metric tons). Global plastic production. https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/

Thevenon, F. and Oliver, J. (2014). Plastic Pollution. Submerge. International Union for Conservation of Nature(IUCN) Global marine and Polar Programme (GMPP).

Ugoamadi, C. C, &Ihesiulor, O. K., (2011). Optimisation of the Development of a Plastic Recycling Machine, Nigerian Journal of Technology, 30(3): pp. 67-81.

UNEP (2011a). United Nations Environment Programme: Converting Waste Plastics into a Resource. http://www.unep.or.jp/

UNEP (2011b). Waste – Investing in Resource and Energy Efficiency, Towards a Green Economy, www.unep.org/greeneconomy/Portals/88/documents/ger/GER_8_Waste.pdf

UNEP (2018). Single-Use Plastics: A Roadmap for Sustainability. ISBN: 978-92-807-3705-9. DTI/2179/JP

Uwaegbulam C., Nwannekanma B. and Gbonegun V., (2018). Producers' responsibility and plastic pollution crisis, Environment. The Guardian Nigeria News.

Verma, R., Vinoda, K. S., Papireddy, M. and Gowda, A.N.S.,(2016). Toxic Pollutants from Plastic Waste- A Review. Procedia Environmental Sciences. 35. 701-708. 10.1016/j.proenv.2016.07.069.

Wong, S. L., Ngadi, N., Abdullah, T. A. T., Inuwa, I. M., 2015. Current state and future prospects of plastic waste as source of fuel: a review. Renew. Sustain. Energy Rev. 50, 1167e1180.

REMEDIATION OF CRUDE OIL POLLUTED SOIL USING POULTRY MANURE

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Abstract

One major problem arising from increased activities in the petroleum industry in Nigeria and many other nations is the leakage or spillage of oil into aquatic and terrestrial environments. An experiment was carried out to investigate the efficacy of the application of poultry manure to ameliorate the phytotoxic effects of crude oil on soil and cowpeas growth. The following materials were used; soil sample, poultry manure, crude oil, plastic pots, and hand trowel for the study under two experimental conditions. The first involved increasing rates of poultry manure from 10 kg to 20 kg to 10ml crude oil and the second involved increasing the levels of crude oil application from 5ml to 20ml while the poultry manure amendment remained at 20kg per pot, and the experiment was monitored for 120 days. It was observed that increasing the crude oil concentration from 0, 10, 15 and 20 kg/pot, regardless of the poultry manure level depressed cowpea growth variables: leaf, stem and root biomass. While increasing rates of poultry manure from 5, 10, 15 and 20ml crude oil also depressed plant growth variables of leaf, stem and root biomass Crude oil was phytotoxic to cowpea because of declining values of number of leaves, height and leaf area at increasing rates of application. Soil treated with 10ml crude oil and amended with 20kg poultry manure produced healthier plants, therefore bioremediation with poultry manure at a certain level with respect to the level of pollution will reduce the effect of crude oil on soil. One major problem arising from increased activities in the petroleum industry in Nigeria and many other nations is the leakage or spillage of oil into aquatic and terrestrial environments. An experiment was carried out to investigate the efficacy of the application of poultry manure to ameliorate the phytotoxic effects of crude oil on soil and cowpeas growth. The following materials were used; soil sample, poultry manure, crude oil, plastic pots, and hand trowel for the study under two experimental conditions. The first involved increasing rates of poultry manure from 10 kg to 20 kg to 10ml crude oil and the second involved increasing the levels of crude oil application from 5ml to 20ml while the poultry manure amendment remained at 20kg per pot, and the experiment was monitored for 120 days. It was observed that increasing the crude oil concentration from 0, 10, 15 and 20 kg/pot, regardless of the poultry manure level depressed cowpea growth variables: leaf, stem and root biomass at 0, 10, 15 and 20 kg; 0.41±0.0251, 1.05±0.0012, 1.17±0.3910, and 1.34±0.1921were recorded respectively; for stem, 0.54±0.0341, 0.75±0.0136, 1.24±0.0045, and 1.77±0.0183were recorded respectively; for root, 0.43±0.1032, 0.49 ± 0.0031, 0.57±0.0002, and 0.69±0.0821 kg were recorded respectively. In experiment (II), while increasing rates of poultry manure from 5, 10, 15 and 20ml crude oil also depressed plant growth variables of leaf, stem and root biomass for leaves, at 5, 10, 15 and 20ml crude oil, 0.11±0.0137, 0.82±0.2194, 0.67±0.8321, and 0.43±0.6102 were recorded respectively; for stem, 0.41±0.0037, 1.90±0.0084, 1.41±0.0028, and1.27±0.0028 were recorded respectively; for roots, 0.20±0.0276, 0.93±0.0281, 0.74±0.0198, and 0.31±0.1022were recorded respectively. Crude oil was phytotoxic to cowpea because of declining values of number of leaves, height and leaf area growth, evident in height ranging from 12.58±0.00219- 6.17±0.0319cm; and in number of leaves ranging from 9.01±0.0218 - 4.88±0.0132; and in leaf area ranging from 26.15±0.0134 -12.84±0.1034for experiment (I). And for experiment (II), the height ranged from 10.22±0.1040-3.08±0.0032cm; number of leaves from 9.23±0.0021 -2.18±0.0231; and the leaf area, ranging from 25.24±0.0031-10.05±0.0001. Soil treated with 10ml crude oil and amended with 20kg poultry manure produced healthier plants, therefore bioremediation with poultry manure at a certain level with respect to the level of pollution will reduce the effect of crude oil on soil. With greater resistance to the effect of crude oil since plants grew luxuriously with wettable green and broad leaves and strong stem.

***Keyword**: Crude oil, Soil, Poultry manure, Pollution.*

INTRODUCTION

The sources of oil spillage into the environment include accidental oil well blow out, loading of oil tank, tank washing, activities of ocean going vessels, port and harbour runoff from pipeline leaks and road tankers accidents. In Nigeria, activities of saboteurs who destroy or burst pipe and flow lines of crude oil have increased the intensity and frequency of crude oil contamination of the environment. Between 1976 and 1980 alone, it was estimated that about 56.1 millions of crude oil entered the aquatic and terrestrial ecosystems in Nigeria (Nwankwo and Ifeadi, 1983), with majority of them during the 1976-1986 periods occurring more as a result of accidental discharges caused by equipment failure such as malfunctioning, age, overloading, corrosion or abrasion of parts (Nwankwo and Ifeadi 1986).

Pollution is defined as the release of substances or energy into the environment by man in quantities that damage either his health or resources (Edwards, 1972). FEPA (1991) defined pollution as a man- made or man aided alteration of chemical, physical or biological quality of the environment beyond acceptable limits, while Nwankwo and Irechukwu (1983) defined it as the addition to any segment of the environment, any material that has detrimental effects on the ecosystem. Pollution can therefore generally be defined as the undesirable change in the physical, chemical or biological characteristics of the air, land and water, which can harmfully affect human life and desirable plant species, industrial processes, living conditions and cultural assets (NAS 1975).

Oil spills destroy farmlands and have significant effects on plant growth, and therefore detrimental in agricultural production. Although, crude oil and its products are vital to living, when they are spilled into the environment, they create serious environmental, economic, and social disaster (Schwendinger, 1968). For this reason, environmental pollution from oil spillage has become a topic of popular concern worldwide and the major pathway of crude oil unto the environment is spillage.

Crude oil pollution has been known to cause a lot of diseases in humans by attacking major organs in the human system which range from the central nervous system to the skeletal system, and even the hair due to the presence of heavy metals which was ingested either directly or which invariably got into the human system by bioaccumulation (Nwilo, *et al.*, 2001).

Crude oil, described as the world's treasure (NEST, 1991), is a vital resource, which sustains and promotes economic growth of many nations. In Nigeria, oil has been reported by Adeyeye *et al.,* (1993) as the life wire of the Nigerian economy. It is produced in the Southern States, which are located in the Niger Delta. They include: Bayelsa, Delta, Edo, Imo, Rivers, Akwa Ibom and Ondo State. Crude oil and its refined products (gasoline, kerosene, lubricating oil, etc) have also been confirmed by Nwilo, (1998) to account for over 90% of Nigeria's national income.

Table 1: Chemical characteristics of some crude oils

Components (weight %)	Prudhoe Bay	South Louisiana	Kuwait	Nigeria
Sulphur	0.94	0.25	2.44	<1
Oxygen	0.23	0.69	0.14	1.89
Nitrogen	10	2.2	7.7	1.29
Nickel	20	1.9	18	1.89-0.40
Vanadium	23.2	18.6	22.7	<0.147
Naphtha	12.5	8.8	16.2	-
Parafin	7.4	7.7	4.1	-
Naphthenes	3.2	2.1	2.4	-
Aromatics	76.8	2.1	2.4	-
boilingfraction (<205ºc)				
Saturated	14.4	56.3	34.0	-
Aromatics	25.0	18.5	21.9	-
Polar materials	2.9	8.4	19.9	-
Insoluble	1.2	0.2	2.5	-

These analyses represent values for one typical crude oil from three distinct geographical regions.
Source: Clark and Brown, (1977).

When crude oil spills on soil, its condition could become unsatisfactory for plant growth (De Jong, 1980),because of insufficient aeration due to a decreased air- filled pore space (Rowell, 1977) and ensuing increased demand for oxygen caused by oil decomposing micro-organisms (Gudin and Syratt, 1975) which limits normal diffusion processes. It could also become unsuitable due to a reduction in the level of available plant nutrients or a rise to a toxic level of elements such as manganese, Udo and Fayemi (1975) reported that soil saturated with natural gas could cause severe physical and chemical changes. Soil aggregates become broken down and the soil frequently appears to be laminated or layered. Water would not penetrate such soils from above but could enter easily from the sides. Isirimah *et al.,* (1989) observed decrease in available nitrogen in the soil with increase in oil pollution. They attributed this to immobilization resulting from the use of carbon materials as an energy source by microbes resulting in an increase in nitrogen demand and thus a decrease in available nitrogen in the soil. Similarly, Isirimah *et al.*, (1989) reported an increase in available phosphorus level, as oil level increased to 2 % after which there was a decrease. Schwendiger, (1968) observed that symptoms of oil pollution of soil were typical of extreme nutrient deficiency in plants. Nutrient deficiency symptoms could be indirectly proportional to water uptake, and as such plant damage was most probably due to a derangement of the plant- water relations of the roots within the soil. Odu, (1989) reported that crude oil pollution up to 1 % could easily be degraded by natural rehabilitation in soils as the oil could be expected to increase organic matter in the soil, which improves the fertility, physical and chemical properties of the soil. It therefore becomes necessary to decontaminate soils polluted with crude oil. Various soil treatments have been used in bioremediation strategies to hasten the process.

Bioremediation/phytoremediation appears to be receiving greater emphasis due to the fact the technique do not leave any negative effect on the soil.

In managing soils that have been contaminated by crude oil, a number of methods have been proposed and adopted. They include soil aeration, bioremediation, and phytoremediation. Out of these methods, bioremediation and phytoremediation methods are widely accepted. Bioremediation of crude oil contaminated soils involves increasing the number of microorganisms in polluted soils by adding mineral nutrient and oxygen, which stimulates the growth of the organisms. Phytoremediation (phyto means plant) on the other hand is a generic term for the group of technologies that use plants for remediating soils, sludges, sediments and water contaminated with organic and inorganic contaminants. Thus, phytoremediation can be defined as the efficient use of plants to remove, detoxify or immobilize environmental contaminants in a growth matrix (soil, water or sediments) through the natural, biological, chemical or physical activities and processes of the plants(Dana, 2014). Plants are unique organisms with remarkable metabolic and absorption capabilities, as well as transport system that can take up nutrients or contaminants selectively from the growth matrix, soil or water. Phytoremediation involves growing plants in a contaminated matrix, for a required growth period, to remove contaminants from the matrix, or facilitate immobilization (binding containment) or degradation (detoxification) of the pollutants. The plants can be subsequently harvested, processed and disposed.

Bioremediation uses living organisms to clean up contaminated soil or water. Despite its broad definition, bioremediation usually refers specifically to the use of microorganisms. Bioremediation is a combination of two words bio-, short for biological, and remediation, which means to remedy.
Soil is a natural body of mineral and organic matter that can change or has changed over a period due to impact of climate and living organisms, with three dimensional entities of length, breadth and depth. Soil is a living entity which literally can die if mismanaged. It is the key component of natural ecosystem because environmental sustainability depends largely on a sustainable soil ecosystem (Adedokun and Ataga, 2007). The soil is a dynamic layer in which many chemical, physical and biological activities are going on constantly. Through time, it has become adjusted to prevailing conditions of climate and plant cover and may change internally when prevailing conditions change (Ademoroti, 1996). There are two types of soil viz; organic and mineral soil.

In agriculture communities, often a year's supply of food can be destroyed instantaneously leading to scarcity or shortage of food and other agricultural produce and because of the careless nature of oil operations, the environment is growing increasingly uninhabitable. People in the affected areas complain about health issues including breathing problems and skin lesions, may have lost basic human rights such as health, safety, access to food, clean water (Baird, 2010 and Fuggle, 2004). Examples include the Minimata disease which cripples, derange, deforms and kills in 1953 which afflicted the residents of Minimata, a small fishing village at Minimata in Japan due to ingestion of methyl mercury a chemical form of mercury. Another effect is the inhalation and ingestion of lead which affects the central and peripheral nervous systems. A most popular effect is the inhalation of cadmium by farmers in Japan which caused the itai-itai disease which results in softening of the bone, body shrinking and eventual painful death of the patient.

A major and most recent effect of oil pollution in Nigeria is the unrest in the Niger-Delta region which is due to their inability to produce agricultural products and poisoning the terrestrial organisms and has resulted in militants kidnapping and killings. The use of bioremediation as a supplemental cleanup strategy for crude oil polluted soil has proven to be a good example of the problems and successes associated with the practical application of the strategy (Table 1). The main aim of this study is to investigate the effects of the addition of poultry manure in ameliorating the performance of crude oil degraded sandy clay loam soil. The specific or short term objectives include: to determine the effect of crude oil contamination at various levels on soil hydro-physico-chemical properties; to evaluate the remediation potential of poultry manure on polluted soil; and to establish the appropriate dosage of manure for optimum remediation by evaluation with *Vigna unguiculata.* The long term objective is to augment the native fertility status of soil to enhance the rate of oil biodegradation, minimize contamination of scarce ground water sources and improve soil and crop production.

MATERIALS AND METHODS

Collection and Treatment of Materials

Thirty sampling plots were marked behind the school of management technology of the Federal University of Technology, Akure. From each plot, four random points were marked and soil samples were collected from them in the top soil (0-20cm depth) using a hand trowel. The samples from the 4 four points were then bulked together and thereafter, the samples collected from all the 30 sampling plots were bulked to form a composite which is the representative of the entire area under study. The collected composite soil samples were then divided (3 kg each) into 32 plastic pots while some part of the samples were transferred to the laboratory, air dried, sieved through a 2mm mesh and analysed to characterise the physico-chemical properties of the soil.

Bonny (Nigeria) light crude oil type was sourced from the NNPC, Warri refinery and used for the experiment.

The Poultry dung was collected from the Teaching and Research Farm Obakekere, FUTA with the aid of soil auger. Samples for microbiological analysis were collected in sterile screw-capped bottles. Analysis commenced immediately upon arrival in the laboratory. Unused samples were refrigerated at 4 ^{0}C.

Experimental Set Up

The pot experiment (consisting of 32 pots) was conducted in a screen house situated behind the School of Science building, The Federal University of Technology, Akure. The soil samples in their plastic pots were watered to saturation and left to drain naturally for two days. The samples were then treated with crude oil to their experimental designed levels. The crude oil polluted soils were subsequently amended with poultry manure at varying level after one week of oil treatment, and allowed to decompose for another four weeks before planting the cowpea seeds.

Experimental Set-up Phase 1

This experiment consists of 16 pots. The prepared soils (3 kg) in the planting pots were treated with 10 ml crude oil, except for the untreated pots that served as experimental control. All pots were amended with 0-20 kg poultry manure one week after oil treatment. Then, four seeds were planted per pot four weeks after initial treatment of the soil with oil, and thinned to two at two weeks after planting (WAP). In this experiment, the crude oil was kept constant while poultry manure was varied. This is to test for the effect of poultry manure on the plant growth.

The design was a randomized complete block, replicated four times. Plant height and leaf area were measured. All measurements were carried out on a weekly basis.

One week after planting, the stem height, leaf area and number of leaves of the germinating cowpea was measured on a weekly basis for the duration of this experiment.

Experimental Set-Up *Phase 2*

This experiment consists of 16 pots. Soil samples were prepared and treated with crude oil and poultry manure as in experiment 1, but at different application rates. The oil level was increased beyond 10 ml level of experiment 1, to include 15 ml and 20 ml except for the check which has the lowest concentration of 5 ml. The poultry manure rate however remained at optimum 20 kg (which was kept constant throughout this experiment). Four cowpea seeds were planted per pot at the 4^{th} week after initial oil treatment and thinned to two per pot after two weeks. The experimental design and measurement of physical parameters were the same as in experiment set-up in phase 1.

This experimental set up is made up of two additional treatments incorporated to act as double control or check (Amadi, 1992). First, soil was not treated with oil and not amended with poultry manure. Second, soil was treated with 5ml oil but un-amended with poultry manure. The objective was to compare the significance of oil treatment and nutrient supplementation on the recovery of soil and growth of cowpea.

RESULTS AND DISCUSSION

Table 2: Physico-Chemical properties of Original Soil, Poultry manure and Crude Oil samples

Parametres	Soil sample	Poultry manure	Crude oil sample
pH	6.60	7.20	4.46+0.00
OC%	1.30	14.80	97.05±0.01
OM%	2.24		-
N%	0.17	2.20	0.10±0.00
P%	23.75	2.95	0.06±0.00
K^+C mol/kg	0.39	2.04	0.17±0.01
Na^+C mol/kg	0.20	1.88	0.07±0.00
Ca^{2+}C mol/kg	1.90	3.27	0.11±0.01
Mg^{2+}C mol/kg	1.40	1.05	0.09±0.01
CECCmol/kg	5.43	2.72	0.44
C/N	6.76	9	970.5
Moisture%	42.34		
WHC%	34.64		
Porosity	41.21		
Sand%	53		
Clay%	31		
Silt%	16		
Textural class	Sandy clay loam		

Results are mean ± standard Deviation of the triplicate samples

OC=Organic Carbon, CEC= Cations Exchange Capacity, WHC= Water Holding Capacity

OM= Organic Matter, C/N= Carbon to Nitrogen Ratio

The physical and chemical properties of the original soil was carried out before the commencement of the experiment (Table 2), and this showed the soil to be slightly acidic (pH 6.60) which is optimum for many plant species particularly more acid tolerant species. The soil is moderate in phosphorus with value of 23.75 mg/kg. Also, potassium was seen to be 0.39 mol/kg which is also adequate for most plant growth. The soil magnesium content (1.40 mol/kg) was also adequate for plant growth because its value falls between 0.42-4.17mol/kg as reported by Amacher et.al. (2007)The same goes for percentage organic carbon (1.30 %) which also falls between values of 1-5 to be moderately adequate for plant growth as reported by Amacher et.al. (2007). The same goes for nitrogen (0.17 %), and calcium (1.90 mol/kg). The soil has particle size composition of 53 % sand, 31% clay, and 16 % Silt, thus the textural class is sandy clay loam. It also has water holding capacity of 34.64 %, porosity of 41.21 % and moisture content of 42.34 %.

Table 3: Effects of Poultry manure on Physico-Chemical properties of Crude oil polluted soil in Experimental set-up phase 1 (4WAP)

Parameters	10 kg of poultry manure and 10 ml of crude oil	15 kg of poultry manure and 10 ml of crude oil	20 kg of poultry manure and 10 ml of crude oil	0 g of poultry manure and 0 ml of crude oil
pH	$7.14^{d} \pm 0.09$	$7.22^{c} \pm 0.09$	$7.25^{b} \pm 0.07$	$6.61^{e} \pm 0.19$
OC%	$4.56^{d} \pm 0.01$	$4.71^{c} \pm 0.04$	$5.43^{a} \pm 0.01$	$1.29^{h} \pm 0.02$
OM%	$7.48^{f} \pm 0.01$	$8.12^{c} \pm 0.01$	$9.35^{a} \pm 0.01$	$2.24^{h} \pm 0.02$
N%	$0.58^{cd} \pm 0.01$	$0.59^{bc} \pm 0.04$	$0.68^{a} \pm 0.05$	$0.17^{g} \pm 0.02$
P%	$30.91^{d} \pm 0.07$	$33.44^{c} \pm 0.02$	$39.65^{a} \pm 0.11$	$23.75^{h} \pm 0.10$
K^{+}(Cmol/kg)	$0.390^{a} \pm 02$	$0.40^{a} \pm 0.04$	$0.45^{a} \pm 0.02$	$0.38^{a} \pm 0.03$
Na^{+}(Cmol/kg)	$0.62^{c} \pm 0.01$	$0.69^{b} \pm 0.02$	$0.77^{a} \pm 0.02$	$0.21^{g} \pm 0.02$
Ca^{2+}Cmol/kg	$3.81^{c} \pm 0.01$	$4.30^{b} \pm 0.02$	$5.30^{a} \pm 0.02$	$1.90^{h} \pm 0.02$
Mg^{2+}Cmol/kg	$1.99^{d} \pm 0.02$	$1.99^{d} \pm 0.01$	$3.69^{a} \pm 0.03$	$1.40^{f} \pm 0.02$

Note: Mean with the same superscript alphabets in a column are not significantly different at 5% level of probability.

Table 3 shows the result of the test carried out four weeks after the pollution of the soil samples showing a slight increase in pH depending on the various intensities of pollutant. The range was between 6.61±0.20 –7.14±0.09 with the highest value of pH for soil polluted with 20 ml crude oil and amended with 20kg poultry manure while the lowest pH value was for the control soil. An increase in organic carbon was observed four weeks after pollution / amendment, with highest value recorded at the highest concentration of crude oil and poultry manure. This is in agreement with Ogboghodo *et al.*, (2004). The organic matter content follows the same trend as the organic carbon with significant increase at one month after pollution. Also, an increase was observed in calcium and magnesium level of soil both at four weeks after pollution. The phosphorus content increased significantly.A decrease in the potassium content of the control experiment was observed at 0.38±0.03 compared to 0.39 of the original soil.An increase in both nitrogen and potassium was observed after pollution and this may be attributed to microbial mineralization of the poultry manure and the dead cells of microorganisms killed by crude oil concentration. It may also be as a result of fixation of atmospheric nitrogen by microorganisms and the nitrogen fixation ability of cowpea, which was assimilated by the hydrocarbons (Udo and Fayemi, 1975).

Table 4: Effects of Crude Oil on Physico-Chemical Properties of Poultry Manure Amended Soil Experiment Set-Up Phase 2 (4WAP)

Parameters	0 kg of poultry manure and 5 ml of crude oil	20 kg of poultry manure and 10 ml of crude oil	20 kg of poultry manure and 15 ml of crude oil	20 kg of poultry manure and 20 ml of crude oil
pH	$6.09^{f} \pm 0.33$	$7.22^{c} \pm 0.39$	$7.26^{b} \pm 0.78$	$7.29^{a} \pm 0.74$
OC%	$2.31^{g} \pm 0.05$	$4.35^{f} \pm 0.01$	$4.43^{e} \pm 0.03$	$4.79^{b} \pm 0.02$
OM%	$3.99^{g} \pm 0.01$	$7.50^{e} \pm 0.51$	$7.64^{d} \pm 0.01$	$8.26^{b} \pm 0.02$
N%	$0.29^{f} \pm 0.01$	$0.55^{e} \pm 0.03$	$0.57^{d} \pm 0.04$	$0.60^{b} \pm 0.02$
P%	$24.09^{g} \pm 0.03$	$27.30^{f} \pm 0.03$	$30.31^{e} \pm 0.02$	$35.78^{b} \pm 0.02$
K^{+}(Cmol/kg)	$0.28^{c} \pm 0.01$	$0.35^{b} \pm 0.01$	$0.40^{a} \pm 0.02$	$0.40^{a} \pm 0.01$
Na^{+}(Cmol/kg)	$0.29^{f} \pm 0.01$	$0.54^{e} \pm 0.02$	$0.57^{d} \pm 0.01$	$0.57^{d} \pm 0.02$
Ca^{2+}Cmol/kg	$2.40^{g} \pm 0.01$	$3.12^{f} \pm 0.04$	$3.30^{e} \pm 0.02$	$3.50^{d} \pm 0.02$
Mg^{2+}Cmol/kg	$1.69^{e} \pm 0.01$	$2.00^{d} \pm 0.02$	$2.10^{c} \pm 0.02$	$3.53^{b} \pm 0.02$

Mean with the same superscript alphabets in a column are not significantly different at 5% level of probability.

The test carried out four weeks after the pollution of the soil samples showed that there was a slight increase in pH depending on the various intensities of pollutant (Table 4). The range was between 6.09±0.34 –7.14±0.09 with the highest value of pH for soil polluted with 20ml crude oil and amended with 20 kg poultry manure while the lowest pH value was for soil polluted with 5ml crude oil only (Table 2.3). An increase in organic carbon was observed four weeks after pollution/amendment, with highest value recorded at the highest concentration of crude oil and poultry manure Table 4.7. This is in agreement with Ogboghodo *et al.*, (2004). The organic matter content follows the same trend as the organic carbon with significant increase at one month after pollution. Also, an increase was observed in calcium and magnesium level of soil both at four weeks after pollution. The phosphorus content increased significantly. A decrease in the potassium content of the control experiment was observed at 0.28±0.01 compared to 0.39 of the original soil.An increase in both nitrogen and potassium was observed after pollution and this may be attributed to microbial mineralization of the poultry manure and the dead cells of microorganisms killed by crude oil concentration. It may also be as a result of fixation of atmospheric nitrogen by microorganisms and the nitrogen fixation ability of cowpea, which was assimilated by the hydrocarbons (Udo and Fayemi, 1975).

Table 5: Effects of Poultry manure on Physico-Chemical properties of Crude oil polluted soil in Experiment Set-Up Phase 1 (16WAP)

Parameters	10 kg of poultry manure and 10 ml of crude oil	15 kg of poultry manure and 10 ml of crude oil	20 kg of poultry manure and 10 ml of crude oil	0 kg of poultry manure and 0 ml of crude oil
pH	5.74 ^{a} ±0.01	5.78 ^{a} ±0.00	5.84 ^{a} ±0.00	5.79 ^{a} ±0.00
OC%	0.21 ^{c} ±0.01	0.24 ^{c} ±0.00	0.26 ^{c} ±0.00	0.20 ^{c} ±0.00
OM%	0.36 ^{c} ±0.01	0.41 ^{c} ±0.00	0.45 ^{c} ±0.00	0.34 ^{c} ±0.00
N%	0.22 ^{d} ±0.02	0.28 ^{d} ±0.01	0.30 ^{c} ±0.01	0.14 ^{e} ±0.01
P%	26.90 ^{c} ±0.10	29.20 ^{b} ±0.13	29.70 ^{a} ±0.12	16.90 ^{h} ±0.11
K^+(Cmol/kg)	0.22 ^{c} ±0.02	0.28 ^{b} ±0.00	0.37 ^{a} ±0.01	0.20 ^{d} ±0.01
Na^+(Cmol/kg)	0.50 ^{c} ±0.89	0.66 ^{b} ±0.01	0.71 ^{a} ±0.00	0.14 ^{e} ±0.02
Ca^{2+}Cmol/kg	3.00 ^{c} ±0.10	3.90 ^{b} ±0.21	4.10 ^{a} ±0.30	1.10 ^{g} ±0.20
Mg^{2+}Cmol/kg	2.10 ^{c} ±0.11	2.30 ^{b} ±0.13	2.90 ^{a} ±0.10	0.90 ^{f} ±0.11
THC (%)	1.09 ^{ab} ±0.10	1.06 ^{ab} ±0.38	1.04 ^{ab} ±0.91	1.13 ^{a} ±0.23

Mean with the same superscript alphabets in a column are not significantly different at 5% level of probability.

For the samples analysed 16 weeks after planting (16 WAP), a decrease in pH value was observed at all intensities of pollution with the highest value (5.84±0.00) at highest concentration of crude oil and poultry manure (20 ml crude oil and 20kg poultry manure) and the lowest value of pH at 5 ml crude oil only. The pH value in the control experiment was similarly observed to have reduced to 5.79±0.00 from 6.60 before planting cowpea in it. This is possibly due to the plants taking up some nutrient of the soil. The difference in pH at various intensities of pollution which ranged from 5.84±0.00 – 5.79±0.00 at the end of the experiment.

The organic matter content follows the same trend as the organic carbon. This is possibly due to the fact that most of the carbon may be going into microbial cells development, which is assimilated by the hydrocarbons (Schwendinger, 1968) rather than the soil (carbon immobilization by soil organisms). Also, an increase was observed in calcium and magnesium level of soil four months after pollution except for the control experiment where the magnesium content reduced after four months of pollution / planting, which was 0.90±0.11 compared to 1.40 (Table 5) of the original soil. The phosphorus content increased significantly both at four weeks and 16 weeks after pollution. Also, potassium content follows the same trend as phosphorus. The eventual decrease of nitrogen and potassium content at four months after planting may be due to the uptake by plants.

Table 6: Effects of Crude oil on Physico-Chemical properties of Poultry manure amended soil Experimental Set-Up 11 (16 WAP)

Parameters	0 kg of poultry manure and 5 ml of crude oil	20 kg of poultry manure and10ml of crude oil	20 kg of poultry manure and15ml of crude oil	20 kg of poultry manure and20ml of crude oil
pH	$5.84^{a} \pm 0.29$	$6.04^{a} \pm 0.19$	$6.18^{a} \pm 0.18$	$6.21^{a} \pm 0.93$
OC%	$0.21^{c} \pm 0.01$	$0.92^{b} \pm 0.02$	$1.22^{a} \pm 0.08$	$1.29^{a} \pm 0.19$
OM%	$0.36^{c} \pm 0.00$	$1.68^{b} \pm 0.00$	$2.10^{a} \pm 0.15$	$2.22^{a} \pm 0.12$
N%	$0.20^{bc} \pm 0.00$	$0.34^{b} \pm 0.00$	$0.39^{a} \pm 0.01$	$0.40^{a} \pm 0.00$
P%	$20.14^{g} \pm 0.10$	$20.81^{f} \pm 0.82$	$20.90^{e} \pm 0.20$	$21.60^{d} \pm 0.32$
K^{+}(Cmol/kg)	$0.10^{c} \pm 0.00$	$0.30^{b} \pm 0.02$	$0.30^{b} \pm 0.00$	$0.34^{a} \pm 0.01$
Na^{+}(Cmol/kg)	$0.24^{d} \pm 0.01$	$0.50^{c} \pm 0.02$	$0.52^{c} \pm 0.10$	$0.52^{c} \pm 0.03$
Ca^{2+}Cmol/kg	$2.00^{f} \pm 0.82$	$2.50^{e} \pm 0.29$	$2.90^{d} \pm 0.30$	$2.90^{d} \pm 0.31$
Mg^{2+}Cmol/kg	$1.50^{e} \pm 0.49$	$2.00^{d} \pm 0.30$	$2.00^{d} \pm 0.10$	$2.00^{d} \pm 0.22$
THC (%)	$0.84^{b} \pm 0.09$	$0.13^{c} \pm 0.01$	$0.08^{c} \pm 0.00$	$0.01^{c} \pm 0.00$

Mean with the same superscript alphabets in a column are not significantly different at 5% level of probability.

For the samples analysed 16 weeks after planting (16WAP), a decrease in pH value was observed at all intensities of pollution with the highest value (6.21±0.9310) at highest concentration of crude oil and poultry manure (20ml crude oil and 20kg poultry manure) and the lowest value of pH at 5 ml crude oil only. The pH value in the control experiment was similarly observed to have reduced to 5.84±0.30 from 6.60 before it was planted with cowpea. This is possibly due to the plants taking up some nutrient of the soil. The difference in pH at various intensities of pollution which ranged from 5.84±0.30-6.21±0.93 at the end of the experiment (Table 6). A significant decrease in the organic carbon content was recorded even in the control experiment. The organic matter content follows the same trend as the organic carbon. This is possibly due to the fact that most of the carbon may be going into microbial cells development, which is assimilated by the hydrocarbons (Schwendinger, 1968) rather than the soil (carbon immobilization by soil organisms). Also, an increase was observed in calcium and magnesium level of soil four months after pollution except for the control experiment where the magnesium content reduced after four months of pollution / planting. The phosphorus content increased significantly. Also, potassium content follows the same trend as phosphorus except for the treatment at 5 ml crude oil concentration which recorded the lowest values of phosphorus and potassium. The eventual decrease of nitrogen and potassium content at four months after planting may be due to the uptake by plants.

Table 7: Heavy metal concentration (ppm) in polluted soil (16WAP)

Treatment with; Crude oil	P/manure	Pb	Cu	Mn	Fe	Cr	Ni	Co	Vn	Zn
-	-	0.09^{c} ±0.02	4.01^{c} ±0.16	2.20^{a} ±0.16	1.30^{d} ±0.18	0.04^{a} ±0.02	0.03^{a} ±0.01	0.04^{a} ±0.01	0.02^{b} ±0.01	7.24^{dc} ±0.08
10ml	10kg	1.50^{a} 0.02	5.10^{a} ±0.16	3.00^{b} ±0.08	2.71^{c} ±0.16	1.00^{c} ±0.02	0.06^{a} ±0.01	0.13^{a} ±0.00	0.03^{b} ±0.02	10.92^{a} ±0.01
10ml	15kg	1.00^{b} ±0.02	4.90^{b} ±0.00	3.00^{b} ±0.00	1.80^{d} ±0.08	0.08^{a} ±0.02	0.04^{a} ±0.01	0.11^{a} ±0.00	0.03^{b} ±0.02	9.21^{d} ±0.01
10ml	20kg	1.00^{b} ±0.02	4.60^{b} ±0.08	2.80^{b} ±0.16	1.60^{d} ±0.23	0.06^{a} ±0.02	0.03^{a} ±0.00	0.08^{a} ±0.02	0.01^{b} ±0.00	8.21^{dc} ±0.16

Mean with the same superscript alphabets in a column are not significantly different at 5% level of probability

From Table 7, a gradual increase in heavy metal concentration in soil polluted with crude oil suggests that heavy metals are present in crude oil and their concentration in soil depend on intensities of pollution and amendment, since there was a steady decrease in intensity of heavy metals in the experiment where the effect of poultry manure amendment was investigated. This is in agreement with the report of Khan and Frankland (1983) that heavy metals like vanadium and nickel are present in crude oil.Despite uptake of heavy metals by plants, their low residues in soils were still higher than the soil natural background level i.e. the control.

Table 8: Heavy metal concentration (ppm) in amended soil (16WAP) in Experimental Set-Up Phase 2

Treatment with; Crude oil	P/manure	Pb	Cu	Mn	Fe	Cr	Ni	Co	Vn	Zn
5ml	-	2.80^{a} ±0.02	5.10^{a} ±0.18	3.80^{c} ±0.18	4.00^{b} ±0.18	0.12^{ab} ±0.02	0.08^{b} ±0.02	0.16^{b} ±0.01	0.04^{b} ±0.02	9.28^{c} ±0.02
10ml	20kg	1.08^{b} ±0.02	4.20^{b} ±0.82	2.30^{a} ±0.08	3.40^{a} ±0.16	0.16^{b} ±0.0231	0.08^{b} ±0.01	0.16^{b} ±0.00	0.05^{b} ±0.00	9.00^{c} ±0.02
15ml	20kg	1.09^{b} ±0.02	4.50^{b} ±0.08	2.60^{a} ±0.08	3.60^{a} ±0.08	0.16^{b} ±0.01	0.09^{b} ±0.02	0.18^{b} ±0.01	0.07^{a} ±0.00	9.60^{c} ±0.02
20ml	20kg	1.10^{b} ±0.00	4.60^{b} ±0.08	2.90^{b} ±0.08	3.90^{b} ±0.18	0.17^{b} ±0.02	0.09^{b} ±0.02	0.19^{b} ±0.02	0.08^{a} ±0.02	10.10^{b} ±0.16

Mean with the same superscript alphabets in a column are not significantly different at 5% level of probability

In Table 8, a gradual increase in heavy metal concentration in soil polluted with crude oil suggests that heavy metals are present in crude oil and their concentration in soil depend on intensities of pollution and amendment, since there was a steady increase in intensity of heavy metals in the experiment where the effect of crude oil pollution was investigated. This is in agreement with the report of Khan and Frankland (1983) that heavy metals like vanadium and nickel are present in crude oil.Despite uptake of heavy metals by plants, their low residues in soils were still higher than the soil natural background level i.e. the control.

In general, metals tend to accumulate in the clay fraction of the soil because clay-sized particles have a large number of ionic binding sites due to a higher amount of surface area. Similarly, metals can be tightly bound to the organic matter of the soil, which was found to be high (2.24). These result in the immobilization of heavy metals making them unavailable to plants (Odu, 1981) and responsible for the amount of heavy metal residue present in the soil.In this experiment, an increase was observed when the heavy metal residues remaining in the soils were compared with the initial concentration of heavy metals present following crude oil application (Tables 6 and 7). This may be due to the sandy-clay-loam nature of the soil. Some of the heavy metals might also be incorporated into the bodies of other organisms exploiting the habitat (e.g. earthworm). Comparing the above result i.e. (Tables 6 and 7) with the target and intervention values for some metals for a standard soil of the department of petroleum resources (DPR), in Table (8), it can be seen that copper content in the soil is above the target value but is still below the intervention value of DPR. The other metals are below the DPR intervention values.

Table 8: Target and intervention values for some metals for a standard soil

Metals	Target values (ppm)	Intervention values (ppm)
Nickel	35.0	210
Copper	36.0	190
Zinc	140.0	72
Cadmium	0.8	17
Lead	85.00	530
Arsenic	200.00	625.00
Chromium	20.00	240.00
Mercury	85.00	530.00

Source: Department of Petroleum Resources (DPR, 1991) target and intervention values for metals in soil.

CONCLUSION

Surface application of crude oil to soil causes significant changes in the soil properties such as soil microbial population, soil heavy metal content, air space as well as nutrients. The amendment with poultry manure helped in the improvement of soil characteristics.

REFERENCES

Adedokun O.M., Ataga A.E. (2007). Effects of amendments and bioaugmentation of soil polluted with crude oil, automotive gasoline oil, and spent engine oil on the growth of cowpea (Vigna ungiculata L. Walp). Sci. Res. Essay, 2: 147-149.

Adegeye A.O., Ayodele, L.A and Ufifo, L.A. (1993). Effects of oil exploration on the forest and wildlife resources in Delta State of Nigeria. Foresters Association of Nigeria Proceedings, Ikeja Lagos, pp 45-52

Ademoroti, C.M.A. (1996). Environmental Chemistry and Toxicology, Foludex press ltd. Ibadan, 215

Amacher M.C., O Neil K.P., Perry C.H. (2007). Soil vital signs: a new soil quality index (SQI) for assessing forest soil health, Res Pap. RMRS-RP-65WWW. Fort Collings, CO: U.S. Dept Agric Forest Service, Rocky Mountain Res Station.pp 12.

Amadi, A.(1992) A double control approach to assessing the effect of remediation of pre-planting oil pollution on maize growth. Delta Agric. J. Nigeria 1 (1);

Baird. J., (2010). Oils shame in Africa . Newsweek, 156 (4). 27-27.

Dana, 2014: Dana A.M. (2014). Phytoremediation as an alternative method to remove lead and cadmium from waste water using some aquatic plants. European Int. Jour. Of Sc. And Tech; 3 (4) 4

Edwards, R.W. (1972). Pollution . Oxford University press Oxford. P.204.

Fuggle, R.F., (2004). Africa Environment outlook. Lake Victoria: A case study of complex inter relationships United Nations Environment programme pp:75-85.

Gudin C, Syratt W.J.,(1975). Biological Aspects of land rehabilitation following hydrocarbon contamination. Environmental pollution 1975; 8:107-112

Isirimah N.O, Zoufa, K; Longanathan P. (1989). Effects of crude oil on maize performance and soil chemical properties in the humid forest zone of Nigeria. Discovery and innovation. 1:95-98.

Khan D.H.;Frankland. 13.(1983). Effects of cadmium and lead on radish plants with particular reference to movement of metals through soil profile and plant. Plant and soil 70: 335-345. [A-83-22-11-1200].

NAS (1975). National Academy of Science. Under-exploited tropical plants with promising economic value, Washington DC. 37-44.

Nwankwo, J.N. and C.N. Ifeadi (1986): The petroleum Industry and the Nigerian Environment In: Proceedings of an International Seminar on "The Status of Oil spill contingency planning in Nigeria" sponsor by NNPC and the Federal Ministry of Works and Housing, Lagos, Nigeria.

Nwankwo, J.N. and Ifeadi, C.N. (1983). The status of oil spill contingency planning in Nigeria. In: The petroleum industry and the Environment. Proceedings of 1983 International seminar NNPC. 93-105.

Nwankwo, J.N. and Irrechukwu, D.O. (1983). Problems of environmental pollution and control in Nigerian petroleum industry. In: proceedings of international seminar on the petroleum industry and Nigerian Environment. NNPC. 102-107

Nwilo P.C. and Badejo O.T. (2001). Management of Oil spill Dispersal Alon the Nigerian Coastal Areas, Department of surveying and Geoinformatics. Faculty of Engineering, University of Lagos, Akoka- Lagos, Nigeria.

Odu, C.T.I., Nwoboshi, L.C., Fagado, S.O. & Awani, P.E. (1989): Post-impact study of SPDCS Nun River 8" delivery line oil spillage. Final report. SPDC, Nig., 95

Ogboghodo, I., Erebor, E., Osemwota, I. & Isitekale, H. (2004): The effects of application of poultry manure to crude oil polluted soils on maize growth and soil properties.- Environmental Monitoring and Assesment 96: 153-161.

Schwendinger, R.B. (1968). Reclamation of soil contaminated with oil. *J. Institute of petroleum Resources, 54: 182-197.*

Udo E.J. and A.A. Fayemi, (1975). Effect of oil pollution of soil on germination, growth and nutrient uptake of corn. *J. Environ. Qual; 4:537-540.*

CHALLENGES AND PROSPECTS OF NEW CLIMATIC REGIMES (ENVIRONMENT BOUNDARIES) FOR AGRICULTURE AND FOOD SECURITY: CASE OF CACAO AND SORGHUM IN THE RAINFOREST ZONE OF NIGERIA

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Abstract

The changing climatic regimes, variability and extremity of weather events manifest as variability in rainfall pattern, high frequencies and intensities of drought/dry spells, shortened length of growing season, extended dry season duration, elevated temperatures, atmospheric dryness and disease and pest pressures. Thus the climatic regimes set new environmental boundaries with implications for agriculture, water resources, food and nutrition security, livelihoods and economic growth. The area suitable for agriculture, seasonal shifts in growing seasons and yield potentials are expected to be affected by new environment boundaries in the humid tropics. However, in the frame of these changes is the increasing need for food to meet population growth. Thus, it is expedient to enhance understanding of the effects and the suitability of the new environmental boundaries for crops to attain productivity increases, and improved food and nutrition security and livelihoods in the tropics.Agrotechnological packages have to be developed and adopted to ameliorate the weather and soil related constraints (rapid nutrient depletion and degradation of soil physical and chemical properties) especially along ecological transect from forest-savanna transition and southern guinea savanna agroecologies of Nigeria.In the nursery and on the field, poor and inadequate growth and establishment of seedlings of permanent crops, cacao in particular, results in sub-optimal plant population, poor establishment, growth, development and yields. On the field during the terminal drought situation of the dry season, cacao (young and fruiting trees) which are seldom irrigated undergo severe hydrothermal stresses with consequences on shoot dieback (death of twigs/ branches), massive leaf senescence, tree death (mortality) and poor yields. Sorghum is a staple food and commodity crop with relevance to food and nutrition security, raw materials for food and pharmaceutical industries, foreign exchange earnings and economic growth. It is thus important to harness opportunities offered by the changing climate and environment boundaries and extend the frontier of crops to varying agroecologies (soil and climate of Nigeria). The need to direct research efforts to develop and adopt improved agrotechnologies and adaptable sorghum varieties to the forest forest-savanna transition and derived savanna agroecologies and new locations which hitherto not suitable for its production cannot be over-stressed

Keywords: *Climatice regimes, food security, Cocoa.*

INTRODUCTION

Global environment change (GEC) is characterized by increasing frequencies and intensities of droughts and dry spells, high temperatures, increased water resource scarcity, high soil and atmospheric aridity, land degradation (soil erosion and fertility depletion), increased insect pests and disease pressures in addition to the rapid decline in quantity and quality of land and accelerated nutrient depletion (IPCC, 2013).The GEC results in climate change and extremes and variability of weather events, this has established new environmental boundaries and created new climatic regimes along the ecological transect of wet to dry forest and savanna (Agele *et al.,* 2016b). However, there is increasing need for improved crop productivity and expand cultivation of crops to meet increasing demand for food by the growing population. Required is enhanced understanding of the values or fitness of the new environmental conditions/and boundaries for cultivation of crops.

Cacao is an important fruit tree species of the humid tropics of Africa (including Nigeria), Indonesia and Malaysia and Central and South America. Cacao is a perennial crop with semi-deciduous growth habit, deep tap root system and over 3-4m height. In Nigeria, cacao cultivation is concentrated in the rainforest agroecological zone characterized by bimodal rainfall pattern between 7 to 8 months duration, and 3 to 4 months of dry season characterized by low humidity, temperatures over 32 ^{o}C and clear skies. In the dry season, cacao trees are characterized by shoot dieback in the crown (patchwork fashion branch and twig dieback) leaves turn yellow and death of branches (branch not flush new leaves next season) under the episodes of the soil and air moisture deficits and high temperatures (Agele *et al.,* 2016a; Famuwagun *et al.,* 2017). In cacao, off-season flowering is known to reduce subsequent season's fruit production. Since fruit trees in plantation are seldom irrigated, they undergo soil and air moisture deficit and high temperature stresses during the dry season, leading to massive leaf senescence, branch die-back and extensive off-season flowering with detrimental consequences on fruit yield subsequent year. The soil and air moisture deficit and high temperature stresses of the dry season may govern cacao phenology (leaf and twig die back syndrome and flowering/fruiting characters),and physiological functions. The environmental stresses constituted by the variability of the seasonal weather conditions (wet-dry transitions) would implicate adjustment of physiological functions in order to maintain physiological integrity and productivity.

Seedlings of fruit tree species are transplanted to fields where they are subjected to increasing intensities of soil and air droughts and extreme soil and air temperatures of the growing seasons. Their survival of these stresses would determine the success of field establishment. The stresses need to be attenuated for enhanced survival and vigour of growth using improved agrotechnical practice (Zuidema *et al.,* 2005; Famuwagun *et al.,* 2017). Drought-induced tree mortality is an important but poorly understood process that leads to major uncertainties regarding the impacts of climate change on biodiversity, ecological communities, and the terrestrial carbon cycle. Worldwide, forest mortality which is often linked to severe drought and temperature has been documented, and tree mortality events are expected to increase with climate change in the future. Even in moist and wet tropical forests, tree mortality associated with drought occurs (McDowell, 2011).Within ecosystems, species may respond differently to drought and high temperature stresses during the growing seasons thus making it difficult to predict how environmental (climate) changes will affect ecosystem and plant distribution.

Sorghum is a staple food as well as a commodity crop, it has huge potential relevant for solving the current development challenge in Nigeria. It is becoming increasing important to examine the suitability of forest-savanna transition and southern guinea savanna zones of Nigeria for long season sorghum production to address the development challenge in Nigeria. There is need for the expansion of crops e.g. sorghum cultivation to agroecologies of Nigeria, for food security, industrial and economic development. The opportunities offered by the changing climate to harness crop potentials via extension of its frontier to forest forest-savanna transition and derived savanna agroecologies of Nigeria has to be explored/harnessed (Jagadish *et al.,* 2016; Agele & Ajao, 2018).

The relevance of examining the suitability of forest-savanna transition and southern guinea savanna zones of Nigeria for long season sorghum production so as to address the development challenge in Nigeria. In order to maintain or increase annual sorghum production in Nigeria, due to the negative impact of climate change in the agroecologies where it has been previously grown, it is expedient to give thoughtful consideration to adapting varieties of sorghum to marginal agroecologies and new locations which are not suitable for its production (Akinseye *et al.*, 2015). The need to direct research efforts to develop and adopt improved/adaptable sorghum varieties to marginal agroecologies and new locations which hitherto not suitable for its production. Also, the highly variable sowing dates, due in part to erratic onset of the rainy season, present an important challenge since grain maturity needs to occur at a more fixed calendar date to coincide with the end of the rainy period for successful grain filling and pest avoidance.

Climate Change (temperature and rainfall) scenarios for the deciduous and evergreen rainforest zones of West Africa including Nigeria have been variously constructed using process-based methods that rely on the General Circulation Models (GCM) in conjunction with Simple Climate Models (SCM) (Akinseye et al., 2016). The results have indicated projected decline in mean annual rainfall values in the semi deciduous forest zone by -2.8, -10.9 and -18.6%and the in the evergreen rainforest forest zone, mean annual rainfall will also decline by -3.1, -12.1 and -20.2% in year 2020, 2050 and 2080 respectively. These projected climatic changes will exacerbate soil moisture conditions during the dry season (November to March) and aggravate the vulnerability of crops to adverse climatic conditions *(Agele et al.,* 2016). Understanding the effects of the new environmental boundaries occasioned by the new regimes of rainfall and temperature and seasonal shifts on agriculture, water resources and food security merit concerted research efforts.

The area suitable for agriculture, the length of growing seasons and yield potentials, are expected to change due to climate change. Climate change impacts is known to have started creating major shifts in area of production and productivity of crops in most parts of the world especially in the Sub-Saharan Africa region. In order to maintain or increase crop production, efforts have to be directed at ameliorating the negative impact of climate change in the agroecologies where these crops have been previously grown, and to improve adaptability of crop varieties to marginal climate and soils (IPCC, 2013). Concerted efforts will have to be geared towards building strategies for adaptation and resilience and development of agrotechnical and production guidelines for climate-stress proofing in the circumstances of the changing environment conditions.

MATERIALS AND METHODS

The experiments were conducted at the Cacao Fields of the Department of Crop, Soil and Pest Management in the Teaching and Research Farm of the University. Young and fruiting cacao trees were randomly sampled and tagged from the field spanning the rainy season (April – November) and dry season (November – April). Treatments were 3 x 3 factorial arrangements of shade (open sun/unshaded, moderate and dense shades) and irrigation (1, 0.7 and 0.4 EPanin the dry season (December to April) and laid out in a split plot design in three replicates per treatment. The cacao trees (active fruiting trees 4 to 5 years old trees) were originally planted under shade consisting of varying population/stand densities of plantain. In the present study, the shade regimes were categorized based on solar radiation integrals (incidence and transmitted radiation and photosynthetically active radiation: PAR) above and below cacao canopies. Measurements were made on microclimatic gradients (relative humidity, air temperatures and solar radiation integrals (light intensity above and below cacao canopy, PAR interception and distribution).Cacao leaf development (canopy dynamics : leaf senescence pattern, leaf area index: LAI), flowering and pod yield characteristics during the dry season and subsequently in the rainy (optimal) season were measured. Branch-die back and tree death (mortality events) syndrome, flushes of new leaves and growth recovery after terminal drought of the dry season were also monitored. Solar radiation integrals (light intensity above and below cacao canopy, PAR interception and distribution) and LAI were measured using Canopy Analyzer System. In another study, seedlings of *Theobroma* genotypes (Amelonado, Trinitario (F3 Amazon) and improved hybrids (PA 150/34 and PA 150/36series) collected from CRIN Ibadan, Nigeria, were subjected to wet-dry cycles in the nursery via application of progressive drought and wet-dry cycles (watering regimes) in phases to simulate either well watered /hydration conditions, dry down/single drought phase and multiple and intermittent wet-dry cycle. At termination of the wet-dry cycles in the nursery, seedlings were planted out on the field following treatment schemes adopted in the nursery. Observations and measurements were made on growth and physiological attributes of cacao species following procedures and methods adopted in the nursery. The cacao plants were randomly sampled and tagged from the field for phenology and physiological measurements spanning the rainy season (April – November) and dry season (November – April).Data collected were; plant growth and development variables spanning the rainy season (April – November) and dry season (November – April)on plant height (cm), stem girth (mm), number of leaves, and number of branches, number of dead seedlings and number of seedlings bearing dead twigs/branches and final survival count at end of the dry season.

The third study was based on adaptation and yield potentials of five local and improved varieties of sorghum (Bida local, Improved Deko, CSR-01, SK 5912 and 121 CKSV-180) were sown at 5 sowing dates (5th and 16th July, 3rd and 17th August and 5th September). The seeds were obtained from ICRISAT, Kano Station, Nigeria. The sorghum varieties were sown at 75 by 30 cm spacing in a 5 by 4 m plot. Seeds were sown at 3-4 per hole and later thinned to 2 plants per hill at 2 weeks after planting (WAP). Data were collected using destructive and non-destructive measurements for number and leaf area per plant, days to 50% flowering, plant height, number of hills per plot at harvest, number of stands per plot at harvest, stover, panicle and grain weight per plant. Data obtained on soil properties and the measured traits the sorghum varieties were subjected to single factor analysis of variance (ANOVA) while the significant means were separated with using the Tukey's Honest Significant Difference (HSD) test at $P < 0.05$.

RESULTS AND DISCUSSION

Weather conditions within cacao fields

The seasonal weather pattern within cacao is presented in Table 1. The rainy (early and late) season (April to July and August to November) and the dry season (December to March) are characterized by higher air temperatures and lower relative humidity compared with the dry season (Table 1). On the average, the rainy seasons had relative humidity average of 71 %) and air temperature of 32.8 ^{o}C compared with the dry season (December to March). Also, higher air temperature and VPD and lower relative humidity were found for the 4 to 6 years old field compared with the 1 year old. The accumulated heat units (growing degree days: GDD) were higher for the 1 year old compared with 4 – 6 years old trees.

Table 1. Seasonal weather conditions in cacao field

Cacao age	PAR (*µmol/m^2/s)*			LAI			RH (%)			VPD (kPa)			Temp (^{o}C)			GDD (^{0}C.d^{-1})		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1 –2 years old field	587	745	987	1.6	2.3	1.4	74	71	36	1.6	1.3	2.9	32	30.4	34	2417	2325	2475
4 –6 years old field	471	669	921	1.8	2.6	1.8	77	80	39	1.5	1.1	2.4	31	28.5	31.6	2337	2178	2423
Agric. Field	828	1123	1464	1.1	1.4	0.85	65	70	31	1.8	1.5	3.2	33	31.7	34.2	2479	2446	2507

Major (a) and Minor (b) rainy season and dry (c) season, relative humidity (RH), temperature (T) and vapour pressure deficit (VPD),
photosynthetically active radiation (PAR: µmol/m^2/s), leaf area index (LAI),

Effects of treatments on tree survival and branch-die back.

The effects of shade treatments on the tree mortality, branch and twig die-back between the onset and end of the dry seasons (2016 to 2017) showed that percentage dead branches and twigs differed significantly among the treatments (Figures 1 and 2). The shade-irrigation combination affected tree mortality, branch and twig die-back between the onset and end of the dry seasons. There were significant differences in percentage of dead trees and trees bearing dead branches and twigs among treatments, the non-irrigated shaded and unshaded (open sun) treatments had significantly higher whole plant mortality and branch die back compared with the irrigated plots (open sun and shaded) (figure).The continuous growth during the rainy season was assisted by the dry season irrigation across the treatment may explained the non-significance of most of the measured growth, flowering and pod yield variables of cacao. The results showed that percentage dead branches and twigs did not differ significantly between irrigation intervals (Figure 1 and 2).

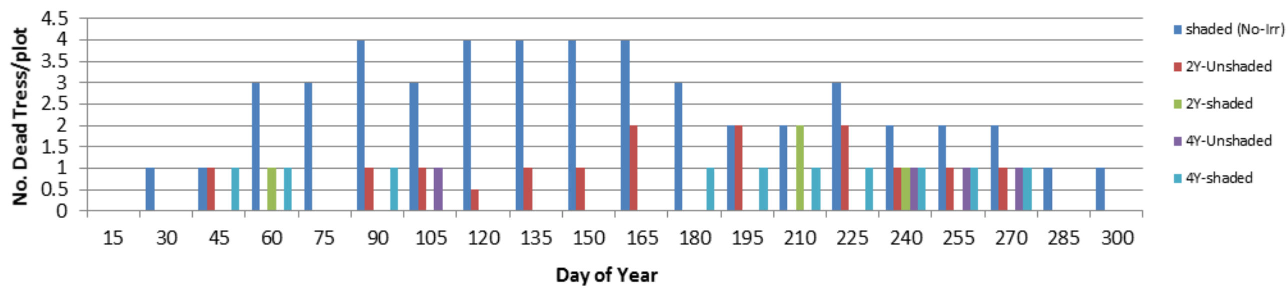

Figure 1. Time course of number of dead trees of unshaded) and shaded cacao as affected by irrigation

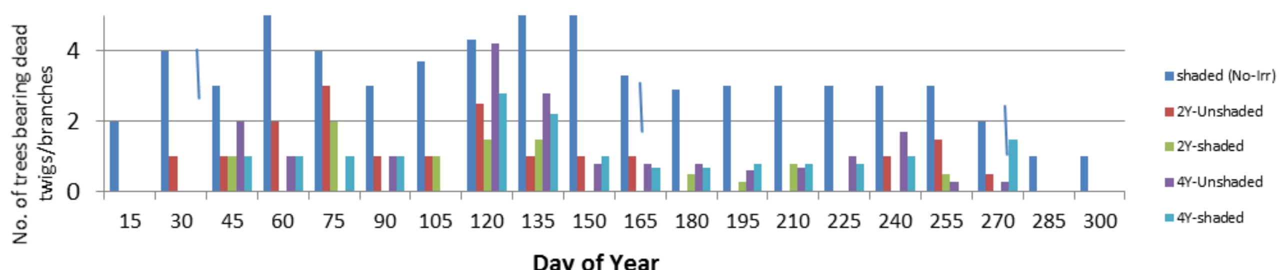

Figure 2. Time course of number of trees with dead branches/twigs for 4-6 years old cacao trees

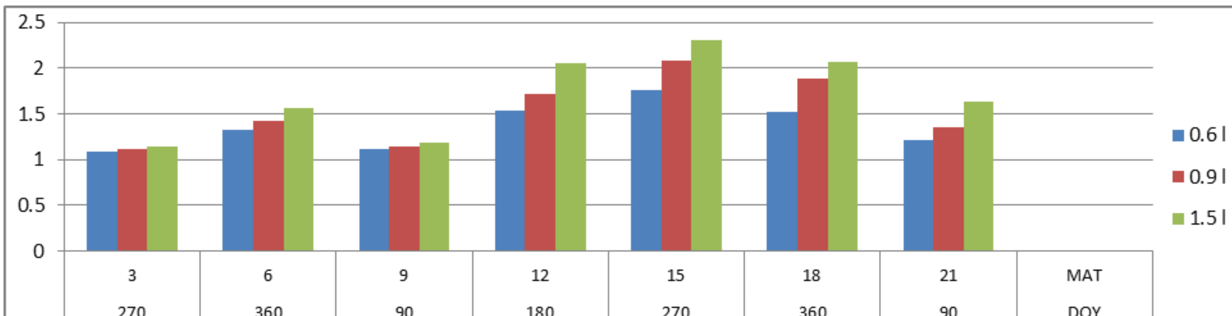

Figure 3. Time course of LAI for the differentailly watetered cacao seedlings

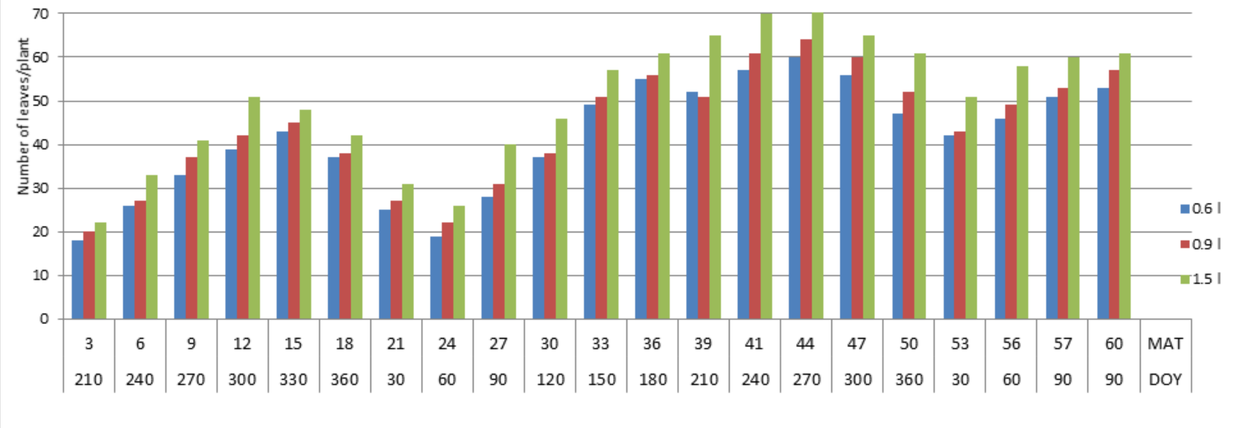

Figure 4. Time course of leaf development among diffrentailly watered seedlins

There were significant increases in branch and leaf development (LAI) for the unshaded (open sun) cacao compared to the shaded (Table 2).

Table 2. Consumptive water use (Evapotranspiration) components for rainfed crops in Akure, rainforest zone of Nigeria (After Agele et al., 2011)

Months	P	S	R	D	ETa	ETo	Eo	ETa/Eo	SE	Tr	SE/ETa	P/ETo	Drought index
Sept	127.0	-14.6	3.1	0.2	131.6	122.5	121.0	1.14	60.9	80.7	4.3	9.0	0.10
Oct	97.1	-12.3	1.4	-0.1	109.8	131.3	142.1	0.76	53.6	55.7	4.9	8.9	0.16
Nov	51.0	-10.3	--	-0.1	78.5	157.2	151.3	0.41	42.4	36.1	5.4	6.5	0.50
Dec	1.3	-9.4	--	-0.1	30.7	143.8	160.2	0.19	18.4	12.3	6.0	4.2	0.79
Jan	0	-7.8	--	-0.1	15.7	118.3	133.3	0.12	11.6	7.4	7.3	--	0.87

The no-shaded (open sun) treatment produced tree with larger canopies (LAI) compared to shaded. The course of leaf development varied among measurement dates (from 270 to 90 day of year: DOY) especially with 3 and 21 months after transplanting (MAT) (Figure 3). In particular, within measurement periods, lowest LAI was obtained at DOY 90 (February of a year) and highest between 180 and 360 DOY (between June and December of a year). However, leaf development increased with age of seedlings on the field (3 to 21 MAT) (Figure 3). The time course of the number of leaves/plant for the different measurement dates (30 to 360; through the year, 270 to 360; September to December, and 30-90 DOY; January to March) showed variations in number of leaves/plant (Figure). Lowest number of leaves per plant were found for period between 360 – 90 DOY and highest between 150- 270 DOY (the dry and rainy season periods respectively. Increases in leaf development commenced after onset of rain (90 to 240 DOY; March to August of a year) and sharp decreases (massive leaf drop) during the dry season (360 to 90 DOY).The effect of differential watering in the nursery was pronounced on seedling mortality on the field especially in the dry season (360 -90 DOY, December to March of a year) (Figure 4). The lowest number of dead trees per treatment was obtained for the 1.5l watered seedlings in the nursery and highest for 0.6 l watering regime Increases in the number of trees bearing dead twigs/branches were observed during the dry season (360-90 DOY, December to March of a year) and lowest between 120 to 300 DOY (Figure 9). The highest number of dead trees per treatment was obtained for the 0.6l watered seedlings in the nursery and lowest for 1.5l watering regime. The moderate to severe water stressed seedlings in the nursery had higher mortality and branch and twig die-back during the dry season, while percentage of dead trees and branches/twigs were lower for the seedlings raised under well watered conditions in the nursery (Figures 5 and 6).

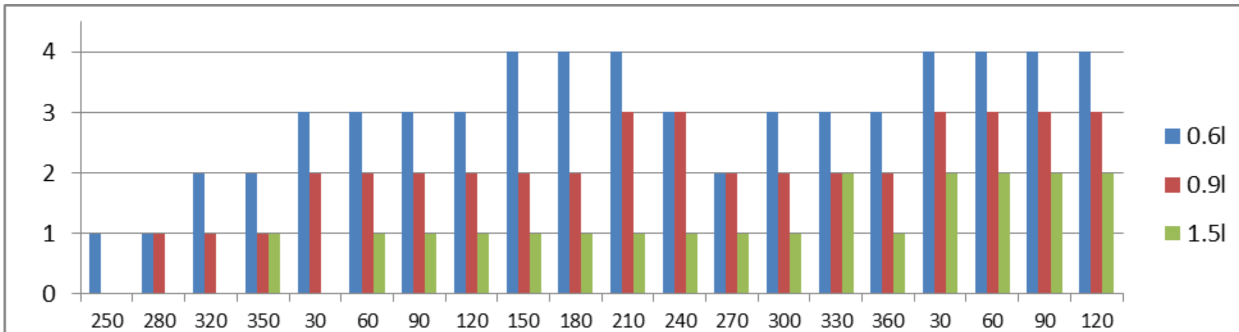

Figure 5. Number of dead teees per treatment plot for diffrentailly watered seedlings

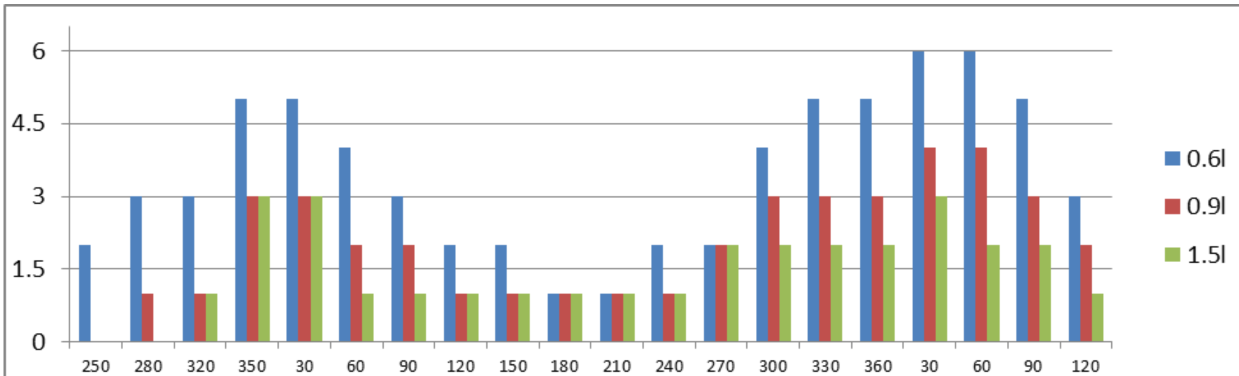

Figure 6. treatmemnt effects on the number of trees per plot bearing dead twigs in cacao seedlings

Differences were obtained in cacao vigour of growth between shaded and open sun (unshaded), irrigated and non-irrigated plots. The treatments produced gradients in the microclimate within cacao field, with modified microclimatic conditions under the shaded plants. Irrigation in the dry season at 5- and 10-days intervals also alleviated soil moisture deficit and high temperature constraints to cacao growth and yield for shaded plants and especially for the open sun treatment. Shading (and irrigation) conferred the benefit of soil moisture replenishment and conservation (through reduced evaporation water loss). The benefit of shade was optimized by irrigation enhanced replenishment of soil moisture and reduced evaporation. For both open sun and shaded plants that were irrigated had enhanced vigour (branching and leaf area development) and reduced mortality of whole trees and branch and twig die back syndrome of the dry season. The significance effects of irrigation may be attributed to more frequent and large have replenishment and hence their separate effects on cacao performance observed in this study. The shade-irrigation treatments enhanced soil moisture (Famuwagun *et al.,* 2016). The shaded but not irrigated condition would have increased evapotranspiration and moisture loss from the soil and leaf surface and consequently, the shoot (branch and twig) die-back and wilting (Daymond *et al*., 2013, Famuwagun *et al.*, 2016). Differences were obtained in field vigour of growth among the differentially watered cacao seedlings in the nursery. The treatments produced gradients in the microclimate within cacao field, with modified microclimatic conditions. The weather conditions of the dry season enhanced soil and air moisture deficit and temperatures which constraint cacao growth. Compared with water stressed seedlings in the nursery, the well watered plants had enhanced vigour (branching and leaf are development) and lower mortality of whole trees and branch and twig die back syndrome of the dry season. The dry season had enhanced evapotranspiration (moisture loss from the soil and leaf surface)and consequently, the shoot (branch and twig) die-back and wilting (Daymond *et al*., 2013, Agele *et al.,* 2017). These results were supported by Zuidema *et al*. (2005) and Agele *et al.* (2017) that moisture is the principal requirement for crop survival during the dry season to supplement soil moisture loss due to transpiration, evaporation and diminishing soil water enhanced by the dry and hot air. The low status of soil moisture and high air and soil temperatures and sunlight intensity conditions appeared to have depressed cacao development in term of number of leaves and canopy extent (LAI). The findings were consistent with that of Daymond *et al.* (2013) that leaf and stem development in cacao will continue throughout the year if a conducive environment is provided in term of moisture, light and nutrients.

Consumptive water use (Evapotranspiration) components forrainfed crops in Akure, rainforest zone of Nigeria (After Agele et al., 2011)

The estimated soil water evaporation (SE) showed that the mean SE was 37 mm. day^{-1}which constituted 5.6 % of ETa for the rainfed crops (Table 4), seasonal rainfall amount represented 57% of ETa while the remainder was deployed to meet SE and change in soil moisture reserve/storage. The magnitude of SE was high which implies high moisture losses to the atmosphere which was not used for crop production. The various ratios of SE/ETa and ETa/Eo (relative wáter use) indicate high intensity of soil moisture déficit stress which increased as these as on progressed from wet (September), moist (October-November), dry (December) to very dry (January) of a year

Growth and yield of sorghum

Grain yield and above-ground biomass differed significantly among the cultivars and across sowing dates (Table 6). The results show that the grain yield and AGB decrease with the delayed sowing date for most cultivars except for CSM63E, Pablo and SK5912 were The heaviest biomass, LAI and tallest plants were observed for Bida local and SK5915 (the log gestation culivars compared with the medium intermediate (CSR-01) and intermediate (improved Deko). Largest grain yields were found for CSR-01, SK 5912, followed by Deko and lowest for Bidaloca and short maturity group 121 CKSV. The results showed that the number of grains per panicle is an important component in achieving high grain yield in sorghum, and this also depends on the time of sowing. It implies that the optimum grain weight per panicle and number of grain per panicle may be achieved in the month of late July and early August planting dates which also serves as the most suitable planting month for sorghum in the study area (a humid, rainforest zone of south west Nigeria. The early (July and August) sowing dates accumulated highest rainfall amount and had averagely 120 days (102 LGS of 120 days) while the later sowing dates (late August and early September) had lower rainfall amounts, in particular, the early September sowing date had shortest LGS (116 days). The intensity of drought stress increased as sowing dates were delayed, in addition to decline in relative water use (ETa/Eo) which further indicated increasing intensity of hydrothermal stresses. This situation negatively affected growth and yield of sorghum in the study area. However, across sowing dates, medium maturity cultivar (CSR-01) had highest seed yields although, heaviest biomass were accumulated by late maturing cultivars (Bida Local and SK 5912) whose anthesis, seed formation and grain filling fell into the periods of high intensity of soil and air moisture deficits and high soil and air temperatures. The early maturing cultivars (improved Deko and 121 CKSV-180) had medium growth and yield performance across sowing dates.

CONCLUSION

The need to ameliorate soil and air moisture deficits and high temperatures (extremity of weather conditions) during the dry season is highlighted by this study to ensured continuous growth and development throughout the dry season. It is imperative to expand the scope of factoring climate variability and change impacts through modelling for enhancing crop productivity in the Sub-Saharan African agriculture. Thus, the estimated early, optimum and lates owing dates during the season would guide and enhance the preparedness of the farmers ahead of each season and also increase their understanding on the inter-annual variability of the rainy season. The estimated mean LGS suggests growing of early maturity cultivars for agroecological zones and both early and medium and late maturity (4 months) cultivars for the zones while the length of growing season (LGS) indicates the adequacy of rainfall and hence soil moisture availability to meet crop water demand. Findings would enhance precision and effectiveness of decision making on sowing, and strengthen the breeders of crop species and varieties to be selected for each location across the ecological zones and for breeders to identify varieties that are more resilient to elevated mean temperatures. The findings would also be a useful input in the development of weather-responsive cropmanagementpackagesand guidelines fortheregion of study.

REFERENCES

Agele S.O, Iremiren G.O, Aiyelari O.P, Famuwagun I.B. 2016a. Mainstreaming adaptation, resilience and disaster risk reduction into extension of frontiers of cacao to marginal soils and climate of the humid tropics in the wake of climate and weather variabilities. ***11th Annual International Symposium on Environment,*** Athens, Greece. Athens Institute for Education and Research*www.atiner.gr*

Agele, S. Famuwagun, B. &Ogunleye, A. 2016b. Effects of shade on microclimate, canopy characteristics and light integrals in dry season field-grown cocoa (*Theobroma cacao* L.) seedlings. *Journal of Horticulture 11 (1); 47 – 56*

Agele, S.O., Iremiren, G.O. &Ojeniyi, S.O. 2011. Evapotranspiration, wáter use efficiency and yield of rainfed and irrigatedtomato in thedryseason in a humidrainforestzone of Nigeria. *International Journal of Biology&AgriculturalSciences* 13, 469-476

Akinseye, 2015. Factoring climate variability and change into crop models for enhancing Sorghum performance in the West African Semi-Arid Tropics (PhD Thesis, Feb.,2015) http://www.wascal.org/publications/doctoral-theses/
Akinseye, 2015. Factoring climate variability and change into crop models for enhancing Sorghum performance in the West African Semi-Arid Tropics (PhD Thesis, Feb.,2015) http://www.wascal.org/publications/doctoral-theses/
Akinseye, F.M, M. Adam, M.P. Hoffmann, P.C.S Traore, S.O Agele, and A.M. Whitbread 2016. Assessing crop model improvements through comparison of sorghum (sorghum bicolor L. moench) simulation models: a case study for West African cultivars. Field Crop Research, Vol. 201:19-31 http://dx.doi.org/10.1016/j.fcr.2016.10.015
Akinseye, F.M, M. Adam, M.P. Hoffmann, P.C.S Traore, S.O Agele, and A.M. Whitbread 2016. Assessing crop model improvements through comparison of sorghum (sorghum bicolor L. moench) simulation models: a case study for West African cultivars. Field Crop Research, Vol. 201:19-31 http://dx.doi.org/10.1016/j.fcr.2016.10.015
Famuwagun, Babadele; Agele, Samuel &Aiyelari, Peter 2017. Shade effects o**n g**rowth and developme**nt** of cacao following 2 years of co**ntinuous** dry season irrigation. (Int J. Fruit Sci, Taylor & Francis.

Gebrekiros G, Araya A and Yemane T, (2016). Modeling Impact of Climate Change and Variability on Sorghum Production in Southern Zone of Tigray, Ethiopia. J Earth SciClim Change, Vol.7:1

Grossi,M.C,FlávioJustino,Rafael de Ávila Rodrigues,CamiloLelis Teixeira Andrade,2015.Sensitivity of the sorghum yield to individual changes in climate parameters: modelling based approach Agrometeorology /Article,Bragantia, Campinas, v. 74, n. 3, p.341-349,

Hammer GL and Muchow RC. 1994. Assessing climatic risk to sorghum production in water-limited subtropical environments. I. Development and testing of a simulation model. Field Crops Research 36, 221–234.

Hammer GL, Carberry PS, Muchow RC. 1993. Modelling genotypic and environmental control of leaf area dynamics in grain sorghum. I. Whole plant level. Field Crops Research 33, 293–310.

Hammer GL, Vanderlip RL, Gibson G, Wade LJ, HenzellRG,Younger DR, Warren J, Dale AB. 1989. Genotype-by-environment interaction in grain sorghum. II. Effects of temperature andphotoperiod on ontogeny. Crop Science 29, 376–384.

Intergovernmental Panel on Climate Change (IPCC). 2013. Climate Change: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the IPCC. Cambridge University Press, Cambridge, UK.

Jagadish, S.V. Bahuguna, R.N. Djanaguiraman, M. Gamuyao, R. Prasad, P.V. and Craufurd, P.Q. 2016. Implications of High Temperature and Elevated CO_2 on Flowering Time in Plants.Frontiers in Plant Science 16; 7: 913.

Peng,S. Huang, J. Sheehy, J.E. Laza, R.C. Visperas, R.M. Zhong, X. Centeno, G.S. Khush, G.S. and Cassman, K.G.2016. Rice yields decline with higher night temperature from global warming. PNAS 101 (27); 9971–9975.doi_10.1073_pnas.0403720101.

Zuidema, P.A., Leffelaar, P.A., Gerritsma, W., Mommer, L., Anten, N.P.R., 2005. A physiological production model for cocoa (Theobroma cacao): model presentation, validation and application. Agric. Syst. 84, 195–225.

CLIMATE CHANGE AND AQUATIC FOOD PRODUCTION IN NIGERIA: AN ECONOMETRIC ANALYSIS

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Abstract
This work examined the effect of climate change on aquatic food production in Nigeria from 1970 to 2015.The Autoregressive Distributed Lags (ARDL) methodology was applied to secondary data. Results reveal that aquatic food output, price and policy variables were I(1)while the climatic variables were I(0). Bounds testing established a cointegrating equation (F=3.82, K=7 p<0.025) .ARD results show that change in price and policy variables, in general, showed promises for aquatic food production in the short run. Furthermore, apart from the 3 year lag level of rainfall, climatic factors also generally favoured aquatic food production in the short run. Long run elasticities estimates of the explanatory variables were insignificant. This is, in the long run, climate change does not affect production, implying probable presence of effective adaptation capacities by aquatic lives and/or producers. The Error Correction Term indicates that about 28% correction of any disequilibrium in aquatic food production is achieved within a year. Investments in loans and technology will help producers expand the ventures to take advantage of the positive influence of climate change. Also, investments in meteorological surveys will help mitigate the 3 year lag negative impact of rainfall and optimize the opportunities the earlier lags present.

Keywords: *Climate, Change, Aquatic, food, Output*

INTRODUCTION
Fish protein represents about 25 percent of the total animal protein consumed by the world's population, second only to beef. Over 950 million people take fish as their primary source of protein (USAID, undated). The awareness of the need for adequate protein in human diet has greatly increased in many developing regions of the world and fish has been widely acknowledged as a rich source of dietary protein (Ajayi, 2001), however, protein intake in developing countries like Nigeria is below the required 75g per person per day (FAO, 2007). This has been attributed to low level of production (Amire, 2010). Factors influencing level of agricultural production in developing countries include among others, the fact that it is weather dependent.

African agriculture is weather dependent (Asrat and simane, 2018) and is predicted to be negatively impacted by climate change (Mousa and Amodou, 2006; Jain, 2006). But climate change is not necessarily generally negative. The net effects of climate change are mixed and location specific **(**Tripathi and Mishra, 2017; Asrat and Simane, 2018). Climate change has both direct and indirect impacts on aquatic live stocks (Zierovogel *et al.,* 2004; Brander, 2007). To fisheries, climate change has direct effects through reduced precipitation and greater evaporation, water quality while the indirect effects alter vegetation patterns that may alter the food chain (FAO, 2008). Other climate related driven factors include temperature, salinity, wind, oxygen, P^H and density structure of the water column. According to Brander (2007), climate change threats to aquaculture arise from stress due to increased temperature, oxygen demand, decreased P^H, increased frequency of diseases and toxic events. Changes in ocean temperature and wind patterns can alter fish migration patterns, spawning sites and the availability of stock for commercial fishing.

Since the impact of climate change can also be mixed, location and species specific, it is necessary for each agricultural species within their respective locations to be studied differently as regards how they are affected by climate change. Although works by Igbokwe and Mkpalo (2011); Okoroh (2010); Onumadu (2010); and Zierovogel*et al.*, (2004) have been carried out on the impact of climate change on agricultural commodities, there is dearth of empirical literature on the impact of climate change on Nigerian aquatic food production. This study seeks to analyse the impact of climate change on aquatic food production in Nigeria. In doing this, it will provide the long and short run estimates of the relationship between climatic factors and aquatic food production in Nigeria. Thus the estimation techniques will have to be beyond the normal OLS. A cointegrating or long run relationship will be estimated. The findings will draw the attention of policy makers and fish producers to the type of climate change related adjustments needed in future production activities.

The well known Johansen cointegration techniques has been used in economic studies (Obayelu and Salau, 2010; Nasir, 2012).This methodology comes handy when variables are integrated in the same order. Hence, the presence of mixed regressors limits the use to which this technique can be put. Pesaran*et al* (2001) proposed a version of Autoregressive Distributed Lags (ARDL) model - which provides a feasible application on mixed regressors and permits distinct estimates of both long and short run elasticities. This has been applied to a number of studies (Muchapondwa, 2009, Naisru, 2012, Ogazi, 2009, Onuche *et al*., 2015).

MATERIALS AND METHODS

In specifying an equation for estimating the short and long run relationships between aquatic food production and climatic factors, we found it necessary to not restrict the explanatory variables to weather elements. This is to avoid specification error since other variables are also related to the supply of aquatic food. Hence, we included prices and policy variables which usually impact on agricultural production. Time series data on aquatic food output (metric tons), Exchange rate(Naira per dollar)price per kg of aquatic food(₦), interest rate (%), Loans to fishery sector (₦'000'000), Rainfall (mm), temperature (^{0}C) and carbon dioxide from 1970 to 2015 obtained from National Bureau of Statistics (NBS), Annual Abstracts of Statistics, several issues of the Central Bank of Nigeria (CBN), Nigeria Meteorological Agency (NIMET), and Food and Agriculture Organization (FAO) were analysed using ARDL.

First, the long run relationship between the output level of aquatic food (fish) and climatic factors is specified in the OLS regression framework as:

$Fish = \beta_o + \beta_1 Exc + \beta_2 pric + \beta_3 inte + \beta_4 lon + \beta_5 Rnf + \beta_6 Temp + \beta_7 Co_2 + e_t$…………1

Where Fish = Aquatic food output (metric tons); Exc = exchange rates, pric=price per kg of aquatic food, inte= interest rate, Lon = loan to fishery sector, Rnf = rainfall, Temp = temperature, Co_2= carbon dioxide emissions, β_o= intercept; $\beta_1 – \beta_7$ = coefficients, and e_t = error term. All variables were analysed in their natural logarithm form. Thus we have:

$lnfish = \beta_o + \beta_1 lnExc + \beta_2 lnpric + \beta_3 lninte + \beta_4 lnlon + \beta_5 lnRnf + \beta_6 lnTemp + \beta_7 lnCo_2 + e_t$ 2

The ARDL model was specified as:

$\Delta Lnfish_t = \alpha + \acute{\omega}_i lnX_{it-1} + \sum_{i=1}^{q} \varpi_1 \Delta lnQfsh_{t-q} + \pi_i \Delta lnX_{it-q} + ECT_{-1}$………3

Where Δ is the difference operator, ln represents natural logarithm, ώ and π_i are coefficients, ECT is the error correction term, q is the lag lengths of the variables in equation 1: successively as 4, 4, 4, 4, 4, 4, 4,3.

RESULTS AND DISCUSSION

We follow standard econometric procedure for time series analysis by testing for the stationarity of the variables. This was done in order to avoid spurious results (Gujarati, 2004). The tests were carried out using Augmented Dickey-Fuller method and the result is presented in Table 1. All variables (except the weather variables which are I(0)) are integrated in order of 1at 5%. This mixed order of integration means that the normal cointegration techniques like the Johansen methods cannot be relied upon in the estimation of a cointegrating equation, hence the use of the ARDL as proposed by Pesaran *et al* (2001)

Table 1: Stationarity test of regression variables

Variable	t-statistics (at level)	t- statistics (at first difference)	Conclusion
Fish	1.689	-10.00	I(1)
Exchange rate	-0.325	-6.621	I(1)
Price of fish	-1.454	4.00	I(1)
Interest rate	-1.800	-8.922	I(1)
Loan	-1.651	-9.150	I(1)
Rainfall	-6.322	-	I(0)
Temp	-5.75	-	I(0)
Co_2	-5.219		I(0)

Source: Data analysis, 2019.*5% critical ADF value=3.589*

Result from the ARDL model of the impact the explanatory variables on aquatic food output is presented in Table 2.The short run elasticity estimates indicate that change in supply lagged by a year had a negative effect on change in subsequent production. The opposite is the case after 3 lags. Elasticity of change in exchange rate was positively related to fish outputat all levels of lag.Taye (1999) in Yaqub (2010) asserts that the mechanism behind positive effect of exchange rate is that devaluation switches demand from imports to domestically produced goods by increasing the relative prices of imports and making export industries more competitive in the international markets, thus stimulating domestic production of tradable goods and inducing more domestic inputs. However, its lags were negatively related to fish output. Aquatic food production only responded to price changes on3 lags. Studies by Muchapondwa (2009), Molua (2010) and Ogazi (2009) have found varying responses of commodities to own prices. In this case, the response of supply to change in price did not take place until in 3rd year, implying that responses to prices are not usually spontaneous and certain as they may be hampered by certain factors outside the control of farmers. For instance, response to price may be hampered by inadequate finance to undertake the investments required for the expansion of production (Muchapondwa, 2009). Interest rate changes also related positively with fish supply. The first lag of loan related negatively with aquatic food output while its higher lags were positively signed. Rainfall related negatively with output of aquatic food supply at 3 lags, although the first lag exhibited a positive relationship. Temperature on the other hand exhibited a positive relationship with fish output. While this finding disagrees with that of Ayinde, Muchie and Olatunji (2011), it agrees with Ogazi (2009).Climate change effects are location and species specific and hence do not have to be the same. In fact Tripathi and Mishra (2017) have argued that the net effects of climate change are mixed depending on the location. Lags 1 and 2 of carbon dioxide also exhibited positive relationships with fish supply. This may not be unrelated to the role of Co_2 in increasing temperature. In general, short run variations in climatic factors seem to favour aquatic food production in Nigeria. Hence the need to optimize the opportunities they present. The Intergovernmental Panel on Climate Change (IPCC) (2007) notes that adaption to climate change does not only entail adjustment to moderate harm it causes but also includes the exploitation of the opportunities it presents.

Analysis of the long run elasticities of the explanatory variables does not suggest any long run relationship between them and the aquatic food production. This may imply high adaptive capabilities of species and/or their producers to climate change. The ECT was appropriately signed and significant. Its value implies a slow speed of adjustment of about 28% towards long run equilibrium. That is, in the event of any distortion, 28% of the long run equilibrium is restored within a year.

Table 2: Regression result on the effect of climatic factors and other determinants on aquatic food supply.

Short run elasticities			Long run elasticities		
Variable	Coefficient	t	Variable	Coefficient	T
D(LNFISH(-1))	-0.205002	-3.675405	LNEXC	0.362292	0.730817
D(LNFISH(-2))	-0.073948	-1.266540	LNPRIC	0.177047	0.425126
D(LNFISH(-3))	0.171686	4.368562	LNINTE	-1.534742	-1.031763
D(LNEXC)	0.086902	6.306899	LNLON	0.031018	0.172416
D(LNEXC(-1))	-0.068243	-5.730208	LNRNF	-1.155135	-0.679522
D(LNEXC(-2))	-0.138482	-6.878887	LNTEMP	1.061749	0.555414
D(LNEXC(-3))	-0.118281	-7.218047	LNCO2	-0.559322	-0.708008
D(LNPRIC)	0.023310	0.830772	C	22.786618	1.292514
D(LNPRIC(-1))	0.041136	1.238671			
D(LNPRIC(-2))	0.395431	7.923952			
D(LNPRIC(-3))	0.276995	8.849017			
D(LNINTE)	0.144299	7.960492			
D(LNINTE(-1))	0.361746	6.256162			
D(LNINTE(-2))	0.355822	7.420518			
D(LNINTE(-3))	0.297037	9.592530			
D(LNLON)	0.000019	0.006605			
D(LNLON(-1))	-0.018900	-6.728469			
D(LNLON(-2))	0.012441	4.371249			
D(LNLON(-3))	0.053839	9.295989			
D(LNRNF)	-0.022649	-1.672981			
D(LNRNF(-1))	0.092195	4.005680			
D(LNRNF(-2))	-0.009134	-0.526525			
D(LNRNF(-3))	-0.067649	-4.233038			
D(LNTEMP)	0.294578	7.082667			
D(LNTEMP(-1))	0.194171	4.163362			
D(LNTEMP(-2))	0.279371	5.585078			
D(LNTEMP(-3))	0.143069	3.461054			
D(LNCO2)	0.019906	1.780402			
D(LNCO2(-1))	0.185126	7.870634			
D(LNCO2(-2))	0.146053	8.644478			
ECT (-1)	-0.281399	-11.232211			

Source: Data Analysis, 2019

CONCLUSION

This study brings to light the impact of climate change on aquatic food production on the short and long run. Generally, the climatic factors investigated appear to favour aquatic food production in the short run. There doesn't seem to be any long run relationship between each of the explanatory variables and the explained variable. This implies the possibility of good adaptation strategies by aquatic lives and the producers involved with aquatic food to climate change. Hence, the aquatic food sector appears to be adjusting well to climate change and need not panic about it but instead expand to take advantage of the positive effects and improve on its adaptation strategies, while attempting to adjust to the negative influence of 3 year lag of rainfall. Investments in credit and improved technology in order to expand production and take advantage of price response, will elicit the optimization of the opportunities provided by the positive impact of changing climate. Furthermore, accurate weather forecasts and predictions through the establishment of better and well equipped meteorological stations in order to ensure early signal will help prevent the negative impact3 year lag rainfall and optimize the opportunities it presents.

REFERENCES

Ajayi, O.Y. (2001). Economics of Fish Farming in Remo and Ijebu Division of Ogun State, Nigeria. B. Agric. Dissertation, Unpublished. Department of Agricultural Economics and Farm Management, Ogun State University. 25pp

Amire, V. (2010). Monitoring, measurement and assessment of fishing capacity: the Nigerian experience. In FAO corporate documentary repository. Retrieved from FAO website on 5TH March, 2012

Asrat, P. and Simane, B. (2018). Farmers' Perception of Climate Changes and Adaptation Strategies in the Dabus Watershed, North-West Eithopia. Asrat and Simane Ecological Processes (2018) (7)7:1 – 13.

Ayinde, O.E., Muchie, M. and Olatunji, G.B. (2011). Effect of climate change on agricultural productivity in Nigeria: a cointegration model approach. *Journal of human ecology.* 35(3):189-194

Brander, K.M. (2007).Global Fish and Climate Change. Proceedings of the National Academy of Science of the United State of America (PNA).Boston city. 104pp.

FAO (2008). Climate change implications for fisheries and aquaculture. In: *The State of Fisheries and Aquaculture 2008*. FAO, Rome, Italy: 87–91.

Food & Agriculture Organization, FAO (2007).State of World Fisheries and Aquaculture. Gujarati, D.N. (2004). Basic Econometrics.McGraw-Hill.1002 pp.

Igbokwe, E. M. and Mkpado, M. (2011). Socio-economic impacts of climate change in Africa. *Agro Science Journal of Tropical Agricultural Food, Environment and Extension.*10. (1): 61-72.

Intergovernmental Panel on Climate Change (IPCC) (2007) Climate change 2007: impacts, adaptation and vulnerability. In: Contribution of working group II to the fourth assessment report. Cambridge University Press, Cambridge, UK

Jain, S (2006). An empirical economic assessment of the impacts of climate change on agriculture in Zambia. CEEPA DP27.Pretoria, University of Pretoria.

Molua, L.E. (2010).
Response of Rice Yields in Cameroon: Some Implications for Agricultural Price Policy. *Libyan agriculture research center journal international*. 1 (3): 182-194

Muchapondwa, E (2009). Supply response of Zimbabwean agriculture 1970-1999. *African journal of agricultural research.* 3 (1): (28-42)

Nasiru, I. (2012). Government expenditure and economic growth in Nigeria: cointegration analysis and causality testing. *Academic Research International*. 2 (3):718-722.

Obayelu, A.E. and Salau, A.S. (2010). Agricultural response to price and exchange rate in Nigeria: application of cointegration and vector error correction model. *Journal of agricultural science.* 1(2): 73-81.

Ogazi, C. G. (2009). Rice output supply response to the changes in real prices in Nigeria: an Autoregressive Distributed Lag model approach.*Journal of Sustainable Development in Africa*. 11(4): 83-100

Okoroh, J. P. (2010). Perception of climate change, effects and mitigation strategies among farmers in Imo State, Nigeria. Msc Research Proposal. Department of Agric Extension, University of Nigeria, Nnsukka.

Onuche, U Abu, G.A, Ater, P. I. and Akor, T.A. (2015). Supply responsiveness of Nigerian fisheries to price and policy factors from 1971-2010. Asian journal of agricultural extension, economics and sociology 7(2):1-10

Onumadu, F. N. (2010). Climate change, causes, consequences and ameliorating approach. Proceedings of the 44th Annual Conference of Agricultural Society of Nigeria LAUTECH pp. 1430-1434.

Pesaran, M.H., Shin, Y. and Smith, R. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*.16:289-326

Tripathi, A and Mishra, A. K. (2017). Knowledge and Passive Adaptation to Climate Change: An example from Indian Farmers. *Climate Risk Management*, 16: 195 – 207.

USAID SPARE fishery and aquaculture (undated). Review of the Status, Trends and Issues in Global Fisheries and Aquaculture, with Recommendations for USAID Investments.

Yaqub, J.O. (2010). Exchange rate changes and output performance in Nigeria: A sectoral Analysis. *Pakistan Journal of Socia; Sciences.*7(2): 23-35.

Zierovogel, G., Nyong, A., Osman, B., Conde, C., Cortex, S., and Downing, T. (2004). Climate Variability and Change: Implication for Household Food Security. AIACC Working Paper, No. 2.

THE ROLE OF URBAN FOREST IN MITIGATING CLIMATE CHANGE AND CREATING GREEN SPACE IN NIGERIA

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Abstract
The human activities has rapidly led to increase in climate change, this is projected to cause substantial environmental changes across most biophysical and societal systems. Forests are of particular concern, because they comprise a key natural resource that is valued the most by people. Relevant literatures were carefully reviewed. Many urban centers in the world are really suffering from lack of information on the services the urban forest provided for them. Most of the green spaces are now replaced with human infrastructure such as building, offices, schools and other urban infrastructures. In Nigeria, the only policy meant for urban forest management is only the Forest Policy, 2006, this policy on serves as guidance to the public without any strict penalties to the any defaulters. This study recommends that forestry extension services should do more in educating the people on the benefits, importance and contributions of urban forest to the environment and the people. Therefore, during construction, expansion and development.
Keywords: *Environmental, Changes, Forestry, Forests*

INTRODUCTION

According to (Organization for Economic Cooperation and Development) current projections indicate that concentrations of greenhouse gases will continue to rise into the undefined future, entailing a process of persistent global warming. Therefore, efforts are being made at the international level to tackle the present climate change problems through climate change mitigation and adaptation. Climate change mitigation efforts are geared towards preventing or reducing emission of the greenhouse gases which are massively responsible for climate change. Tree planting and others (reduction of emission levels, the use of biofuel, change of lifestyle, etc., are the mitigation recommended during the climate meetings at International level.

Urban forest is the collection of trees within the City, in a larger sense it is any tree found within the settlement of a city. Trees in the urban forest provide numerous ecosystem benefits (Nowak, 2006; Stenger *et al.*, 2009). With the increased influx of people to the urban centers, trees are removed for erection of houses, offices and other infrastructural development without minding what happen to the environment for this cause there is a need to integrate the role of the urban forest into long-term planning and climate adaptation strategies in order to improve environmental quality (Gill *et al.*, 2007).
Trees in urban areas make available shade against extreme solar radiation, and protect buildings and humans against the damaging effects of strong winds and torrential rains associated with climate change. The conservation, restoration and sustainable management of ecosystems can help reduce vulnerability to climatic hazards such as hurricanes, rising sea levels, floods and droughts. Hence, the global advocacy for greening the Earth by planting trees in urban areas and centres like churches, schools, hospitals, recreation centres, markets, to mention a few (Mant *et al.*, 2014).

Since tree species vary in their attributes, the effectiveness of trees in urban areas to achieve this goal will depend to a large extent on the planting of tree species that have the desired growth and structural attributes capable of enhancing climate change adaption and mitigation.
This study carefully sought for relevant literatures on which recommendations are extracted.

MATERIALS AND METHODS

Climate Change

The human activities has rapidly led to increase in climate change, this is projected to cause substantial environmental changes across most biophysical and societal systems. Forests are of particular concern, because they comprise a key natural resource that is valued the most by people. Though climate change effects vary across the globe, even the most modest predictions of temperature rise project a considerable global mean increase of 1.3-1.9°C by mid-century, depending on the GHG emission scenario (Meehl *et al.* 2007). The farther into the future, the greater the discrepancies among scenarios, but the increase of average annual temperature by the end of the century could be as high as 2-4.5°C. Temperature increases may initially drive forest productivity (Boisvenue & Running 2006), but the farther the projections go, productivity can fall (Fischlin *et al.* 2007). Moreover, while these projections consider only annual averages, seasonal climate variability may have a bigger influence on forest productivity in the long-term (Bugmann & Pfister 2000). Temperature also drives the spread of pests and disease, like the recent outbreaks of mountain pinebettle in BC due to lack of low-temperature winters (Carroll *et al.* 2004).

Furthermore, temperature changes have a direct influence in the processes that determine local weather, chiefly precipitation, wind and the frequency and/or intensity of extreme weather events (IPCC 2007).
Even a modest 2°C departure from mean temperature would imply different climate conditions from those under which most forests have evolved in recent centuries according to (IPCC 2007). For a list of such projections for significant urban regions in Canada I refer to Duinker & Ordonez (2010). The single or combined result of these climatic changes will drive changes in forest ecosystem resources, site conditions, disturbances, and individual tree variables (Williamson *et al.* 2009). For a list of associated effects in forests due to influencing climate variables, I refer to Duinker & Ordonez (2010).

Description of Green Spaces in Urban Landscape

Green space is a recent term and its origin can be traced from the urban nature conservation movement and the European thinking about green space planning which started in the UK (Swanwick *et al*., 2003; Dunnett *et al*., 2002).

The meaning of green space is often confused with other terminologies in urban planning especially open space and public open space. In most cases these terms are used loosely or interchangeably. For clarity between these terms and better understanding of the meaning of green spaces in the urban planning practice, some authors have come up with the following definitions in both developed and developing countries. In the developed countries, Fratini & Marone (2011) use the term urban green spaces to cover all areas that are naturally or artificially covered with vegetation. Fam *et al.* (2008) defines urban green spaces as all vegetated spaces including trees, shrubs, and grasses.

Similarly, Dunnett *et al.* (2002) described urban green spaces as lands that are made up mainly of unsealed, permeable, "soft" surfaces such as soil, grass, shrubs, forests, parks, gardens, wetlands and trees which are privately or publicly accessible or managed. In the views of Jim and Chen (2003), urban green spaces consist of outdoor places which have some amount of vegetation and can mainly be found in semi-natural areas. Kit Campbell Associates (2001) opined that urban green spaces consist of any vegetated land or structure, water or geological feature which can be found in urban areas. According to Baycan-Levent *et al.* (2002), urban green spaces are public or private urban areas, primarily covered by vegetation which are directly or indirectly available to users. In the context of developing countries, Cilliers (2013) dwelling on the works of Tzoulas *et al.* (2007) and Sandstrom (2002) used the term urban green spaces to refer to entire urban green infrastructure which covers a network of all natural, semi-natural and artificial ecological systems found at all spatial scales within, around and between urban areas. In broader terms, Yusof (2012) defined urban green spaces as any area or land within an urban area covered with vegetation or water.

Irrespective of the minor differences that exist in the various definitions on green spaces, it can be deduced that in both developed and developing world there is some common agreement on the meaning of urban green spaces. In both contexts the criteria for defining green spaces centred predominantly on the availability of green vegetation which makes urban green spaces to broadly cover all urban spaces or lands that to some extent have some form of vegetation either natural or artificial and are available for human usage.

This view makes it quite explicit that the term urban green spaces is not limited to parks and gardens but refers to a much wider set of land cover types that have vegetation on them such as forests, woodlands, urban trees, allotments and many more.

To get much insight on the meaning of urban green spaces, Swanwick *et al.* (2003) came up with the following description. According to them, urban areas are made up of the built environment and external environment between buildings. The external environment consists of two main entities, "green space" and "grey space". The green space is a useful land that consists predominantly of unsealed, permeable, 'soft' surfaces such as soil, grass, shrubs and trees (Swanwick *et al.*, 2003) and they may either be linear (green vegetation along routes), semi-natural (woodland), functional (allotments) and amenity (parks and gardens) in nature.

The second component of the external environment which is 'grey space' is simply land that to a greater extent sealed, impermeable and has 'hard' surfaces such as concrete, paving or tarmac. The grey spaces are of two types, functional grey spaces (which provide a specific purpose such as roads, pavements, car parks and many others) and civic grey spaces (publicly accessible areas planned basically for public enjoyment, including town squares, plazas and esplanades).

In view of this classification, Swanwick *et al.* (2003) classified urban open spaces as a combination of green spaces and civic grey spaces and defined it as that part of urban areas that contributes to its services, either visually by contributing positively to the urban landscape, or by virtue of public access. All open spaces that the general public have access to as referred to as public open spaces.

In summary, urban green spaces can be said to be a subset of urban open spaces. Whilst urban green spaces are limited to only the vegetative part of the urban environment specifically the soft lands, urban open spaces on the other hand encompass all aspects of green spaces in addition to those hard land surfaces of urban areas (grey spaces) made purposely for human enjoyment. Putting the various ideas together, the term urban green spaces is used in the context of this study to cover all natural and semi-natural spaces in urban areas that are primarily covered by vegetation, either publicly or privately owned and are easily available for human usage.

Climate Impacts on Urban Forests

Climate change would generate a substantial loss and gain of urban forest habitat due to the loss or gain of ecosystem quantity. In general, climate change means that forest ranges, hinterland and urban, are moving in a latitudinal and altitudinal manner. This shift is corroborated with studies in Canada, a country with such a considerable forest resource (McKenney *et al.* 2007).

This impact also involves sea-level, which could rise from 0.18 to 0.59cm globally by the end of the century (IPCC 2007).These shifts may restrict certain tree species to a smaller or bigger area, changing the forest structure. Another impact of significance is the change in forest habitat due to changes in ecosystem quality. Changes may involved changes in precipitation, temperature and frost events, soil quality, including sea-level, which can affect the salinity of certain soils and water bodies in coastal ecosystems, among others variables of change.

Under these new conditions certain tree species would lose their ability to thrive. In particular, ecosystem change would affect their regeneration rates, their representativeness in the forest, their age diversity, and their general health and aesthetics (CCFM, 2009). For example, tree species more suitable to the new conditions may invade a site that had before not been suitable. This invasion may be by species belonging to the native forest surrounding the urban forest or otherwise by alien species, and this would happen more copiously in unmanaged areas, like naturalized parks or abundant tree stands, in the long-term. Moreover, young, healthy trees may be more capable to endure climate change, while seedlings and old trees will probably not. An impact of great concern is the change in frequency and intensity of disturbances, such as extreme weather events and pests and diseases. In most climate models, disturbance increase either in frequency or intensity and occur at a local to regional scale.

An increase in intensity and decrease of frequency hurricanes or droughts, for example, would mean more damage to urban forest stands and individual trees. Pests and diseases have an intense effect on individual species, which in turn affects the species mix in the urban forest. Human influences in the urban forest may downplay many of these impacts. Firstly, environmental quality is a determinant of forest species ranges at a broad scale.

Climate impacts on the urban forest occur at a small scale but it's becoming large scale because of rapid development by human in urban center. Here, other factors may take part in the thriving of species, such as seed dispersal, biotic interactions, genetic adaptations, and human decisions that involve urban sprawl, replacement of green infrastructure by grey infrastructure among others. However, the long-term significance of climate change impacts can never be underestimated. The quantification of such impacts depends on the resolution of small-scale models, which is still low for many coupled forest-climate models. The development of these models is an ongoing process that must take into account urban microclimates (Wilby, 2007) and other factors of stress. Finally, environmental changes in the urban forest environment affect the way the urban forest functions and the values it provides.

INSTITUTIONAL ARRANGEMENT GOVERNING URBAN FOREST IN NIGERIA

According the institutional arrangement governing urban forest in Nigeria, only three ministry really do the management of the urban forest in Nigeria. Also, I observed that the only policy used by this three ministry is the National Forest Policy, 2006.

This policy said that government will recognize and emphasize the protective role of forests in watersheds, buffer zones around rivers and hills so as to prevent water and wind erosion as well as siltation of watercourses and as carbon sequesters. This further stated that this are actualize by Promoting National Tree Planting and Agro-forestry Practices outside forest reserves in order to increase the area under forest cover. Also, the policy states further by saying that government is committed to improving the livelihoods and wellbeing of urban people by supporting urban forestry and improving the urban landscape and environment. This further stated that this can be actualize by Roadside planting; establishment of green areas and botanical garden and zoo establishment.

Lastly, it was discussed out of the policy that Agroforestry practices would be aimed at increased wood production, food security, and socio-economic development as well as provide environmental protection. This can be actualize by encouraging planting of tree anywhere farm is located, even if it is within urban areas.

RESULTS AND DISCUSSION

According the review literatures, it had been deducted that human activities had really caused serious challenges on climate change through rapid development at the Urban Centers. Many urban centers in the world are really suffering from lack of information on the services the urban forest provided for them. Most of the green spaces are now replaced with human infrastructure such as building, offices, schools and other urban infrastructures.

In Nigeria, the only policy meant for urban forest management is only the Forest Policy, 2006, this policy on serves as guidance to the public without any strict penalties to the any defaulters.

CONCLUSION AND RECOMMENDATIONS

This paper has shown how an urban forest climate response can be fitted to a broad sustainable urban forest management framework and comprise both mitigation and adaptation responses. Though climate issues are not addressed significantly in many urban forest management plans developed in Nigeria it is expected that concerns for climate impacts and vulnerability may bring climate to the forefront of sustainable urban forest management in the future.

This study recommends that forestry extension services should do more in educating the people on the benefits, importance and contributions of urban forest to the environment and the people. Therefore, during construction, expansion and development of infrastructures, attention should be paid on conserving trees rather than cutting them down.

REFERENCES

ABDOLLAHI, K. K., NING, Z.H. APPEANING, A. (ed.) (2000). Global climate change & the urban forest. Franklin Press Inc. and GCRCC, Baton Rouge. 77 pp.

ADGER, W.N., AGRAWALA, S., MIRZA, M.M. Q., CONDE, C., O'BRIEN, K., PULHIN, J., PULWARTY, R., SMIT, B. and TAKAHASHI, K. (2007). Assessment of adaptation practices, options, constraints and capacity. Climate change 2007: Impacts, adaptation and vulnerability.

BUGMANN, H., PFISTER, C. (2000). Impacts of interannual climate variability on past and future forest composition. Regional Environmental Change 1 (3): 112-125.

CARROLL, A. L., TAYLOR, S. W., RÉGNIÈRE, J. and SAFRANYIK, L. (2004). Effects of climate change on range expansion by the mountain pine beetle in British Columbia (Information Report BC-X-399). In: SHORE, T. L., BROOKS, J. E. STONE, J. E. (ed.). Mountain pine beetle symposium: Challenges and solutions, Kelowna, BC, October 30-31, 2003. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC, p. 223-232.

CCFM (2009). Vulnerability of Canada's tree species to climate change and management options for adaptation: An overview for policy makers and practioners. Canadian Council of Forest Ministers (CCFM), Ottawa, ON. (Available at: www.ccmf.org, retrieved: February, 2010).

DUINKER, P. N., ORDONEZ, C. (2010). Beyond forest restoration for climate-change mitigation and adaptation: The case of Canada's forests. Commonwealth forestry conference 2010, 28th June - 2nd July. CFA, Edinburgh, UK.

DWYER, J. F., NOWAK, D. J. (2000). A national assessment of the urban forest: An overview. Society of American Foresters 1999 National Convention, Portland, Oregon, October, 1999, p. 157-162. FISCHLIN, A., MIDGLEY, G .F., PRICE, J. T., LEEMANS, R., GOPAL, B., TURLEY,C.,

IPCC (2007). Climate change 2007: The physical science basis. In: SOLOMON, S., QIN,D.,

KENNEY, W.A. (2008). Urban forest strategic management plan town of Oakville: 2008-2027. In: Anonymous (ed.) Government Document. Urban Forest Innovations Inc. (UFII), Oakville. (Available at: www.oakville.ca/forestry.htm, retrieved: February, 2019).

KLEIN, R.J.T., HUQ,S., DENTON,F., DOWNING,T.E., RICHELS,R.G., ROBINSON,J.B. and MCKENNEY,D.W., PEDLAR,J.H., LAWRENCE,K., CAMPBELL,K. HUTCHINSON,M.F. (2007). Beyond traditional hardiness zones: Using climate envelopes to map plant range limits. BioScience 57 (11): 929-937.

MCKINNEY, M.L. (2002). Urbanization, biodiversity, and conservation. Bioscience 52 (10): 883-890.

WILBY, R.L. (2007). A review of climate change impacts on the built environment. Built Environment 33 (1): 31-45.

WILBY, R.L., PERRY,G.L.W. (2006). Climate change, biodiversity and the urban environment: A critical review based on London, UK. Progress in Physical Geography 30 (1): 73.

INVESTIGATIVE IMPACT OF NITROGEN, PHOSPHORUS AND NODULATION FORMATION ON TREE SEEDLINGS AND STANDS GROWTH

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Abstract
Soil enrichment in the nursery and established fields are unavoidable. Deforestation and desertification as an agent of edaphic destruction in parts of the country called for the soil restoration. This will assist in improving the yield and growth vigour of seedlings and tree. This study surveyed on the effect of nitrogen, phosphorus and nodulation formation on the growth of the seedlings and stands. Fertilizer recommendation for soils and tree seedlings is a dynamic process in view of generation of the new knowledge, changes in the soil nutrient status, changes in plants and planting patterns and associated management practices. Application of nitrogenous fertilizer is more importance in nursery establishment. Faiherbia albida, Leucanea leucocephala observed to fix more nitrogen into the soil while mycorrhizais essential for Pinus caribea (Pines) propagation. Training and educative progrommes are essential for the forest workers in order to boost productivity and exposed them to nursery techniques. Also, concerned people and organizations must provide adequate farm inputs, incentives and subsidies to the forest nurseries and farmers where and when necessary.
Keywords: *Nitrogen, Phosphorus, nodulation formation, seedlings, stand and growth*

INTRODUCTION
Soil nutrient is a substance taken by a cell from its environment and used in catabolic or anabolic reaction with soil to the plant (Patel, 2008).It is the physical properties of forest soils developed under natural conditions by the influence of permanent vegetation over a long period of time. Physical properties of forest soils may be its permanent properties unless modified by harvesting operations, shifting cultivation and forest fires. Important physical properties of forest soils include texture, structure, porosity, density, aeration, temperature, water retention and movement. The physical properties of forest soils affect every aspect of soil fertility and productivity (Osman, 2013). The interaction of numerous physical, chemical and biological properties in soil controls plant nutrient availability. Understanding these processes and how they are influenced by environmental conditions assist in optimizing nutrient availability and plant productivity. Nutrient supply to plant roots is a very dynamic process. Plant nutrients (cations and anion) are absorbed from the soil solution by plant roots which also release small quantities of ions (H^+, OH^- and HCO_3^-). All aqueous solutions (soil water or plant cell water) must be electrically neutral where an equal number of ions with positive (cations) and negative (anions) charges are present .Thus, if there is an imbalance in cation and anion uptake in plant root cells, these cells release cations or anions depending on the imbalance. This process can influence soil solution Ph (John *et al*., 2013). Soils also contain minerals that can dissolve to resupply the soil solution. Addition of nutrients or ions through fertilization or other inputs increases ion concentration in the soil solution. Although, some of the added ions remain in

solution, some are adsorbed to mineral surfaces or precipitated as solid minerals. As soil microorganisms degrade plant residues, they remove absorb ions from the soil solution into their tissue. When microbes or other organisms die, they release nutrients back to the soil solution. Microbial reactions are important to plant nutrient availability as well as other properties related to soil productivity (John *et al*., 2013). Efficient nutrient management programs supply plant nutrients in the adequate quantities to sustain maximum plant growth and yield while minimizing environmental impacts of nutrient. Substantial economic and environmental consequences occur when nutrient availability through effective nutrient management practices requires knowledge of the interactions between the soil, plant and environment (John *et al*., 2013). The objective of the surveyed research is to determine various kinds of nutrient at appropriate level suitable for seedlings growth and stand development.

Table 1: Soil potting mixtures application in some forest nurseries

Location	Soil component (parts per volume)	Fertilizer and insecticides (m^3)
Bukuru (Plateau State)	4 Fine sand; coarse sand , 4 composted cow manure	454 -500 totalfert +1kg dieldrin, 2%dust +250borate/m^3
Nagaguta (Plateau State)	4 Fine sand , 1 coarse sand , 4 composed cow manure, 1 loamy forest soil	454g -590g $(NH_4)_2SO_4$, 590g Single Super Phosphate, 295g murate of potash and 2% dieldrin dust
Ibadan (Oyo State)	River sand (1)	1.5-1.7 kg each of Single Super Phosphate (granular) bone meal and horn flakes
Zaria (Kaduna State)	2 River sand , 1cow manure	2.4 kg totalfert, 1.2kg (2% dieldrin)
Jakarade (Kano State)	4 Top soil, 3 cow manure	885g NPK, 590g dieldrin dust
Kano (Kano State)	4 Top soil, 3 well-rooted pig manure	885g NPK and 590kg dieldrin

Source: Nwoboshi, 1982; Fagbenro and Aluko, 1987

Table 2: Mean performance of selected species at the seedling stage

Species name	Germination percentage (%)	Shoot length (cm)	Root length (cm)	Nodules form
Faiherbia albida	60	30.9	21.2	14
Leucanea leucocephala.	45	30.2	20.2	12
Acacia Senegal	40	26.4	19.4	14

Source: Ilu *et al*., 2013

MATERIALS AND METHODS

Impact of mycorrhiza

Mycorrhiza represents symbiotic association between certain fungi and plant roots which enhances the uptake and nutrients; associated with the hyphae of either an ectotrophic or endotrophic fungus. The ectotrophic fungus forms a sheath or fungal material around rootlets. These are found in the tropics among members of Dipterocarpaceae and Caesalpiniacea and a few tropical representatives of Fagaceae, Pianaceae and Myrtaceae. Theendotrophic fungi formno sheath but its filaments grow within and between the epidermal and cortical cells and extend to the soil. Another symbiotic association of silvicultural importance is that between the root of most legumes and bacteria. The bacteria derived food, nutrients and water from the legume (Wilson, 1937). Attempts to introduce Pines into region where the soil was not highly fertile and the proper symbiont was lacking have almost in variably ended in conspicuous failure (Daubenmire, 1959).The importance of mycorrhizae to these pines and forest tree species seems to be that they are highly efficient accumulators of nutrient ions which subsequently become available both to the host tree and to the fungus (Melin, 1962). Most mycorrhiza requires carbon for their nutritional obligation and the most favourable carbon source for growth are glucose and other simple sugars. The mycorrhiza depends exclusively on the supply of simple carbohydrate. Since a number of species have found to utilize it, particularly if they are supply with small quantity of glucose and some undoubtedly produce cellulose, hemicelluloses and amylases (Lamb,1999). The ability to produce this exo-enzyme varies widely with very little exception; product is not as great as that found in free living Basidiomycetes lead litter (Linderberg, 2000).From the result of experiment conducted it could be concluded that, *Faidherbia albida* had greater affinity to form association with Bacteria over *Acacia senegal* and *Leucanea leucocephala*. Thus *Faiherbia albida* couldfix more nitrogen than other nitrogen fixing tree species (Ilu *et al*., 2013).

Table 3: Effect of different sources of nitrogen on various growth characters of selected species treated for twelve (12) weeks

Species	**Leaf numbers at final harvest**	**Leaf area (cm^2)**	**Leaf dry weight (g)**	**Shoot dry weight (g)**	**Root dry weight (g)**	**Shoot root Ratio**
		Control (nil N)				
Dalbergia latiofolia	11	68.66	0.317	0.240	0.278	0.86
Terminalia ivorensis	10	68.47	0.242	0.142	0.519	0.27
Gmelina arborea	13	85.68	0.391	0.343	0.992	0.34
Terminalia superba	6	47.31	0.150	0.207	0.347	0.60
Means	**10**	**67.53**	**0.275**	**0.233**	**0.534**	**0.52**
	Potassium nitrate		KNO_3			
D. latifolia	10	65.03	0.247	0.246	0.312	0.79
T. ivorensis	31	963.39	4.270	2.113	3.874	0.55
G. arborea	15	830.36	5.191	4.256	7.234	0.59
T. superba	13	481.97	1.949	1.207	1.776	0.68
Means	**17**	**585.19**	**2.914**	**1.956**	**3.299**	**0.65**
	Calcium nitrate		$Ca (NO_3)$			
D. latifolia	8	59.94	0.575	0.314	0.189	1.66
T. ivorensis	28	702.74	2.519	0.998	1.725	0.58
G. arborea	37	1758.00	7.294	7.346	8.662	0.85
T. superba	14	660.09	2.678	1.775	2.018	0.88
Means	**22**	**795.19**	**3.266**	**2.608**	**3.149**	**0.99**

	Ammonium nitrate		$(NH_4)_2SO_4$			
D. latifolia	8	70.98	0.329	0.237	0.218	1.09
T. ivorensis	27	776.38	2.740	1.392	1.602	0.87
G. arborea	17	282.59	1.233	0.999	1.660	0.59
T. superba	14	410.81	1.787	0.887	1.174	0.76
Means	**17**	**385.19**	**1.522**	**0.874**	**1.164**	**0.83**
	Ammonium nitrate		$(NH_4)_2SO_3$			
D. latifolia	16	180.66	0.738	0.334	0.287	1.16
T. ivorensis	30	1063.70	3.459	1.356	1.664	0.82
G. arborea	31	1667.20	9.342	3.819	8.235	0.46
T. superba	15	776.27	3.969	1.862	1.966	0.95
Means	**23**	**921.96**	**4.377**	**1.843**	**3.038**	**0.85**

Source: Fagbenro and Aluko, 1987

Effect of nitrogen

Nitrogen is one of the macro-nutrients required by plants for its optimum growth. It is an essential component of protein in a living plant. Nitrogen encourages over ground vegetation growth and also influences the deep green colour of the plant. It also helps in the formation of starch for plant use. The mere fact that Nitrogen is abundant in the atmosphere does not means that it can be taken in directly by plants and brings about the need for fertilizer application. Application of inorganic fertilizers at the rate of 15.0g of Urea enhanced the production of healthy and vigorous *Enterolobium cyclocarpum* seedlings because it had the highest values for height growth, root length and also stem diameter of *Enterolobium cyclocarpum* seedlings (Salami, 2015).It was also reported that the NPK (15:15:15) 3-4g/pot go a long way to produce very healthy and strong *Treculia africana* shoot height as a parameter (Salami*et al*, 2018). According to (Fagbenro and Aluko, 1987) shoot height, dry matter production, leaf size and number as well as chlorophyll contents were best for *Dalbergia latifolia*, *Terminalia ivorensis*, *Gmelina arborea* and *Terminalia superba* when Ammonium nitrate was the source of Nitrogen. This was followed by calcium nitrate and potassium and potassium and nitrate than Ammonium sulphate while the least response was observed from the Nitrogen Free Source (control). Based on his observations, Adebagbo (1981) suggested that adequate Nitrogen fertilization be developed on extensive soil test and knowledge of the nutrition requirement of the individual plant species.Jose (2003) also reported high loses of phosphorus and mineral uptake may lead to poor cell differentiation and multiplication. There were no significant differences in stem diameter produced by seedlings during the experiment. However, the best treatment combination recorded was NPK10g. This indicates that nitrogen and phosphorus play important roles in stem diameter formation. Pinkard *et al*., (2007), working with reported for *Eucalyptus globules*, reported that seedling collar diameter increment did not show significant differences (P>0.05) with nutrogen application. Seedling collar diameter increments for fertilized seedlings were generally better than those of the control experiment. Burslem *et al.*, 1995 and Gbadamosi, 2006 also reported similar results for tree seedlings. In table 2 presented data of the effect of sources on the growth of the four tree seedlings. Aluko and Aduayi (1984) have carried out pot culture experiments for predicting fertilizer requirements of *Terminalia ivorensis* and *Terminalia superba*. They found that application of 100 and 200 ppm Nitrogen for *Terminalia ivorensis* and 200 and 400 ppm Nitrogen for *T. superba* increased shoot height, stem diameter, leaf production and induced healthy growth of the seedlings in an alfisol, *Terminalia superba* was found to be tolerant to high Nitrogen application while *T. ivorensis* was not. Similarly, the best response in terms of morphological growth was obtained at 100 ppm phosphorous applied in the form of single super phosphate. Xiankai (2010) observed that low-to-medium levels of N addition (100 kgNha^{1}yr^{1}) generally did not alter plant diversity through time, high levels of N addition significantly reduced species diversity.Emerhi and Nwiisuator (2014) observed that mean values of nitrogen content of wood, bark and leaves were 0.5743 and 1.02668. The effect of sites on nitrogen content of wood and bark of the mangrove species was significant ($P<0.05$) but not significant ($P>0.05$) in the leaves. This agrees with results found by Orman and Will (1960). However this was not consistent in all the samples drawn. Wood nitrogen content was not significantly affected by tree size. The nitrogen content of trees of the same species within the same diameter class (a) varied significantly in bark and leaves. Nitrogen contents for sapwood and heartwood were not significantly different. Nitrogen contents did not vary significantly along the bole in both wood and bark. The nitrogen contents of leaves sampled from different position within the crown were not significantly different ($P>0.05$)

Table 4: Level of Nutrient Applied

Commercial fertilizers	Elements	0kg/ha Level 1	50kg/ha Level 2	175kg/ha Level 3	300kg/ha Level 4
Urea 46% of Nitrogen	N	0	0.1683	0.6416	1.100
TSP 48% of P_20_5	P	0	0.1733	0.6300	1.0797

Source: Rafiqul Hoque, *et al.*, 2004

Application of N significantly affected survival percentage, collar diameter fresh root, fresh shoot weight, total leaf area, dry matter production (root, shoot leaf) and total biomass of the seedlings. Different levels of N and P applied are given in Table 4. The effect of P was generally not significant. Though there were some differences due to different fertilizer doses the interaction effects of both N and P were not significant on any parameter measured with *Antho cephalus chinensis.* Rafiqul Hoque, *et al.*, (2004)

Impact of phosphorus

Phosphorus is relatively immobile with little leaching to ground water in most mineral soils; P in poultry waste is rapidly hydrolyzed and chemically precipitated or adsorbed. Phosphorus management for high applications should be based on the chemical, physical and biological reactions of P in soil (Edwards and Daniel, 1992; Reddy *et al.*, 1978). The amount of p in the soil depends on precipitation/adsorption reactions, mineralization have shown little focus on p as compared with N transformations in poultry waste amended soils (Edwards and Daniel, 1992; Sharpley, *et al.*, 1994a). Phosphorus is found in Organic and inorganic soluble and insoluble forms. In some soils water soluble inorganic P is rapidly converted into water insoluble P (Reddy *et al.*, 1980). Total phosphorus (p) in surface soil varies from 0.005 to 0.15% and decreases with increasing weathering intensity. This total soil p is much lower in humid and tropical region soil.Unfortunately, the quantity of total soil P has little or relationship to P availability. Therefore, understanding the relationships and interactions of p in the soils and the factors that influence availability to plant is essential for efficient p management and protection.The most common visual symptoms include overall stunting of the plant and a darker green colouration of leaves. With increasing p deficiency the darker green colour changes to a greyish green to bluish green metallic luster.Emerhi and Nwiisuator (2014) who observed that overall mean values phosphorus contents for wood bark and leaves in the mangrove species were 0.04088, 0.06215 and 0.06928% dry weight of wood respectively. There was no significant differences ($P<0.05$) between the species and tree sizes (Table 1). There was also significant difference ($P<0.05$) between the wood in radial and axial direction.

Problems with use of fertilizers in forestry

Despite the fact that inorganic fertilizer is generally recognized and acceptable as a means of improving the soil nutrients, some limitations come into focus and this discourages its usage in both agricultural and tree production. Evenwith positive responses observed, no government or privateorganization in Nigeria presently committed management to investment in forest fertilization. More than any other consideration, the problem with forest fertilization is mainly economic. From all indication, inorganic fertilizers are likely to become increasingly more expensive.Another gap is that illiterate farmers and nursery workers find inorganic fertilizers most difficult to apply correctly. Leaf deformation and complete cutting up of tree seedlings can be negative affect of increase in the acidity of the soil which is due to application of in appropriate quantity of wrong inorganic fertilizers (Salami, 2002). In the circumstance, the judicious utilization of locally available organic materials for tree seedlings production will more than complement the use of chemical fertilizers. The increased use of organic materials such as poultry manure, cow dung, saw dust and town refuse which are abundant in the country offers a possibility for effectively supplementing plant nutrient requirements (Fagbenro and Aluko, 1987).

CONCLUSION

Summary

Positive responses have been obtained in a number of fertilizer experimental works. The responses to nitrogen and phosphorus fertilizers and some trace element fertilizers lead to the belief that significant success can be achieved in improving site quality through their uses. Therefore,for substantial increased in the tree seedlings and stands yield. Nitrogen and Phosphorus are needed in all the soils. Soils and leaf analyses are important tools in the rational and belief of the seedlings and tree. Agrochemicals and other agricultural inputs are expensive and have not always been available in good time for the best result. Also, Agrochemical industries should be accessible to forest nurseries with inputs at less expensive rate to reduce production costs. This will lead to low cost of production. State government should accede to request of entrepreneurs with good industrial outreach programmes by subsidizing the raw materials from for industrial processing. Provision of more fertilizer warehouses is inevitable. Federal Government through Forestry Research Institute of Nigeria must able to discharge their duties by providing awareness and training on importance of chemical fertilizers. State government, agricultural banks and Non-Governmental Organization should enhance foresters and farmers with different interventions such as provision of agrochemicals, other farm inputs and subsidize.

REFERENCES

Adams, Z.A 2018: Effect of seed treatments and potting mixtures on the early growth performance of *Balanities eagyptiaca* (L) Delile. A project submitted to the Department of Forestry and Wildlife Management, Federal University Dutse, Jigawa State. Pp23

Aluko, A.P and Aduayi, E.A 1983: Response of forest tree seedlings (*Terminalia ivorensis*) to varying levels of nitrogenous and phosphorus. *Journal of Plant Nutrient* Vol 6, No. 3:219-237.

Burslem, D. F., Grubb, P. J and Turner, I. M 1995: Responses to nutrient addition among shade tolerant tree seedlings of lowland tropical rain forest in Singapore. *Journal Tropical Ecology*, 83: 113-122.

Daubenmire, R.F, 1959: *Plants and Environment. A textbook of plant autecology*. John Wiley and Sons Inc 422pp

Edwards, D.R and Daniel, T.C 1992: Environmental impacts of on-farm poultry waste disposal – a review *Biological Resource Technology* 41: 9-33.
Emerhi, E. A and Nwiisuator, D 2014: Evaluation of Phosphorus and total Nitrogen contents of mangrove species in Niger delta. Proceedings of the 37th Annual Conference of Forestry Association of Nigeria held in Minna, Niger State 9th- 14th November 2014. Pp 47-57
Fagbenro, J. A and Aluko, A.P 1987: Fertilizer use in the production of forest trees in Nigeria. Proceedings of the National fertilizer seminar, held at Port-Harcourt. October 28-30. Theme: Towards efficiency of fertilizer use and development in Nigeria.
Gbadamosi, A. E 2006. Fertilizer response in seedlings of medicinal *Enantia chlorantha Oliv*. *Tropical SubtropicalEcosystem*, 6: 11-115.
Ilu, K. J, Sani, M.S, Yau, I.A and Imam, M 2013: Germination, Growth and Nodulation studies in three nitrogen fixing tree species, proceedings of the 36th Annual Conference of the Forestry Association Nigeria held in Uyo, Akwa Ibom State Nigeria. Pp 436-439.
John, L.H., Samuel L.T., Weiner, L.N and James D.B 2013: Soil fertility and fertilizers: Introduction of Nutrient Management 8th edition pp185-221Melin, E, 1962
Jose, L. M 2003. Nitrogen and Phosphorus reabsorption in tree of Neo-tropical rain forest *Journal of Tropical Ecology*, 19: 465-468.
Lamb, R.J 1999: In C Roderic(ed). The biology of symbiotic fungi pp253-255.
Lindeberg, G. 2000: Tran Elr Mycological society, 63:295-306.
Nwobochi, L. C 1982: Tropical Silviculture. Principles and Techniques. Ibadan University Press Publishing House University of Ibadan, Ibadan, Nigeria.
Orman, H. R and Will, G. H 1960: The nutrient content of *Pinus radiate* trees. N.Z.J science 3:510-522.
Osman, K. T. 2013: Forest Soils, DOI 10.1007/978-3-319-02541-4_2, © Springer International Publishing Switzerland.
Patel, S. V., Golakiy, A., Savalia, S.G and Gajera, H.P.2008:A Glossary of Soil Sciences. International Book Distributing Co
Pinkard, E.A., Ballie, C, Patel, V and Mohammed, C. L 2007: Effects of fertilizing with Nitrogen and Phosphorus on growth and crown condition of *Eucalyptus globolus* Labill. experiencing insect defoliation. *Forest Ecology Management*~~.~~, 231: 131-137.
Rafiqul Hoque, ATM., Hossain, M. K., Mohiuddin, M and Hoque, M M 2004: Effect of inorganic fertilizers on the initial growth performance of *Anthocephalus chinensis. Journal of Applied sciences.* Asian Network for Scientific Information.4(3): 477-485, ISSN1607-8926.
Reddy, K. R, Overcash, M R, Khalel .R and Westerman, P W 1980: Phosphorus adsorption description characteristics of two soils utilized for disposal of animal wastes *Journal environment* 9: 86-92
Salami, K. D. 2015. Comparative effect of Nitrogenous and Phosporous fertilizers on the Growth of *Enterolobium cyclocarpum* Jacq Seedlings. Nigeria Tropical Biology Association (NTBA) 2015. Conservation in 21st Century Nigeria: Transcending Disciplinary Boundaries, Vol 2. 5th Annual Biodiversity Conference held at Federal University of Technology, Akure (FUTA) from 19 – 20 May. 2015:265-268
Salami, K. D., Jibo A.U and Lawal, A.A. 2018 Effects of Organic and Inorganic Fertilizer on the Early Growth Performance of *Treculia africana*. LINN (AFRICAN BREAD FRUIT). *Dutse Journal of Agriculture and Food Security* (DUJAFS). Vol 5:(2) 28-36.
Sharplay, A N., Chapra, S.C., Wedepoli, R., Sims, J.T Daniel T.C and Reddy, K. R 1994a. Managing Agricultural Phosphorus for protection of surface waters. Issue and options. *Journal Environmental Quality* 23:437-451
Xiankai, L. U., Jiangming, M.O and Frank, S. G Effects of experimental Nitrogen additions on Plant Diversity in an Old-growth Tropical Forest. Marshall University Marshall Digital Scholar Biological Sciences Faculty Research

THE IMPACT OF WATER, SANITATION, AND HEALTH ON KEY HEALTH AND ENVIRONMENTAL OUTCOMES: A REVIEW OF LITERATURES

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Abstract

A critical review of literatures relating to Water, Sanitation and Health (WASH) was undertaken from variety of journals. The review was conducted using a systematic approach of publication quality. The review purpose was to identify the impact of water, sanitation and health on health and our environment. A series of journals and articles was gathered on 8 different areas identified by UNICEF, WHO, United Nation, World Bank, and Research publication on which WASH can plausibly have a strong impact: diarrhoea, nutrition, complementary food hygiene, maternal and newborn health, menstrual hygiene management, school attendance, oral vaccine performance, and neglected tropical diseases. Also, through these impacts can seek to help in addressing its WASH activities and to achieve universal and sustainable water and sanitation services and the promotion of hygiene, with a focus on reducing inequalities especially for the most vulnerable children, wherever they are; both in times of stability and crisis.

***Keywords**: Water, Sanitation, Health, Environment.*

INTRODUCTION

Water and Sanitation is one of the primary drivers of public health. I often refer to it as “Health 101”, which means that once we can secure access to clean water and to adequate sanitation facilities for all people, irrespective of the difference in their living conditions, a huge battle against all kinds of diseases will be won". According to the United Nations report, more than half of the population in developing countries still lacks access to the most basic form of sanitation (United Nations 2007). Somewhat more progress has been made in the water sector, but 21% of the population in developing countries still does not have access to adequate drinking water (UNDP, 2007/2008). The situation is most severe for Sub-Saharan African countries, where 63% of the population lacks access to basic sanitation and 45% of the population lacks safe drinking water supply (UNDP, 2007/2008).

From a public health perspective, the lack of access to water and sanitation infrastructure is disconcerting. Several studies have documented the significant positive effect of water and sanitation on reducing child diarrhea (Esrey *et al.,* 1991; Fewtrell *et al.,* 2005; and Waddington *et al.,* 2009). Moreover, improved water and sanitation has been shown to lower the health risks related to schistosomiasis, trachoma, intestinal helminthes and other water related diseases. In addition, improved water and sanitation is likely to reduce the burden of disease related to other major health issues by reducing the average stress level for the immune system, and thus strengthening the immune response to new infections. This phenomenon has been labeled the Mills Reincke Multiplier in honor of Hiram Mills and J.J. Reincke, who first noted the health benefits of water-borne disease improvements on other disease-specific mortality rates (Cutler and Miller, 2005; Ewbank and Preston, 1990).

Despite the large number of observational and intervention studies on improved water and sanitation supply, a comprehensive empirical evidence base on their private and public health impact is still lacking. One of the millennium goals is to reduce by half the number of people without adequate water supplies by the end of 2015, and the same goal for sanitation was recently added at the Johannesburg Earth Summit

However, the World Health Organization and UNICEF are advocating a target of water and sanitation for all by the end of 2025; to meet this target, some 2.9 billion people will need improved water supplies, and an almost unbelievable 4.2 billion people will need improved sanitation. (World Health Organization 2000). These figures translate into 310,000 people needing improved water supplies and 460,000 people needing improved sanitation per day during the 25 years to 2025. We should be able to meet the water target—we did better in the 1980s - but there is almost no chance that we will meet the sanitation target. (Mara D, 2001).

Meeting the MDGs for water and sanitation in the next decade will require substantial economic resources, sustainable technological solutions and courageous political will. We must not only provide “improved” water and “basic” sanitation to those who currently lack these fundamental services, but also to ensure that these services provide: safe drinking water, adequate quantities of water for health, hygiene, agriculture and development sustainable sanitation approaches to protect health and the environment. As we move forward to meet this challenge, it is critical that we learn from past mistakes and identify creative new approaches to provide sustainable water and sanitation.

The scope of this study, was to review publications on key factors or areas identified by UNICEF, WHO, United Nation, World Bank, and Research publications on which WASH can plausibly have a strong impact on our health and our environment. This work involved the critical consideration of personal reviewed and other published literature relating to water, sanitation and health in our environment. It aims to provide evidence for specific elements of UNICEF’s WASH Strategy, 2016-2030. In particular, it seeks to present the evidence on the importance of WASH to other environmental outcomes beyond child diarrhoea. A key rationale for investing in WASH is the importance of WASH to other Sustainable Development Goal (SDG) outcomes. The essential inputs that the WASH sector provides, in the form of services and hygiene promotion, have multiple impacts beyond the WASH outcome itself, such as nutritional status, or education. This study describes the contribution to WASH outcomes by other sectors and summarizes the evidence for investment in these areas. It considers the following outcomes to which this scope of study is committed: diarrhoea, nutrition, complementary food hygiene, maternal and newborn health, menstrual hygiene management, school attendance, oral vaccine performance, neglected tropical diseases, and disability. With this in mind, the objectives of this study are specifically to: Interpret the evidence on WASH and qualitative approach to WASH based on the consensus of the evidence established with regard to strategic priorities of UNICEF, International bodies concern and Research publications. State the vision of UNICEF and WHO in achieving clean water, sanitation and environmental hygiene by 2030. Identify the challenges in WASH, WASH related burden diseases and the proposed solution on WASH to be of benefit to our environment.

MATERIALS AND METHODS

Interpreting the evidence on WASH

WASH brings together several interventions, which are frequently implemented by multiple agencies. These interventions affect a wide range of direct outcomes, beyond just health outcomes. As a result, the evidence is complex and, therefore, difficult to classify. Nonetheless, expectations on the quality of evidence needed to justify interventions have increased in recent years, and consensus has formed around rules of best practice for analysis, weighing and combination of such evidence.

Randomized Controlled Trial (RCT) have emerged as the gold standard for quality of evidence as they are judged to reduce systematic error – or bias – to the greatest extent possible (Jüni *et al.*, 2001). Increasingly in the WASH sector, various econometric methods are also being employed to interrogate cross-sectional and longitudinal data to address important questions (Spears, 2012).

Beyond this, there are of course a wide range of qualitative approaches which can be employed in isolation or in combination with quantitative methods, and which are essential to many areas of research, in particular those which are highly sensitive. For example, eliciting information from people about violence – possibly of a sexual nature – experienced while tending to their urinary, defecation or MHM (Menstrual Hygiene Maintenance) needs, can be a difficult process, provoking feelings of shame or inadequacy. Beyond these methods and approaches, a very broad range of research disciplines is actively engaged in WASH research; epidemiologists, economists, microbiologists, geographers, anthropologists, statisticians, and engineers, to name but a few. As a result of this, the WASH literature may reflect the broad challenge of delivering interventions which require both changes in infrastructure and in behaviour, and which influence people's lives in many different ways.

Based on the qualitative approach, there variety of literatures highlighting number of points where evidence-based consensus has been established, or is emerging in these areas, and these are summarized here:

- ✓ Despite discussion in recent years around the best approach for estimating the proportion of the diarrhoeal disease burden attributable to poor WASH, there is strong consensus that the majority of this disease burden is due to poor WASH
- ✓ WASH plausibly influences child growth in multiple ways. While the magnitude of effect for WASH interventions on undernutrition is less clear, there is a strong and growing consensus, in both the WASH and nutrition sectors, that WASH is an essential component of strategies to reduce undernutrition, and that efforts should be concentrated on that.
- ✓ Inadequate food hygiene practices can lead to high levels of microbial contamination of food, and interventions focusing on critical control points may reduce this contamination. While we need to better understand how to assess their impacts on child health, there is growing consensus on the importance of integrating food hygiene components into both WASH and nutrition programmes.
- ✓ WASH plausibly affects maternal and newborn health through multiple direct and indirect mechanisms, and WASH coverage in delivery settings in low and middle-income countries is extremely low. There is a consensus that safe WASH in health facilities—and in other delivery settings—is critical for accelerated progress on maternal and newborn health.

- ✓ Further rigorous research is needed on the impact of poor menstrual hygiene management on environmental and health outcomes, but the challenges and barriers associated with menstrual hygiene management among schoolgirls and women are well documented through qualitative studies. Few would contest that a girl or woman without access to water, soap, and a toilet, whether at home, school, or work, will face great difficulties in managing her menstrual hygiene effectively and with dignity. Furthermore, there is consensus on what is required to enable safe, dignified management of menstrual hygiene: knowledge, materials and facilities
- ✓ In many countries, it has been reported that poor WASH facilities act as a barrier to student attendance and enrolment. This affects girls in particular, but especially girl's post menarche, when their MHM needs may not be addressed. Until recently, there was little robust evidence to support this but there has now been a least one rigorous intervention study supporting the positive effect of improved WASH on school attendance—for both boys and girls—when services are well designed and managed. In addition, there is a growing body of evidence around successful approaches to increasing access to WASH in schools.
- ✓ While the evidence for the impact of WASH on oral vaccine performance is only suggestive and further research is needed to demonstrate its effect, there is a recognition that routine immunization campaigns may be a useful entry point for promoting safe hygiene among caregivers.
- ✓ While investments to address neglected tropical diseases remain largely focused on treatment measures such as mass drug administration (MDA) campaigns, there is strong consensus, supported by good evidence, that WASH plays an important role in preventing the transmission of these diseases.
- ✓ The distribution of WASH-related mortality and morbidity is inequitable, and falls disproportionately on the poor, on women and on children. There is a clear consensus that for WASH policy and programmes to be effective, they must address this inequality.

The vision of UNICEF / WHO on WASH

Water, sanitation and hygiene (WASH) are essential for health, welfare and livelihoods so as to achieve universal access to safe drinking water, sanitation and hygiene. Increased access and better services lead to higher levels of school achievement and improved economic productivity. Yet too many people do not have these basic human rights.

The targets by 2030 are;

- ✓ To eliminate open defecation
- ✓ To achieve universal access to basic drinking water, sanitation and hygiene for households, schools and health facilities;
- ✓ To halve the proportion of the population without access at home to safely managed drinking water and sanitation services; and
- ✓ To progressively eliminate inequalities in access.

These recommendations have been developed through an extensive technical consultation; over 100 experts from over60 organizations worldwide have debated them during the last three years. They are ambitious, yet achievable.

Global challenges in water, sanitation and health

It is currently estimated that 1.1 billion people in the world lack access to improved water supplies and 2.6 billion people lack adequate sanitation (UNICEF *et al*., 2004). The global health burden associated with these conditions is staggering, with an estimated 4000–6000 children dying each day from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene (WSSCC 2004). The UN Millennium Development Goals (MDG) aim to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation by the year 2015.

Although, some parts of the world are making encouraging progress in meeting these goals, serious disparities remain. Lack of access to improved drinking water is still a serious problem in large portions of Asia where an estimated 675 million people are without improved drinking water sources (UNICEF *et al*., 2004). In Sub-Saharan Africa, only 36% of the population has access to basic sanitation (UNICEF *et al*., 2004). To meet the MDG for sanitation alone implies that sanitation must be provided for approximately 2.1 billion people from 2002 to 2015 when adjusting for population growth.

Therefore the challenges affecting water, sanitation and health are;

- ✓ Water quality in distribution systems,
- ✓ Water scarcity, provision of safe,
- ✓ Ecological sanitation
- ✓ Water and sanitation approaches for megacities,
- ✓ Disparities in water and sanitation acces.

In order to provide toilets for 2.1 billion people over 13 years requires a minimum of 44,300 installations per day for the next 13 years (assuming one toilet for every 10 people). If one assumes that the cost per installation is $100 USD for basic dry sanitation, then the investment required just to install the most basic level of sanitation over the next 13 years is $4.4 million USD per day (UN Millennium Project 2005). Meeting the MDGs for water and sanitation in the next decade will require substantial economic resources, sustainable technological solutions and courageous political will. We must not only provide "improved" water and "basic" sanitation to those who currently lack these fundamental services, but also to ensure that these services provide:

- ✓ Safe drinking water,
- ✓ Adequate quantities ofwater for health, hygiene, agriculture and development
- ✓ Sustainable sanitation approaches to protect health and the environment.

The WASH-related burden of diseases:

Poor WASH conditions are major causes of preventable illness and deaths throughout the developing world and are the leading causes of diarrhoeal deaths of children. Globally, 64.2 million disability-adjusted life years (DALYs: DALY is a measure of overall disease burden, expressed as the number of years lost due to ill health, disability or early death.) are attributed to unsafe water, poor sanitation and hygiene practices, (A. Prüss-Üstün, R. Bos, F. Gore, and J. Bartram, World Health Organization, Geneva,2008, cited in Department for International Development Evidence Literature Review, 2011–2012.) of which 52.5 million (82 per cent) are in low-income countries. The burden of disease falls heavily on children, with children under 5 accounting for 88 per cent of the DALYs in low income countries (over 46 million DALYs). Regionally, the burden of disease due to unsafe water and poor sanitation falls heavily on sub-Saharan Africa (46 per cent of global DALYs) and South Asia (34 per cent of total DALYs). The burden of disease falls heavily on children; diarrhoea is the second biggest killer of children under 5 worldwide. Each episode of diarrhoea in children contributes to malnutrition, reduced resistance to infections and when prolonged, to impaired physical and cognitive growth and development as well as school readiness and performance.

- ✓ WASH and stunting**:** A recent Cochrane review found some evidence of a small but significant effect on stunting of certain WASH interventions (Dangour, *et al.*, 2013.).Environmental enteric dysfunction (EED) is a syndrome of inflammation, reduced absorptive capacity and reduced barrier function in the small intestine (Crane *et al.,* 2015).

EED is associated with stunting and underweight as well as the increased risk of serious infection seen in children with undernutrition. It is also implicated in the poor response to oral vaccines (Ali Faisal Saleema, *et al.*, 2015).There is a significant impact of sanitation on stunting (Jeffrey S. Hammer, and Dean Spears, 2013).

Lack of access to safe water and basic sanitation undermines efforts to reach other MDGs. Three quarters of the world's population without sanitation live in 11 countries (United Nations Children's Fund and World Health Organization Joint Monitoring Programme 2012).In terms of proportion of population affected, sub-Saharan Africa and South Asia lag far behind the rest of the world, with many countries in those regions having over 50 per cent of their populations without access to improved sanitation, and the highest proportions of people practising open defecation (41 per cent in South Asia, 25 per cent in sub-Saharan Africa). These data demonstrate the need for targeted sanitation interventions in both sub-Saharan Africa and South Asia in order to address the current lack of progress. Two-thirds of the world population without access to safe water reside in 10 countries. In terms of the proportion of population served, sub-Saharan Africa, with Oceania, lags behind other regions. Sub- Saharan Africa contains the majority of countries considered off track to meet the MDG target.

WASH, poverty and inequality:

- Poor sanitation and high-risk hygiene behaviours confine the poor in a vicious cycle of poor health, environmental degradation, malnutrition, reduced productivity and loss of incomes. For women and adolescent girls, the lack of privacy and dignity has deleterious impacts on health and safety, self-esteem, education and well-being. Even with progress being made to reach the MDGs, the poorest and the most marginalized and vulnerable are being excluded.
- People in rural areas are five times more likely to be without clean drinking water and more than twice as likely to have no access to adequate sanitation as those in urban areas. Less than half the rural population in developing countries have access to improved sanitation, while over one fifth lack access to an improved source of drinking water. However, it is clear that rapidly increasing urban populations are placing greater strain on existing facilities and that the urban poor are very underserved group. While a rural focus may be justified in WASH programmes, the burgeoning needs of the urban poor also require attention.
- Women and girls are affected disproportionately by lack of access to clean water and basic sanitation and as a consequence spend a great deal of time each day queueing for public toilets or seeking secluded spots to defecate, putting them at risk for sexual and other violence. Women are twice as likely as men to fetch water: time that cannot be spent on more productive economic or

social uses. A World Bank study in four countries demonstrated that school attendance for girls increased significantly for every hour reduction in water collection.

- Improvement in hygiene is important, but progress is slow: The adoption of good hygiene behaviours, particularly hand washing, has been shown to have a major impact on health, particularly by reducing diarrhoeal disease. Hand washing also helps reduce acute respiratory infections (ARI), although the evidence is less strong.
- WASH in schools is still under-prioritized in many low-income countries despite its acknowledged benefits: As of 2015, UNICEF found that globally 69 per cent and 66 per cent of schools have access to adequate water and sanitation, respectively. The issue is more serious in least developed countries with 51 per cent coverage in schools for water and only 47 per cent for sanitation. Globally there has been a 6 per cent increase for both sanitation and water coverage in schools between 2008 and 2013 (United Nations Children's Fund, 2014). However, in some cases, WASH facilities may have been built in the first place (when the school was constructed or later on) but not been adequately maintained. Giventhe need for progress in this area, a lot of further investment will be needed specifically targeting the improvement of WASH facilities in schools.
- Climate change affects sustainability of WASH outcomes worldwide, with water stress and scarcity occurring due to changes in precipitation patterns, coupled with increasing demand due to population growth. There will be continued support required for countries' efforts in diseases prevention, emergency preparedness, WASH sustainability and adaptation strategies such as rain water harvesting.
- This will require increasing the capacity of UNICEF so that staff in the field have the appropriate skills and capacity to meet the commitments related to the WASH Core Commitments for Children (CCC) to deploy fully-trained personnel in emergencies and to assist governments in emergency preparedness planning.

Proposed solutions

WASH is an essential foundation for the protection of public health and a life-saving intervention in humanitarian crises. Evidence shows that the sustained utilization of safe drinking water and hygienic latrines together with habitual hand washing with water and soap (at critical times) is effective at reducing WASH associated mortality and morbidity. WASH interventions make a significant contribution to reducing preventable child deaths, addressing undernutrition, helping girls and boys achieve their right to education, reducing the burden particularly on women and girls – of fetching water and ensuring their dignity. While investment in drinking water supplies alone provides benefits in terms of time saved and improved health, investing in a combination ofWASH interventions provides the greatest health benefits.

More specifically, sector interventions are based on:

- ✓ Access to a safe drinking water source located on premises, available when needed and free of faecal (and priority chemical) contamination. Bringing a safe water supply close to households is essential to prevent WASH related diseases and facilitate hygiene by providing more water for a variety of purposes. It also addresses the gender inequity of the burden of water collection borne by women.

- ✓ Access to sanitation, namely the provision of facilities and services for safe management and disposal of human urine and faeces. 'Safely managed sanitation services' means using an improved sanitation facility(Flush or pour flush toilets to sewer systems, septic tanks or pit latrines, ventilated improved pit latrines, pit latrines with a slab and composting toilets.)which is not shared with other households and where excreta is safely disposed in situ or treated off-site. Increasing access to safely managed sanitation services requires scaling up and behaviour change, together with supply-side interventions that work at scale.
- ✓ Hand washing with soap is one of the most cost effective ways of reducing the global infectious disease burden, including diarrhoeal disease and respiratory infections, and is a focus of many public health campaigns. Washing hands with soap can reduce the risk of diarrhoea by 50 per cent(Curtis and Cairncross, 2003.)and ARI by around 20 per cent, thereby addressing two major causes of death among children under 5.
- ✓ WASH facilities/practices in schools can contribute to the control of diarrhoea, helminths and trachoma; it may encourage school attendance, especially of girls, and help children to learn more effectively. Schoolchildren can learn WASH in schools is still under-prioritized in many low-income countries despite its acknowledged benefits. There are sets of interventions ranging from group hand washing to sanitation and water facilities installations in the schools with hygiene promotion programmes.
- ✓ Sustaining existing water supply systems continues to be a major challenge for the sector. Developing capacity of communities and local institutions to manage, repair and maintain water systems as well as supporting government and community to conduct real-time monitoring will help improve service sustainability. This is mainly done through a 'sustainability compact' setting out the obligations of different stakeholders and through 'sustainability audits' that monitor progress against the compacts.

CONCLUSION AND RECOMMENDATIONS

This Review literature has been able to interpret WASH and the affected areas where necessary attention are needed to be given. Also**,** to move along with the mandate of UNICEF and WHO in achieving clean water, sanitation and environmental hygiene by 2030. It has enlightened the society where UNICEF, WHO and other international bodies identified the necessary challenges in WASH, WASH related burden diseases and the proposed solution on WASH to be of benefit to our environment.

To mark the transition from the MDG to SDG era, UNICEF has to develop a new WASH strategy in early 2016 to define the organization's role in helping countries achieve the SDG targets. Which are:

- ✓ No one must practises open defecation;
- ✓ Everyone must has safe water, sanitation and hygiene at home;
- ✓ All schools and health centres must have water, sanitation and hygiene;
- ✓ Water, sanitation and hygiene are sustainable;
- ✓ Inequalities in access should be progressively eliminated.

REFERENCES

A. Prüss-Üstün, R. Bos, F. Gore, and J. Bartram (2008). Safer water, better health: Costs, benefits and sustainability of interventions to protect and promote health, Geneva: World Health Organization, Geneva, cited in Department for International Development EvidenceLiterature Review, 2011–2012.

A.D. Dangour, L. Watson, O. Cumming, et al., (2013). “Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children”, Cochrane Database Systematic Review, vol. 8: CD009382, August 1

Ali Faisal Saleema, (2015). “Immunogenicity of poliovirus vaccines in chronically malnourished infants: A randomized controlled trial in Pakistan,” *Vaccine*, vol. 33, no. 24, June 4, pp. 2757–2763

Cutler, D., & Miller, G. (2005). The Role of Public Health Improvements in Health Advances: The Twentieth-Century United States. Demography, 42 (1), 1-22.

DT Jamison, et.al, Disease Control Priorities in Developing Countries, pp. 771-792.

Esrey, S. (1996). Water, Waste and Well-Being: A Multi-country Study. American Journal of Epidemiology, 143 (6), 608-623.

FACTS AND FIGURES (2004). World Health Organization Water, Sanitation and Hygiene Links to Health -*updated March 2004

Fewtrell, L., & Kaufmann, R. (2005). Water Sanitation and Hygiene Interventions to Reduce Diarrhoea in Developed Countries: A Systematic Review and Meta-Analysis. Lancet Infectious Diseases.

Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000, TheLancet, Vol. 379, No. 9832, 11 May 2012, available at <www.thelancet.com/journals/lancet/article/PIIS0140- 6736(12)60560-1/abstract>, accessed 10 December 2015.

http://www.developmentgoals.org/Environment.htm.

http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.doc [paragraph 7].

Jeffrey S. Hammer, and Dean Spears, (2013). ‘Village Sanitation and Children’s Human Capital: Evidence from a Randomized Experiment by the Maharashtra Government’, Policy Research working paper, no. 6580, World Bank, Washington, D.C., August 1

Jüni, P., Altman, D. G., & Egger, M. (2001). Assessing the quality of randomized controlled trials. Systematic Reviews in Health Care: Meta-Analysis in Context, Second Edition, 87-108.

Mara D. D. & Feachem R. G. (2001). Taps and toilets for all two decades already, and now a quarter century more. August 21:13—14.

Polio Vaccine Fails in India Due to Polluted Drinking Water’, The Refusers, 13 June 2013, available at <http://therefusers.com/refusers-newsroom/polio-vaccine-fails-in-india-due-to-polluteddrinking water/#.Voqo8XlIg5v>, accessed 10 December 2015.

R.J. Crane, K.D. Jones, and James A. Berkley, (2015). “Environmental enteric dysfunction: An overview”, Food and Nutrition Bulletin, vol. 36, no. 1 supplement, pp. S76–87.

Spears, D., Ghosh, A., & Cumming, O. (2013). Open defecation and childhood stunting in India: an ecological analysis of new data from 112 districts. Plot One, 8(9), e73784

UN Millennium Project (2005). Health, dignity, and development: what will it take? Earth scan/James & James, London, UK.

UNDP (2007/2008). Human Development Report. New York: United Nations Development Program.

UNICEF & WHO (2004). Meeting the MDG Drinking Water and Sanitation Target: A Mid-Term Assessment of Progress. UNICEF/WHO, Geneva, Switzerland.

United Nations (2007). The Millennium Development Goals Report 2007. New York: United Nations.

United Nations Children's Fund (2014). 'Advancing WASH in Schools Monitoring', UNICEF, New York, February 2014

United Nations Children's Fund and World Health Organization (2012). Joint Monitoring Programme, Progress on Drinking Water andSanitation, p. 19.

V. Curtis and S. Cairncross (2003). "Effect of washing hands with soap on diarrhoea risk in the community: A systematic review," The LancetInfectious Diseases, vol. 3, no. 5, May 2003, pp. 275-81.

Waddington, H., Snilstveit, B., White, H., & Fewtrell, L. (2009). Water, sanitation and hygiene interventions to combat childhood diarrhoea in developing countries. International Initiative for Impact Evaluation. Synthetic Review 001.

World Health Organization (2000). Global Water Supply and Sanitation Assessment 2000 Report. Geneva, Switzerland: World Health Organization; 2000.

WSSCC (2004). The Campaign: WASH Facts and Figures. http://www. wsscc.org/dataweb.cfm?edit_id=292&CFID=13225&CFTOKEN =70205233.

EVALUATION OF SUSTAINABLE ECOTOURISM PRACTICES OF IDANRE HILLS, ONDO STATE, NIGERIA.

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Abstract
Ecotourism comes with a promise to promote responsible travel to natural areas, positively contribute to environmental conservation, and enhancing the well-being of local communities. This study was aimed at evaluating the environmental impacts of ecotourism practices in Idanre Hills from the perception of the host communities. Total of one hundred and fifty (150) respondents based on their disposition and willingness to participate in the study. The data collected was rated on a five point likert scale and then subjected to weighted mean analysis, descriptive and inferential statistics. Decision rule for upper limit of data for impacts is 4.5-5.0 and the lower limit score < 1.5. The respondents disagreed (2.21) that visits to participate in ecotourism activities have led to destruction of landscape beauty in their community. However, the respondents agreed (3.74) and commented that the ecological environment of the heritage site have been preserved since the inception of tourism in the area. Length-of-stay of the host community respondents' had significant relationship with their perception of the impact of tourism at this level (-0.18). Ecotourism at the site have contributed to the preservation of the natural resources and attractions thereby confirming the attribute of self environmental sustainability of the site.*

***Keywords**: Ecotourism, Idanre hills, Conservation, Heritage*

INTRODUCTION

Although many definitions abound, the most often used definition of sustainable development is that proposed by the Brundtland Commission (Cerin, 2006; Dernbach, 1998; Dernbach, 2003; Stoddart, 2011).The key principle of sustainable development underlying all others is the integration of environmental, social, and economic concerns into all aspects of decision making. All other principles in the Sustainable Development framework have integrated decision making at their core (Dernbach, 2003; Stoddart, 2011). It is this deeply fixed concept of integration that distinguishes sustainability from other forms of policy. Manning *et al.,* (2011) likewise explained that monitoring and evaluating success of ecotourism operations is a critical but sometimes neglected step in all management frameworks. For survival, humans are dependent on eco-system in the form of clean environment, social and economic needs. The survival and quality of eco-system is transformed by humans. For example, energy consumption, deforestation, waste generation in land and ocean, as well as the corresponding carbon emission from these activities can adversely affect these services for future generations (Fayyaz *et al.*, 2018). Investigating the long run association between tourism, energy, and carbon emission for Cyprus, Katircioglu *et al.,* (2014) found that a long run relationship is running from energy consumption and tourism to CO2 emission. Furthermore, conditional causality indicates that tourism has negative impact on environment and increases the energy consumption. Using tourist led CO2 emission from electricity, heating, and transport sectors for Malaysia, Ng *et al.,* (2016) confirms through bound test a long run association among these variables and a further confirmation through the Vector Error Correction Model (VECM) causality approach. Using the panel data of European countries, Arbulú et al., (2015) support the Environmental Kuznets Curve (EKC) hypothesis and suggest that there is a significant relationship between tourism and waste generation. Justification for this research stems from previous studies related to this area which have shown that environmental knowledge, environmental attitude, and environmental behavior are positively related to each other (Lee, K. 2011; Zsóka *et al.*, 2013]. Several studies (Ashley *et al.*, 2001; Maldonado, 2001; Angelica *et al.*, 2010; Datta and Barneji 2015; Fayyaz *et al.*, 2018, etc) have evaluated the sustainable practices of eco-tourism within diverse frameworks with as much focus on its environmental impact. However, there is dearth of information on the environmental sustainability of the Idanre Hills in relation to the adjoining local communities.

MATERIALS AND METHODS

Study Area Description

Location, Size and Boundary

The Idanre hills constitute one of the highest elevated parts of south-western Nigeria. It lies between longitudes 07º00' and 7º10' and latitude 5º00 and 5º13'. An estimated area of 432sq km on the topographic map 1:100,000 sheet 264 of the Nigerian Ordinance Survey map is proposed as the project area. The area of study is characterized by a hilly topography with elevation ranging from about 600ft (182.88 meter) around the south western corner and 2980ft (883.92 meters) above sea level at the north-western corner of the core area of study.

Vegetation of the sites

The vegetation of the core and buffer areas of the proposed Idanre World Heritage site is made up of Forest/Savana mosaic, Riparian forests, and Abandoned farmlands.

Fauna composition of the sites

The fauna composition of the site spread across order *rodentia, canivora, artiodactyla, primates, pholidota, hyracoidea,* etc. Examples are Giant pouched rat *Cricetomys gambianus*, Rufous bellied rat *Lophuromys sikapusi*, Baboon *Papio anubis*, Pangolin *Manis triscuspis*, Mona monkey *Cercopithecus mona*, African Civet *Civettictis civetta*, Duiker *Cephalophus sp*, Bushbuck *Tragelaphus scriptus, etc.*

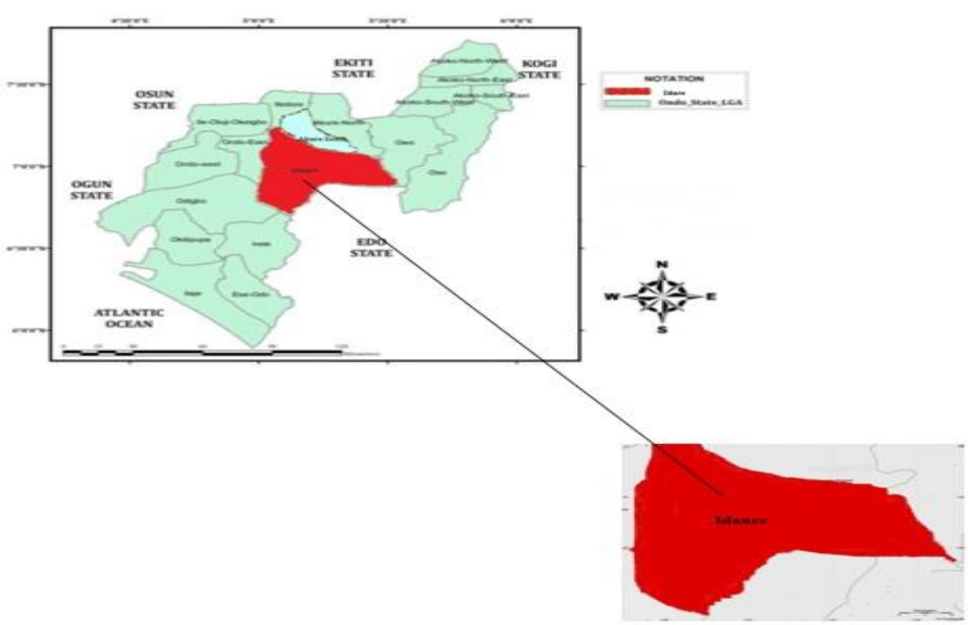

Figure 1: Map of Idanre where the study area is located

Source: Field survey, 2017

Methods of Data Collection and Analysis

Reconnaissance survey was conducted at the study site and the adjoining communities in order to familiarize with the sites and ascertain the dependability of the designed method for the study. Secondary data was collected through review of literatures on the study area. Primary data was collected through administration of structured questionnaire and Field observation and Oral Interview. A multi-stage sampling procedure was used to select sample respondents. In the first stage, three adjourning communities (Alade, Odode, Atosin) to the site was purposely selected based on their proximity to the site. In the second stage, the closest of the three adjourning communities to Idanre Hills was sampled. At the third stage the five quarters which constitute the Odode community were sampled. A total of one hundred and fifty (150) respondents were selected based on their willingness to participate in this study in the following proportion Isalu quarters (50), Idale (25), Yaba (25), Irowo (25), Akpao-Idole (25). A 5-point rating Likert scale (Strongly Disagree=1 to Strongly Agree=5) was used to analyse data obtained on the environmental impacts of ecotourism on the local communities. Weighted mean scores were computed and the upper limit of data concerning the impacts is 4.5-5.0 and the lower limit score <1.5. Descriptive statistics was expressed in tables on percentage and graphs.

Weighted Mean (WM) = fSDX1, fDX2, fUX3, fAX4, fSAX5 = Weighted Frequencies (WF)

Sum of Weighted Frequencies/Sum of Initial Frequencies=Weighted Mean (WM) (i.e.Weighted mean (WM) = **Σwx/Σw**)

Spearman's correlation as a non-parametric test used to measure the strength of association between two variables was used to evaluate the monotonic relationship between socio-demographic characteristics of the community and their perception of the environmental impact of tourism. It is denoted by *P*, the standard Spearman's Rank Correlation Coefficient formula is stated below:

$$\rho = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

Where:

P = Spearman's Rank Correlation coefficient χ_i = Sort the data by the first column

y_i = sort the data by the second column $\sum_I$ = total number of values.

Decision Rule on Environmental Impacts; Strongly agree= 4.5-5.0, Agree= 3.5-4.4, Undecided=2.5-3.4, Disagree=1.5-2.4, Strongly disagree= <1.5

RESULTS AND DISCUSSION

Demographic Characteristics of the Respondents

The research survey was conducted on respondents within the age bracket of 18years and above. Analysis of the data (Table 1) revealed that greater percentage of the respondents obtained tertiary education (34.7%) and these are largely indigenes (Figure 3) that have stayed in the community for a period of 21-30years (32.0%) and above (31.3%).Respondents that are entrepreneurs in small scale businesses represents 42.7% while those that are formally employed are 35.3%. The respondents' level of conservation knowledge (Figure 3) varies from slightly aware (14.7%), moderately aware (46.0%), and aware (18.7%) to highly aware (4.7%).

Table 1: Demographic Characteristics of the Respondents

VARIABLE	FREQUENCY	PERCENTAGE
Gender		
Male	71	47.4
Female	72	48.0
Education		
Non-formal education	2	1.3
Primary	2	1.3
Secondary	42	28.0
Standard school	15	10.0
Teacher grade	29	19.3
Tertiary education	52	34.7
Age		
18 - 30 years	59	39.3
31-50 years	74	49.3
Above 51 years	7	4.7
Marital status		
Single	25	16.7
Married	110	73.3
Widow/widower	6	4.0
Divorced	1	0.7
Religion		
Christianity	121	80.7
Islam	17	11.3
Traditional	3	2.0
Period of stay in the community		
0-10 years	27	18.0
11-20 years	20	13.3
21-30 years	48	32.0
Above 30 years	47	31.3
Occupation		
Farmer	7	4.7
Livestock keeper/pastoralist	6	4.0
Formally employed	53	35.3
Entrepreneur	64	42.7
Others	12	8.0
Household composition		
1	13	8.7
3	7	4.7
4	33	22.0
5	40	26.7
6	34	22.7
7	7	4.7
8	3	2.0
10	1	0.7
Conservation knowledge		
Yes	114	76.0
No	20	13.3

Source: Field survey, 2017

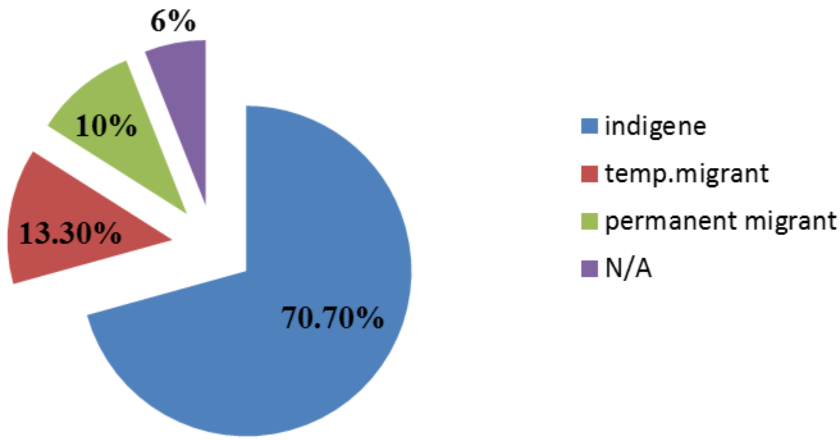

Figure 2: Nativity of host community respondents

Source: Field survey, 2017

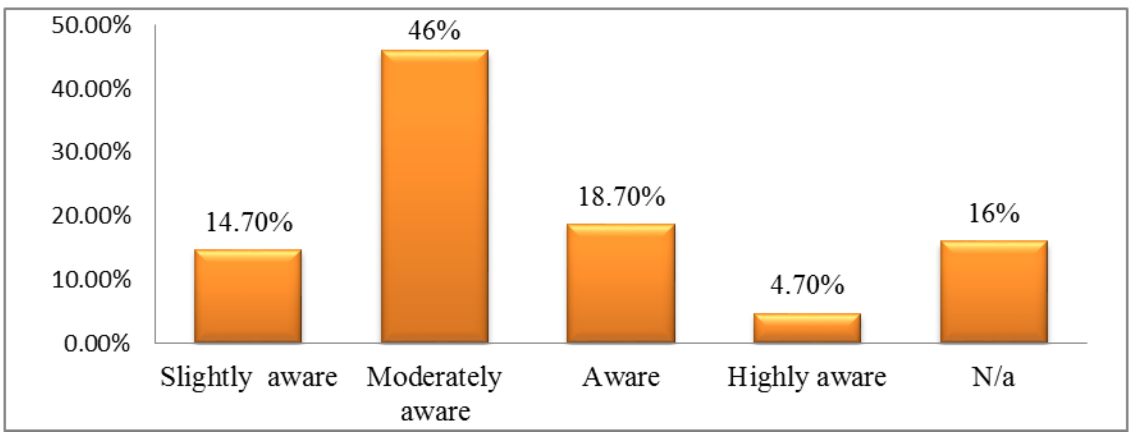

Figure 3: Awareness on conservation, biodiversity and ecotourism among host community respondents

Source: Field survey, 2017

The Environmental Impact of Tourism

The impact of ecotourism on the environmental lives of the respondents was subjected to likert scale of five (Table 2). Weighted mean scores were computed and the upper limit of data concerning the impacts is 4.5-5.0 and the lower limit score <1.5. The respondents disagreed (Weighted mean: 2.21) that visits to participate in ecotourism activities have led to destruction of landscape beauty in their community. Although the respondents largely agreed (Weighted mean: 3.51) to the fact that tourism in their community produces a lot of waste but this is usually effectively controlled as enough waste bins and waste conveying vehicles are always situated at access points for the populace during tourism activities. However, the respondents agreed (Weighted means: 3.74, 3.52, 3.65) and commented that the ecological environment of the heritage site have been preserved since the inception of tourism in the area giving more value to the tangible and intangible resources of the site, this is in tandem with Rathore and Masinda (2011) that tourism provides a reason to preserve the natural scenery and man-made historic sites, ecological sensitive areas, traditional towns and neighbourhoods and protected areas. Angelica *et al.*, 2010 also accrue to this, in their research on the Lapa Rios lodge an ecotourism site in the Osa Peninsula have made impressive contributions to environmental conservation since its opening in 1993.

Table 2: Likert Scale Analysis of the Environmental Impacts of Ecotourism

ENVIRONMENTAL IMPACT VARIABLES								
Pollution								
Tourism creates environmental pollution	6	78	21	41	2	399	2.70	U
Tourism creates noise, littering and congestion	8	63	24	53	0	418	2.82	U
Tourism creates water pollution	24	79	15	26	2	341	3.34	U
Solid Waste								
Tourism produces waste	1	30	20	87	10	519	3.51	A
Tourism biz throw tons of garbage	9	24	34	78	1	476	3.26	U
Tourism destroys the beauty of landscape	31	76	21	16	3	325	2.21	D
Preservation Of Wildlife And Ecology								
Tourism preserve natural environment	0	34	19	81	15	524	3.52	A
Tourism improves ecological environment	1	26	19	67	36	558	3.74	A
Tourism does not contribute o negative vegetation	11	15	23	66	34	544	3.65	A

Key: Strongly agree= SA, Agree= A, Undecided=U, Disagree=D, Strongly disagree= SD
Source: Field survey, 2017

HYPOTHESIS TESTING

Table 3: Relationship between socio-demographic characteristics of the community and their perception of the impact of tourism

The study showed that socio-demographic characteristics of the respondents had significant relationship with their perception on the impact of tourism. Length of stay of the respondents' in the community had significant relationship (-0.18*) with their perception of the impact of tourism. However, Age, had no significant relationship with the respondents' perception of the impact of tourism.

Relationship between socio-demographic characteristics of the community and their perception of the impact of tourism

Variables	(r)	Decision
Sex	-0.00	NS
Age	-0.03	NS
Level of education	0.00	NS
Marital status	-0.10	NS
Religion	-0.05	NS
Nativity	-0.07	NS
How long have you lived in the community	-0.18*	S
Occupation	-0.01	NS

Source: Field survey, 2017
KEY: S= Significant, NS= Not Significant

CONCLUSION

The ecotourism potentials of the Idanre hills are quite revealing and as basis for its qualification as a unique heritage site. The site have contributed to the preservation of natural resources and attractions such as the geological, hydrological, cultural, flora and fauna attractions and resources, thereby confirming the attribute of self environmental sustainability accrued to the site.

REFERENCES

Angelica M. Almeyda Zambrano, Eben N. Broadbent, William H. Durham. (2010). Social and environmental effects of ecotourism in the Osa Peninsula of Costa Rica: the Lapa Rios case. *Journal of Ecotourism* 9:1, 62-83.

Arbulú, I.; Lozano, J.; Rey-Maquieira, J. (2015). Tourism and solid waste generation in Europe: A panel data assessment of the Environmental Kuznets Curve. *Waste Manag.* 46, 628–636. Ashley, Caroline, Roe, D., and Goodwin, H., (2001). Pro-Poor Tourism Strategies: Making Tourism Work for the Poor, *Pro-Poor Tourism Report No. 1, Overseas Development Institute, Nottingham, UK* www.propoortourism.org.uk/strategies.html

Cerin, P. (2006). Bringing economic opportunity into line with environmental influence: A Discussion on the Coase theorem and the Porter and van der Linde hypothesis. *Ecological Economics*, 209-225.

Datta, D. and Banerji, S., (2015): Local tourism initiatve in an eastern Himalayan village: sustainable ecotourism or small-scale nature exploitation? In: Szymańska, D. and Rogatka, K. editors, *Bulletin of Geography. Socio-economic Series*, No. 27, Toruń: Nicolaus Copernicus University, pp. 33–49. DOI: http://dx.doi.org/10.1515/bog-2015-0003.

Dernbach, J. C. (1998). Sustainable development as a framework for national governance. *Case Western Reserve Law Review*, 1-103.

Dernbach, J. C. (2003). Achieving sustainable development: The Centrality and multiple facets of integrated decision making. *Indiana Journal of Global Legal Studies*, 247-285.

Environmental Pollution: Evidence from the One Belt One Road Provinces of Western China. *Sustainability, (www.mdpi.com/journal/sustainability)10*, 3520; doi:10.3390/su10103520.

Fayyaz Ahmad, Muhammad Umar Draz, Lijuan Su, Ilhan Ozturk , Abdul Rauf (2018). Tourism and

Katircioglu, S.T.; Feridun, M.; Kilinc, C. (2014). Estimating tourism-induced energy consumption and CO2 emissions: The case of Cyprus. Renew. *Sustain. Energy Rev*, 29, 634–640.

Lee, K. (2011). The role of media exposure, social exposure and biospheric value orientation in the environmental attitude-intention-behavior model in adolescents. *J. Environ. Psychol*. 31, 301–308.

Maldonado, Carlos, (2001). Turismo: Mercado y Sostenibilidad, *Equipo Técnico Multidisciplinario Para Los Países Andinos, Oficina Internacional Del* Trabajo, Geneva, Switzerland

Ng, T.H.; Lye, C.T.; Lim, Y.S. (2016). A decomposition analysis of CO2 emissions: Evidence from Malaysia's tourism industry. *Int. J. Sustain. Dev. World Ecol.* 4509, 1–12. *[*

Rathore, D. and C Masinda, M. (2011). The Socio-Cultural and Environmental Gains and Loss of Tourism to The Livelihood of Indigenous Societies Living Along The Tourist Road from Makuyuni to Ngorongoro Gate in Arusha, Tanzania. *Proceedings of the eighth tawiri scientific conference, 6th - 8th december 2011, at corridor springs hotel, arusha, tanzania* (p,178).

Stoddart, H. (2011). *Pocket Guide to Sustainable Development Governance* (London: *Stakeholder* Forum and Commonwealth Secretariat), 9, *www.uncsd2012.org/rio20/content/documents/A%20Pocket%20Guide%20to%20Sustainable%20Development%20Governance.pdf.*

Zsóka, Á.; Szerényi, Z.M.; Széchy, A.; Kocsis, T. (2013). Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. *J. Clean. Prod.* 48, 126–138.

COMPARATIVE ASSESSEMENT OF SOME HEAVY METALS BIOACCUMULATION IN JUVENILE AFRICAN CATFISH *(CLARIASGARIEPINUS)* EXPOSED TO DETERGENT AND SPENT OIL POLLUTANTS

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Abstract
Head, trunk and tail of juvenile Clarias gariepinus exposed to pollutants; Detergent, Spent Oil and Detergent & Spent Oil in the volume 20mg/L, 4mg/L and 20mg/L & 4mg/L respectively, and were observed for the uptake of some selected heavy metals (Cu, Pb, Fe, Mn, and Zn). The study reveals the contamination of fish samples with heavy metals. The uptake of heavy metals in Fish samples were in the order of Fe> Zn> Cu> Mn> Pb in all pollutants, in the trend of Head>Trunk>Tail. The highest mean concentration was observed in Fe 48.33 ± 0.88(mg/kg) in the head of samples treated with detergent & Spent Oil, with uptake levels higher than the maximum permissible limits prescribed by WHO/FAO. Whereas the concentration of heavy metals Cu, Pb, Mn and Zn were below the maximum permissible limits. The lowest mean concentration was observed in the tail.

Keywords: *Heavy metals, Bioaccummulation, Catfish, Oil pollutant.*

Environmental pollution is a worldwide problem and heavy metals belong to the most relevant pollutants. The development of industries has led to increased emission of pollutants into the ecosystem (Saleh *et al.*, 2010). Environmental pollution can cause diseases, poisoning, and even bring about mortality for fish and aquatic organisms at large, the absorption and the accumulation of different biological tissues on pollutant varies (Wan *et al.,* 2013). Pollution is the contamination of Earth's environment with materials that interfere with human health, the quality of life, or the natural functioning of ecosystems (living organisms and their physical surroundings). Although some environmental pollution is a result of natural causes such as volcanic eruptions, most is caused by anthropogenic activities. Some of these pollutants sometimes find their way into the human system through the food chain. In the body, pollutants may undergo biotransformation, metabolism and excreted without the risk of toxicity depending on the chemical characteristics and their dose. However, some of the pollutants resist chemical transformation and accumulated in the tissues including the liver, kidney and nerve to cause toxicity (Gabriel, 2006).

INTRODUCTION

Water pollution is the introduction by man, directly or indirectly, of substances or energy to the aquatic environment resulting in delirious effects such as hazards to human health, hindrance to fishing activities, impairment of water quality and reduction of climate amenities. Contamination also, caused when an input from human activities causes an increase of a substance in fresh or seawater, sediment and organism above the natural background level for that area and for those organisms (Clark, 2001). Industrial development in the developing and undeveloped countries has resulted in heavy metal contamination of local water. Metal pollution may damage aquatic organism (either fresh or marine water) at the cellular level and possibly affect ecological balance. Exposure and ingestion of polluted aquatic marine products such as seafood can cause health problems in human and animals including neurological and reproductive problems (Allen *et al.*, 2004).

The term heavy metal refers to any metallic chemical element that has a relative high density and is toxic or poisonous at low concentrations or a metal, often toxic to organisms, that has a relative density of 5.0 or higher, e.g. lead, mercury, copper, and cadmium. Heavy metals consist less than one per cent of living mass organisms, and their different density cause to some disorders, Heavy metals (HM) are natural trace components of the aquatic environment, but their levels have been on the increase due to industrial effluent, geochemical structure, agricultural and mining activities (Sprocati *et al.,* 2006). All these sources of pollution affect the physicochemical properties of the water, sediments and biological components, thus negatively affecting the quality and quantity of fish stocks (Singh et al., 2006) Environmental pollution is a worldwide problem; heavy metals constitute one of the most important pollutant challenges. The progress of industry has led to increased emission of pollutants into the ecosystem. Environmental pollution can cause poisoning, diseases and even death to fish. The absorption and accumulation of different pollutants vary among different biological systems. Therefore, the aim of the present article is to highlight the impact of the bioaccumulation of heavy metals in the head, trunk and tail of fish and the factors affecting their dissemination. The objectives of the study are to know the accumulation levels of toxic heavy metals in Juvenile catfish. These objectives can be achieved through determination of the rate of heavy metals concentration and accumulation using different pollutants (Detergent, spent oil and detergent and spent oil) and the quantity of the accumulation of selected heavy metals (Cu, Zn, Pb, Mn and Fe); identification of the part of the fish (Head, Trunk and Tail) mostly affected; and observing the level of accumulation of the selected heavy metals if it is above the permissible limits of WHO/FAO

MATERIALS AND METHODS

Study Location

The study was conducted in Federal University of Technology Akure, Ondo state Nigeria, at the school fisheries research farm of the fisheries and aquaculture department technology.

Pond Preparation

8 ponds were prepared, limed with agricultural lime $CaCO_3$. Each pond dug to a square shape with a dimension of 2m x 1.4m x 1m and an outlet pipe (0.7m) was fixed with a wire screen **(**72mm**)** at the opening of the pipe to prevent fish from escape and to stop overflow. The water source of the ponds is mainly through seepage and rainfall and was filled to a water level of 0.6m depth.

Experimental Procedure

160 juvenile *Clarias gariepinus* were stocked in the ponds, 20 fishes to each pond with mean weight 28.58± 0.41g and standard length of 6.3 ± 0.3cm, and fishes were acclimatized for 24 hours. After 24 hours, fishes are feed daily in the morning and night with feeds; Durante, Multifeed, Coppens and Vitals feed to each pond respectively. Growth parameters; weight and standard length were taken every 3 weeks.

pollutants was introduced by week 3, The period of the exposure of juvenile Clarias gariepinus to pollutants was such that no mortality was observed in detergent (20mg/L), spent oil (4ml/L) and mixture of detergent and spent oil (20mg/L and 4ml/L) .At week9 fishes were analysed for bioaccumulation of heavy metals of the head, trunk and tail of the fish.

Experimental Design

8 ponds (earthen) with dimension of 2m x 1.4m x 1m, was used for 4 treatments (pollutants) with 1 replicate, the experiment was designed as such, Treatment 1; control, Treatment 2; detergent, Treatment 3; Spent oil and Treatment 4; Detergent and spent oil. The concentration of pollutants are detergent (20mg/L), spent oil (4ml/L) and mixture of detergent and spent oil (20mg/L and 4ml/L) and this was applied every 2weeks.

Sample Preparation

3Samples of juvenile *Clarias gariepinus* were collected randomly from the each pond (FUTA fish farm) and taken immediately to the laboratory for analysis. A clean washed stainless knife was used to cut the fish samples into 3 regions which are the head, trunk and tail region, each sample region is then placed and oven dried at 550^{o}C FOR 24hours in an electric laboratory oven model TT 9803 techmel USA. Each sample was macerated using porcelain mortar and a pestle, 1g of dried fish sample is then taken to the muffle furnace to produce ash, samples are allowed to cool in a desiccator, then mixed with Nitric acid (10ml), add distilled water was added to make up 50ml in a volumetric flask. It was then filtered into a conical flask with filter paper into a dispensing bottle to the extract. Determination of heavy metals was done using the Using Atomic Absorption Spectrophotometer (AAS Model Pye Unicam SP9).

Statistical Data Analysis

Statistical analysis of the results was carried out using analysis of variance (ANOVA) (Ozdmar, 2009). Means of significance were separated using Duncan's t-test ($p<0.05$).

RESULTS AND DISCUSSION

The results in Tables below shows the concentration of selected heavy metals in the head, trunk and tail of Juvenile (Catfish) obtained from samples across treatments and compared with standard guidelines on food safety by the WHO (2011) and FAO (2011).

Table 1: Heavy Metals Uptake Compared in the Head, trunk and Tail of juvenile *C. gariepinus*

	CONTROL				
Fish Part	Fe	Pb	Cu	Mn	Zn
Head	45.41±3.20[a]	0.44±0.44[a]	0.80±0.24[a]	0.75±0.003[a]	17.73±0.77[a]
Trunk	36.24±4.44[b]	0.29±0.29[b]	0.62±0.11[b]	0.59±0.00[b]	5.86±0.02[b]
Tail	27.14±1.16[c]	0.24±0.24[c]	0.19±0.13[c]	0.16±0.01[d]	5.86±0.02[b]
WHO limits, 2011	43.00	2.00	30	N/A	1000

N = 2, (P>0.05), Values are means ± SE from two replicates. N/A= Not available

Table 2: Heavy Metals Uptake Compared in the Head, trunk and Tail of juvenile *C. gariepinus*

	DETERGENT				
Fish Part	Fe	Pb	Cu	Mn	Zn
Head	46.58±2.95[a]	0.34±0.34[a]	1.15±0.38[a]	0.76±0.05[a]	20.11±3.16[a]
Trunk	35.53±5.33[b]	0.25±0.25[b]	0.78±0.28[b]	0.62±0.15[b]	6.96±0.76[b]
Tail	26.31±1.09[c]	0.17±0.17[c]	0.26±0.20[c]	0.18±0.008[c]	6.80±0.92[b]
WHO limits, 2011	43.00	2.00	30	N/A	1000

N = 2, (P>0.05), Values are means ± SE from two replicates. N/A= Not available

Table 3: Heavy Metals Uptake Compared in the Head, trunk and Tail of juvenile *C. gariepinus*

	SPENT OIL				
Fish Part	Fe	Pb	Cu	Mn	Zn
Head	46.76±0.42[a]	0.72±0.63[a]	1.55±0.50[a]	0.76±0.05[a]	24.68±2.43[a]
Trunk	36.17±2.59b	0.47±0.44[b]	0.82±0.23[b]	0.63±0.003[b]	7.35±0.76[b]
Tail	29.35±1.09[c]	0.45±0.28[b]	0.26±0.23[c]	0.18±0.02[c]	7.35±.76[b]
WHO limits, 2011	43.00	2.00	30	N/A	1000

Table 4: **Heavy Metals Uptake Compared in the Head, trunk and Tail of juvenile *C. gariepinus***

	DETERGENT & SPENT OIL				
Fish Part	Fe	Pb	Cu	Mn	Zn
Head	48.33±0.88[a]	0.68±0.48[a]	1.45±0.72[a]	0.75±0.01[a]	24.72±2.74[a]
Trunk	37.05±3.29[b]	0.55±0.43[b]	0.83±0.31[ab]	0.64±0.05[b]	6.78±0.34[b]
Tail	26.50±3.37[c]	0.36±0.30[c]	0.47±0.25[c]	0.18±0.01[c]	6.78±0.34[b]
WHO limits, 2011	43.00	2.00	30	N/A	1000

N = 2, (P>0.05), Values are means ± SE from two replicates. N/A= Not available

Table 5: **Heavy Metals Uptake Compared in the Head, trunk and Tail of juvenile *C. gariepinus***

	FISH PARTS	SELECTED HEAVY METALS (Mg/Kg).				
		Fe	Pb	Cu	Mn	Zn
CTRL	Head Trunk Tail	45.41±3.20[a] 36.24±4.44[b] 27.14±1.16[c]	0.44±0.44[a] 0.29±0.29[b] 0.24±0.24[c]	0.80±0.24[a] 0.62±0.11[b] 0.19±0.13[c]	0.75±0.003[a] 0.59±0.00[b] 0.16±0.01[d]	17.73±0.77[a] 5.86±0.02[b] 5.86±0.02[b]
DET	Head Trunk Tail	46.58±2.95[a] 35.53±5.33[b] 26.31±1.09[c]	0.34±0.34[a] 0.25±0.25[b] 0.17±0.17[c]	1.15±0.38[a] 0.78±0.28[b] 0.26±0.20[c]	0.76±0.05[a] 0.62±0.15[b] 0.18±0.008[c]	20.11±3.16[a] 6.96±0.76[b] 6.80±0.92[b]
SP. OIL	Head Trunk Tail	46.76±0.42[a] 36.17±2.59[b] 29.35±1.09[c]	0.72±0.63[a] 0.47±0.44[b] 0.45±0.28[b]	1.55±0.50[a] 0.82±0.23[b] 0.26±0.23[c]	0.76±0.05[a] 0.63±0.003[b] 0.18±0.02[c]	24.68±2.43[a] 7.35±0.76[b] 7.35±0.76[b]
DET&SP. OIL	Head Trunk Tail	48.33±0.88[a] 37.05±3.29[b] 26.50±3.37[c]	0.68±0.48[a] 0.55±0.43[b] 0.36±0.30[c]	1.45±0.72[a] 0.83±0.31[ab] 0.47±0.25[c]	0.75±0.01[a] 0.64±0.05[b] 0.18±0.01[c]	24.72±2.74[a] 6.78±0.34[b] 6.78±0.34[b]

RESULTS AND DISCUSSION

The results in the Tables above shows the heavy metals concentrations are the highest in fish samples contaminated with detergent mixed with spent oil, spent oil, and detergent and control respectively, and. It shows that the distribution of these heavy metals varies with body part, that the head has the highest concentration followed by the trunk and the tail. The adsorption of metals onto the gills surface as the first target for pollutants in water could also be a significant influence in the total metal levels of the gills (head). Target organs such as gills and intestine are metabolically active parts that can accumulate heavy metals in higher levels (M. Khail et al., 2008). The estimated accumulation of heavy metals in the Fish samples in all treatments (control, detergent, spent oil and spent oil & detergent) were all in the descending order :Fe> Zn > Cu> Mn> Pb.

The grand mean concentrations of the selected heavy metals in these fish samples were such that, the highest grand mean concentrations of Fe found in the Head, Trunk and tail across treatments are head (detergent & spent oil);48.33±0.88(mg/kg),trunk(detergent & spent oil); 37.05±3.29(mg/kg), and tail(spent oil); 29.35±1.90(mg/kg) respectively, while the lowest grand mean concentrations of Fe found in the Head, Trunk and tail across treatments are head (control); 45.41±3.20(mg/kg), trunk(detergent);0.25±0.25(mg/kg) and tail(detergent); 0.17±0.17(mg/kg).

Iron (Fe) is essential to most life forms and to normal human physiology. In humans, iron is an essential component of proteins involved in oxygen transports from the lungs to the tissues (Dallman, 2006). It is also essential for the regulation of cell growth and differentiation. The grand mean concentration of iron 48mg/kg was higher than WHO/FAO maximum permissible limit of 43mg/kg for Catfish. Fe interactions in biological tissues has reported that excess amount of Fe causes rapid increase in pulse rate and coagulation of blood in blood vessels, hypertension and drowsiness (Davies etal., 2006).

Zinc (Zn) is toxic to fish and macroinvertebrates at sublethal concentration (Nwani et al., 2007). Although zinc is an essential element (Dimari et al., 2008) it is a potential toxicant to fish (Farkas et al., 2008) with adverse effects. The highest grand mean concentration for zinc in the head, trunk and tail across treatments are head (detergent & spent oil); 24.72±2.74 (mg/kg), trunk (spent oil) 7.35±0.76 (mg/kg) and tail (spent oil) 7.35±0.76 (mg/kg), while the lowest grand mean found in the head, trunk and tail are all found in (control); Head; 17.73±0.77 (mg/kg), Trunk (control); 5.86±.022(mg/kg), and tail 5.86±.022(mg/kg). The bioaccumulation of zinc affects tissue respiration leading to death by hypoxia, induces changes in vein and heart physiology, and causes a significant decrease in haemoglobin and haematocrit. Decreases plasma protein (Kori-Siakpere et al., 2008)

The estimated accumulation of Copper (Cu) with the highest grand mean concentration in the head, trunk and tail across treatments are all found in the treatment with detergent head1.15±0.38(Mg/kg), trunk 0.78±0.28(Mg/kg), and tail 0.26±0.20(Mg/kg)while the lowest grand mean concentrations were found in control Head 0.78±0.24(Mg/kg), Trunk 0.62±0.11(Mg/kg), and tail 0.19±0.13(Mg/kg),, High concentrations of copper can alter haematology (James et al., 2008), respiratory and cardiac physiology (Sorensen 1991), and may also lead to retarded growth and inhibition of spawning (Benoit, 2005). Concentrations as low as 5.3 to 31.9 mg/ℓ in soft waters may be toxic to larval fish (depending on the pH and dissolved organic carbon and calcium concentrations),

Manganese is an essential trace element for both animals and man; necessary for the formation of connective tissues and bone, growth, carbohydrate and lipid metabolism, embryonic development of the inner ear, and reproductive function (WHO, 2011). The highest grand mean concentration of manganese detected in the Head trunk and tail of fish samples from this study are Head (spent oil); 0.76±0.05(mg/kg); trunk(detergent and spent oil); 0.64±0.05(mg/kg) and tail(spent oil); 0.18±0.02(mg/kg) while the lowest grand concentration detected are all found in (control) Head; 0.75±0.00(mg/kg), trunk 0.5900±0.00 (mg/kg) and tail 0.16±0.01 (mg/kg) which are all below the WHO/FAO maximum permissible limit of 5.5(mg/kg), symptoms of manganese toxicity in man include dullness, weak muscles, headaches and insomnia but from the results of this study, the traces found in the fishes could not cause such severe health effects in a short run among the majority of fish consumers. Mn in the fish samples could also be traced to entry to the pond through the introduction of detergent and spent oil overtime.

Relatively low concentrations of Pb were found in fish samples with the highest grand mean concentration detected are as such that the head (spent oil) 0.72±0.63(mg/kg), trunk(detergent & spent oil) 0.55±0.43(mg/kg) and tail (spent oil) 0.45±0.28(mg/kg) were found, compared to those of the lowest grand mean concentration found in the head 0.34±0.34 (mg/kg), trunk 0.25±0.25(mg/kg), and tail 0.17±0.17167(mg/kg) which were found in the treatment with detergent.

CONCLUSION

In very small concentrations, many of these metals are necessary to support life. However, in larger concentrations, they become toxic. They build up in biological systems and become a significant health hazard. This study shows that the distribution of these heavy metals varies with body part of fish samples, that the head has the highest concentration followed by the trunk and the tail. The adsorption of metals onto the gills surface as the first target for pollutants in water could also be a significant influence in the total metal levels of the gills (head). It indicates that while the concentration of Zn, Cu, Mn, and Pb both in the Head, Trunk and tail of all the fish samples were within the WHO (2011) and FEPA (2003) prescribed limits that of Fe (except in the trunk and tail), were beyond the limits. The general trend of bioaccumulation of metals were all the same with all pollutants, Fe at the highest while Pb at the lowest closely followed by Mn, Cu and Zn in ascending order. The highest concentration observed with pollutants is the spent oil.

Although, the concentrations of most heavy metals especially in the detergent did not reach critical levels presently, the cumulative effect might be dangerous in the future if exposure to pollutants is long term.

REFERENCES

Abu Hilal, A. H., Ismail, N. S., 2008, Heavy Metals in Eleven Common Species of Fish from the Gulf : Journal of Biological Sciences, V.1, Number 1, P. 13 . 18.

Adewoye, And Lateef, A. (2004): Evaluation of the microbiological characteristics of Oyun river – A polluted river in North-central Nigeria. Pollution Res23 (14); 587 – 591.

Adewoye, S. O. And Fawole, O. O. (2002). Acute toxicity of soap and detergent effluent to fresh water *Clarias gariepinus* fingerlins. African J Sci (In press).

Adewoye, S.O., Fawole, O.O., Owolabi, O.D. And Omotosho, J.S. (2005).Toxicity of cassava wastewater effluents to African catfish: *Clarias gariepinus* Ethiop. J. Sci., 28 (7): 189-194.

Ajiwe, V. I. E., Nnabuike, R. O., Onochie, C. C. And Ajiobola, V. (2000). Surface water pollution by effluents from some industries in Nnewi Area. Journal of Applied Science, 4(2): 810 – 820.

Alabaster, J.S., Lloyd, R., (1980). Water quality criteria for fish, 2nd. Ed., London, Butterworths. Atuma, S.O., Egborge, A.B.M., (1986).

Allen, J. And M. Moore, 2004. Environmental prognostics: Is the current use of biomarkers appropriate for environmental risk evaluation?. Marine Environmental Research, 58: 227-232

Allen, P.: Chronic Accumulation of Cadmium in the Edible Tissues of *Oreochromis aureus* (Steindachner): Modification by Mercury and Lead. Arch. Environ. Contam. Toxicol., 29, 814 (1995).

AnetorJi, AdeniyiFaa, OlaleyeSB (2003). Molecular Epidemiology: A Better Approach for the Early Detection of Pathophysiologic Response to Environmental Toxicants and Diseases. Afri. J. Biomed. Res. 6: 113-118.

Ayandiran T. A, Fawole O. O, Adewoye S. O. And Ogundiran M. A. (2009). Bioconcentration of metals in the body muscle and gut of *Clarias gariepinus* exposed to sublethal concentrations of soap and detergent effluent. J. Cell Anim. Biol. **3** (8) 113-118.

Begüm, A., Amin, M.D.N., Kaneco, S., And Ohta, K., (2005). Selected elemental composition of the muscle tissue of three species of fish, Tilapia nilotica, Cirrhinamrigalaand Clariusbatrachus, from the fresh water Dhanmondi Lake in Bangladesh. Food Chemistry, **93:** 439–443.

Benoit Da (1975) Chronic effects of copper on survival, growth, and reproduction of the bluegill (Lepomismacrochirus). Trans. Am. Fish. Soc. **2**: 353-358.

Bhattacharya, A. K., Mandal, S. N. And Das, S.K. (2008). Heavy metals accumulation in water, sediment and tissues of different edible fishes in upper stretch of gangetic West Bengal. Trends in Applied Science Research, 3: 61 – 68.

Bruton, M.N. & Allanson B.R. 1980. Growth of Clariasgariepinusin Lake Sibaya, South Africa. South African Journal of Zoology 15: 7-15.

Bruton, M.N. 1979a. The food and feeding behaviour of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, South Africa, with emphasis on its role as a predator of cichlids. Transactions of the Zoological Society of London 35: 47-114.

Bruton, M.N. 1979b. The breeding biology and early development of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, South Africa, with a review of breeding in species of the subgenus Clarias (Clarias). Transactions of the Zoological Society of London 35: 1-45.

Bruton, M.N. 1979c. The survival of habitat desiccation by air-breathing Clariid catfishes. Environmental Biology of Fishes 4: 273-280. Page | 19

Clark, R.B., 2001. Metals. In: Marine pollution. Oxford University Press, Oxford, 5th Ed., pp: 98-125.

Dallman P.R. (2006). Biochemical basis for the manifestations of iron deficiency. Annual Review of Nutrition ;6:13-40.

Dimari, G. A., Abdulrahman, F. I., Akan, J. C. And Garba S. T. (2008). Metals concentrations in tissues of Tilapia galilaeus, Clariaslazera and Osteoglossidae caught from Alau Dam, Maiduguri, Borno State, Nigeria. American Journal of Environmental Science, 4(4): 373 – 379.

Eniola, K.I.T. And Olayemi, A.B. (2002). Some Aspects of Bacterial-Detergents interaction in fresh water environment. Bioscience Research communication 14 (6): 645-649.

Ezemonye, L. I. N. And Kadiri, M. O. (2000). Biorestoration of the Aquatic Ecosystem: The African perspective. Environmental Review, 3(1): 137 – 147.

Ezemonye, L. I. N., Enobakhare, V. And Ilechie, I. (2006). Bioaccumulation of heavy metals (Cu, Zn, Fe) in freshwater sanila (Pila ovate; Oliver 1804) from Ikpoba River of Southern Nigeria. Journal of Aquatic Sciences, 21(1): 23 – 28.

FAO/WHO (2011); Joint FAO/WHO food standards programme codex committee on contaminants in foods, fifth. Session pp 64-89.

Farkas, A., Salanki, J. And Specziar, A. (2002): Relation between growth and the heavy metals concentrations in organs of bream, Abramisbrama L. populating lake Blaton. Arch. Of Environ. Contam. Toxicol. 43(2): 236- 243.

Federal Environmental Protection Agency (Fepa) (2003). Guidelinesand Standards for Environmental Pollution Control in Nigeria, pp. 108.

Folournsho, B. And Oronsaye, J. A. O. (1990). The toxicity of cadmium to Clariasangularias in soft water. Nigerian Journal of Applied Sciences, 8: 85 – 92.

Gabriel, O.M., O. Rita, A. Clifford And O. Kennedy, 2006. Heavy metal pollution of fish of Qua-Iboe River Estuary: Possible implications for neurotoxicity. The International Journal of Toxicology, 3(1): 1-6.

IGFA, 2001. Database of IGFA angling records until 2001. IGFA, Fort Lauderdale, USA. Johnels, A.G. 1957. The mode of terrestrial locomotion in Clarias. Oikos 8: 122-129.

Hecht, T. &Lublinkhof, W.1985. Clariasgariepinusx Heterobranchuslongifilis(Clariidae: Pisces): a new hybrid for aquaculture. South African. Journal of Science 81: 620-621.

Hecht, T., Uys, W. &Britz, P.J. (Editors). 1988. Culture of sharptooth catfish, Clarias gariepinus, in southern Africa. National Scientific Programmes Unit: CSIR, SANSP Report 153, 1988, pp 146.

Henken, A.M., Brunink, A.M. & Richter, C.J.J. 1987. Differences in growth rate and feed utilization Page.20

Kori-Siakpere, O. And Ubogu, E. O. (2008).Sublethal haematological effects of zinc M. Khail and H. Faragallah, Egypt J. Aquat. Res., 34 (2008) 1. 366(2-3): 649-658.

Mason, C. 2006. Biology of freshwater pollution. Longman Scientific and Technical, Harlow, England.

Nwani, C. D., Nwoye, V. C., Afiukwa, J. N. And Eyo, J. E. (2009). Assessment of heavy metal concentrations in the tissues (gills and muscles) of six commercially important freshwater fish species of Anambra River south-east Nigeria. Asian Journal of Microbiology, Biotechnology and Environmental Sciences, 11(1): 7 – 12.

Obasohan, E.E. (2007). Heavy metal concentrations in the offal, gill, muscles and liver of a freshwater mudfish (Parachanaobscura) from Ogba River, Benin City, Nigeria. African Journal of Biotechnology, 6(22): 2520 – 2627.

Ogundiran M.A, Fawole, O.O., Adewoye, S.O. And Ayandiran, T. A. (2009) Pathologic Lesions in the Gills Structures of Clarias gariepinus on exposure to sub lethal concentrations of soap and detergent effluents. J Cell and Animal Biol 3 (5), 078-082

Ogundiran, M. A.,Fawole, O. O. And Adewoye, S. O.(2007). Effects of Soap and Detergent Effluents on the Haematological Profiles of Clarias gariepinus. Science focus 12(1) 84-88.

Oguzie, F. A. (2003). Heavy metals in fish, water and effluents of lower Ikpoba River, Benin City. Pakistan Journal of Science and Industrial Research, 46(3): 156 – 160

Olojo, E. A. A., Olurin, K. B., Mbaka, G. And Oluwe-Mimo, A. D. (2005). Histopathology of the gill and liver tissues of the African catfish Clarias gariepinus exposed to lead. African Journal of Biotechnology, 4(1): 117 – 122.

Oze O, Oze R, Anunuso C, Ogukwe C, Nwanjo H, Korie K (2006). Heavy Metal Pollution Of Fish Of Qua-Iboe River Estuary: Possible Implications For Neurotoxicity. The Internet J. Toxicol. 3(1)

SUSTAINABLE MANAGEMENT AND INTEGRATED CULTURAL LANDSCAPE APPROACH IN NIGERIA

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Abstract

Over the years concerted efforts are being put in place by the Federal Government of Nigeria in a bid to ensure enlistment of additional heritage properties on UNESCO World Heritage List. The paper examined underlying factors hindering the successful enlistment and sustainable development of Cultural Landscape in Nigeria with a view to achieve inclusive and integrated cultural landscape approach. Bottom top management approach, ignorance, vandalism , stealing, poaching, weak government policy, indiscriminate consumption and utilization of heritage resources form part of the challenges toward achieving sustainable development. Strict compliance with the guiding principles of the proposed frame work on Integrated Community Based Management (ICBM) approach as developed in this write-up will greatly safeguard cultural landscape in Nigeria from ineffective top bottom management principle and other identified threats. Policy makers, conservation professionals, researchers in the field of Heritage resource Conservation, ecotourism and cultural heritage tourism will find the ICBM approach very useful.

Keywords: *heritage properties, sustainable development, community, cultural landscape.*

INTRODUCTION

In September 25th 2015, countries adopted a set of 17 goals to end poverty**,** protect the planet and ensure prosperity for all across the World as part of a new sustainable development agenda.Each of these goals have specific targets set to be achieved over the next fifteen years.

Information obtained from the United Nations Sustainable Development Goals Knowledge Platform revealed detail account of concerted efforts United Nations have demonstrated toward saving the world from poverty, fostering partnership and integration and ensuring environmental sustainability. This is dated back to June, 1992 Earth Summit in Rio declaration, Brazil to September 2015 in New York where 2030 Agenda for Sustainable Development with 17 goals at the UN Sustainable Development Summit was adopted.

Sequel to the Earth Summit in Rio de Janeiro, Brazil, members of the United Nations adopted the Millennium Declaration at the Millennium Summit in September, 2000. This summit led to the elaboration of eight Millennium Development Goals (MDGs) targeted at reducing poverty by the year 2015. Between September 2000 and year 2015 series of meetings have been held ended with declaration and outcome document. Notable among these include Johannesburg Declaration on Sustainable Development and the Plan of Implementation, adopted at the World Summit on Sustainable Development in South Africa in 2002. At this summit, the member states reaffirmed their commitments to poverty eradication and the environment, and built on Agenda 21 and the Millennium Declaration by including more emphasis on multilateral partnerships. Twenty years after the Earth Summit that was held in Rio de

Janeiro in 1992, another United Nations Conference on Sustainable Development popularly referred to as Rio+ 20 was held in in June 2012 with the adoption of the outcome document Future We Want". At this conference an agreement was reached, inter alia, to launch a process to develop a set of SDGs to build upon the MDGs and to establish the UN High-level Political Forum on Sustainable Development. The Rio +20 outcome also contained other measures for implementing sustainable development, including mandates for future programmes of work in development financing, small island developing states and more. As it that was not enough, in 2013 the General Assembly set up a 30-member Open Working Group to develop a proposal on the SDGs. In January, 2015 was regarded as post-2015 development agenda this culminated to the adoption of 2030 Agenda for Sustainable Development with 17 goals at the UN Sustainable Development Summit in New York in September 2015.

Prior to the Earth Summit in Rio de Jainero in 1992, precisely on the 16th Nov, 1972 at the 17th session of the general conference of the United Nation for Educational, Scientific and Cultural Organisation (UNESCO) the attention of the World was drawn on the need to protect and conserve the World Cultural and Natural Heritage. This convention was declared primarily UNESCO convention concerning the protection and preservation of the World Cultural and Natural heritage. The most significant feature of the 1972 World Heritage Convention is that it links together in a single document the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two. The 1972 World Heritage Convention is recognized as one of the oldest and best supported of the international Multilateral Environmental Agreements (MEAs). The World Heritage Convention was signed into beingby the UNESCO General Conference in 1972 and has been ratified (at early 2011) by 187countries (States Parties), meaning it is almost universally embraced (UNESCO, 2012).

Natural and Cultural heritage are regarded as properties with scientific, conservation and aesthetic values (UNESCO, 2000).Within the two definitions of ‘cultural heritage’ and ‘natural heritage’ the World Heritage Convention recognizes four different types of World Heritage property including Cultural properties, Natural properties,Mixed properties and Cultural Landscape. Cultural landscape are illustrative of the evolution of human society and settlement over time under the influence of physical constraints and opportunities presented by their natural environment and of successive social, economic and cultural forces both internal and external (ICOMOS, 2001).
The World Cultural and Natural Heritage are regarded as tourist magnate of intrinsic values attracting attention of large number of visitors. Oladeji, 2016 opined that heritage resources are irreplaceable sources of life and inspiration, our touchstones, our points of reference, our identity and contemporary tourist magnate.

The need to integrate sustainable tourism principles into the mechanisms of the World Heritage approach has been realized by UNESCOin setting up UNESCO World Heritage and Sustainable Tourism Programme (UNESCO-WHSDP). UNESCO-WHSDP is a new approach based on dialogue and stakeholder cooperation where planning for tourism and heritage management is integrated at a destination level, the natural and cultural assets are valued and protected, for sustainable development through appropriate tourism management (UN World Tourism Organisation, 2005)

The International Experts Meeting on Cultural Landscapes of Outstanding Universal Value held in Templin, Germany, in 1993, has drafted an action plan that assist the States Parties in the identification, assessment, nomination and management of these properties for their inclusion in the World Heritage List. This action plan has been approved by the World Heritage Committee with emphasis on the need for the inclusion of cultural landscapes on the lists.

Soon after, the first inscriptions started to occur. The associative cultural landscape of the Maori sacred mountains in Tongariro National Park, New Zealand was the first site inscribed. Between 1993 and 2007, more than forty cultural landscapes were designated as World Heritage sites.
The three established categories of cultural landscape are designed cultural landscape, organically evolved cultural landscape and the associative cultural landscape are all represented on the list, with the majority of these sites in Europe, although there are some from other parts of the world. Ironically, Nigeria can only boast of two these cultural landscape-Sukur Cultural landscape in Adamwa State and Osun Osogbo sacred grove, Osun State. Others that have been nominated but are yet to be enlisted on UNESCO Heritage List include Idanre hill is categorized as associative cultural landscape is a landscape with powerful definable, religious, artistic or cultural associations with the natural element rather than material cultural evidence, which may be insignificant or even absent. Primitive peoples historically maintained a spiritual relationship with the nature around them. In all cultures, man attributed supernatural meanings to the natural surroundings: land to plant, forests, mountains, caves, rivers, lakes, or seas. These elements, which gave rise to myths, religious beliefs or practices, became an indispensable part of the vision of the world and identities of many peoples and have been passed down from one generation to another. For that reason they were closely connected to their daily life and generated strong feelings of ownership and belonging.

The Idanre hills constitute one of the highest elevated parts of southwestern Nigeria. The area of study is characterized by a hilly topography with elevation ranging from about 600ft (182.88 meter) around the south western corner and 2980ft (883.92 meters) above sea level at the northwestern corner of the core area. Idanre hill has some other adjourning hills that are significant to the community. The hills include Orosun hill, Ahaha hill and Ilarun hill that surround the ancient Idanre; Others are Okinkinrin hill at Ugbolokun; Lagigbidi hill at Oke Iwonja and Abalofin hill at Igbiepo.

Management of Cultural landscape in Nigeria

The mannerof management isregarded as determinant factor towards achieving sustainability and integrated approach in cultural landscape conservation. Lynn and Schenck (2008) described management as a way of getting work done through the efforts of others. Mitch, 2004 examined management as a process of forming a strategy and the implementation and executing the strategy. Management consist of interrelated tasks of formulating, planning and implementing policy; controlling, channeling and allocating organization's resources in order to achieve the set objectives of a particular programme. Management can either be bottom up, top bottom or collaborative process.

Management practices adopted in Sukur Cultural landscape and Osun Osogbo acred grove differ from those other cultural landscapes that are not on UNESCO List. While institutions like National Commission for Museums and Monuments established by Decree number 77 of 1979 are charged with the responsibilities of ensuring maintenance, inventory, conservation, promotion and training and research of cultural landscape, other public institutions like Ministry of Culture and Tourism, Nigeria Films Censorship Board National Copyright Commission, National Gallery for Arts also perform their statutory functions (Emeghara, 2015). It is observed that there is no recognize local community organization or group among the list of institutions that oversee managementof cultural Landscape that not yet enlisted on UNESCO List .Thus, the management approach can be regarded as top–bottom.

This is unlike what is operating in the two cultural landscape that already enlisted on UNESCO List. Sukur Cultural Landscape and Osun Osogbo grove are guided by the UNESCO policies and directive. According to the international management standards for heritage site management, heritage sites management is the general responsibility of the National governing body with the management directives from UNESCO. The National Heritage Board and the Country Administration Board may take such conservation measures necessary in order to protect and care for ancient monuments and remains that include relocation, refurbishment, and enclosure or preservation of the ancient monuments and remains or clearance (UNESCO, 2002). ICOMOS, 1999 stated that heritage conservation is considered as integration of the processes including retention, reintroduction, maintenance, preservation, restoration, reconstruction, adaptation and interpretationthat tend to retain importance of all historic places which are selected.

There is therefore a need for a shift in pragmatism from top bottom approach to a collaborative and stakeholders engagement in other to achieve integrated cultural landscape approach in Nigeria. This forms part of the view of Lynn and Schenck (2008) and Mitch, 2004 while examining the concept and significance of effective heritage management as an important tools in heritage site management. This is clearly stated in Article 5(a) of the World Heritage Convention that each State Party which has signed theConvention 'to adopt a general policy which aims to give the cultural and natural heritage afunction in the life of the community and to integrate the protection of that heritage into comprehensive planning programmes'(UNESCO, 2012). This is an essential part of World Heritage site Management that could be adopted in the management of Cultural landscape in Nigeria that all stakeholders possibly affected by the listing of a site should be made aware of, consulted and involved in the interpretation and assessment of its values, the preparation and presentation of the nomination and subsequent management systems.

Community participation in heritage management has become a worldwide phenomenon since the last two decades as the bottom-up approach has spread across the field of heritage conservation (Yung and Chan, 2011). The shift of the focus of heritage conservation from place-based conservation to more people-centered conservation (that is from conservation of only built heritage to conservation of the cultural heritage of the people) has contributed largely to this notion. The recognition of heritage has been broadened from only monuments and sites to cultural landscape and intangible heritage (Jokilehto, 2017). According to Chitty, (2017), 'locally-led, active participation and social relevance are, then, dominant characteristics of the 21st century democratized cultural heritage practice'. In this new approach, because of the nature that the culture of the communities is the focus and is to be preserved, the participation of local communities is essential so they can be involved in the decision-making process. This allows them to not only express their opinions, but also to actually take part in the planning and management processes of heritage conservation.

The importance of community participation in planning, development, and management in heritage conservation has also been acknowledged by international organizations. The policy of the United Nations' Educational and Scientific Organization (UNESCO) has been adopting the view that 'heritage protection does not depend alone on top-down interventions by governments or the expert actions of heritage industry professionals but must involve local communities' since the conference in Amsterdam in 2003 on 'linking universal and local values' (Labadi and Logan, 2016). In many countries, participatory approaches to heritage conservation and management have proven to be successful and more culturally and socially sustainable than top-down approaches. Through involving local communities in heritage management, benefits can be brought about not only for the communities themselves, but also for the society as a whole. Socially, the community life can be improved. Community participation helps the communities build a sense of identity, community, and place because it gives the communities stronger links to a common identity, history and heritage. Besides, social inclusion, cohesion, and understanding can be strengthened by fostering a sense of shared responsibility towards the places in which people live. Social capital and trust between people and the government can be increased (Cimadomo, 2015; Labadi, 2016).

Threats to conservation and management of cultural landscape in Nigeria

Greatest threat that militates against the protection and conservation of cultural landscape with associated resources in Nigeria is ignorance.This assertion is based on the findings from literatures (Ogunmola, 2016) and confession from the culprits apprehended in act of poaching, stealing, lumbering and act of vandalism to cultural and natural heritage resources in notable cultural landscape in Nigeria (Oladeji and Olupinla 2016;).It will be recalled that cases of poaching, stealing,vandalisation and indiscriminate felling of trees have been recorded in some of the cultural herniate landscape in Nigeria.In February, 2015, a major stakeholder, a traditional Chief of Idanre also at the Core Zone felled trees and cut them into planks with the intention of building a five star Hotel at the site.Poaching and killing of Elephant that was reported in Idanre on the eve of Wildlife Day in March 2017 caught the attention of the worldNaturally, it is evident that people are not conditioned to preserve anything that they place no value on. Majority of Nigerians are ignorant of the values and relevance of cultural heritage resources to the development of the society. According to McKercher and du Cros, 2002, ignorance of the negative impacts of tourism exists in countries where the growth of heritage tourism is starting to take off and ethos of conservation has not been established.

Closely linked to ignorance is neglect on the part of Museum Professionals and Heritage officers which leads to irreversible damage to cultural objects (Eluyemi 2002). In abid to promote tourism in cultural landscape, improper site planning leading to construction of infrastructure facilities to satisfy tourists is a major threats to the cultural properties. For instance, the construction of Dam project at the Core Zone of Idanre Hill in a bid to promote tourism to the site destroy the cultural and traditional symbol of Arun river .It altered the course of Arun river and in the process destroyed the authenticity and integrity of the site; being one of the reasons that made UNESCO to consider Oke-Idanre cultural landscape for enlistment in the first place. Modernization has greatly altered the authentic values of cultural landscape. Timothy and Nyaupane (2009) and Timothy, (2011) opined that many residents in less developed and developing regions are less committed to preservation of cultural heritage properties as they connect it with

backwardness and it is antithetical to modernization. After all this may lead to resident's actions of scarpping the old cultural heritage resources and replacing with the new ones (Gazaneo, 2003).
The massive outflow of Nigerian antiquities outside the country has been attributed to inadequate and effective Nigerian antiquity laws. There is need for stringent legislation against smuggling and trafficking in artifacts.For example, section 21 of Decree 77 of 1979 bans selling and buying of antiquities. However, the punishment of breach of this law is grossly inappropriate e.g. N2, 000.00(Two thousand naira) or 2 years in prison (Archibong, 2010).

Studies have indicated that excessive numbers of careless visitors cause serious damage to historic sites (Austin, 2002; Timothy and Byod, 2002). For instance rather than taken the normal route or entrance to Oke-Idanre Heritage Site some visitors use alternative routes and different outlets that are abound around the site. Footpaths through Aghagha staircase, Ajin pass Egbe or Ufona road pass and Arokunso pass lead to the site. This makes it extremely difficult for the Heritage Managers to monitor movement of people and effectively secure the site from unwanted and careless visitors The fire outbreak that ravagedIdanre Cultural Landscape in December 2015 was not unconnected to human activities such as smoking, bush burning and hunting for wild animals at the site. Farming and poaching activities that can easily ignite fire outbreak is a daily occurrence at the site.

Visitors' pressure (graffiti), the act of writing or drawing on the walls of Heritage buildings by tourists who want to document their visit to the site is a threat to the preservation of the site. These are visible at the first primary school building, old court house and the Oba's palace at the site. This act if not checked, overtime will completely deface the site.
Other notable rampant problems associated with the physical heritage environment includes wear and tear, vandalism , excessive litter, erosion or soil compaction , air pollution, and illegal trade in artifacts(Timothy and Nyaupane, 2009 ; Timothy, 2011). Isarun Erigi ash cave is eroded while the ancient walls of Old Oyo Empire in Old Oyo National Park have been broken. Insecurity in the Nothrern part of the countery leading to the death of a staff of National Commission of Museums and Monuments at Sukur Cultural Landscape, Adamawa some years ago has grossly affected visitation to the site and secutity of properties. Urbanisatiuon and encroachement has been reported in some parts of Osun Osogbo Sacred grove, Igbo Olodunmare Sacred grove and Idanre Cultural Landscape

Framework for Integrated Community Based Management (ICBM) approach in Nigeria.
Promoting **Intergraded Community Based Management (ICBM)** approach will go a long way toward realizing some of the targeted goals of SDGs that are related to integrated and inclusive resources management, planning , production and consumption . It is on this premises that this ICBM approach is proposed with the underline principles:
Proper assemblage and organization of resources and integrating these resources in effective manner. There should be no wastage of time, money and effort. Disorganized resources of men, machines, money, materials, methods, maintenance should be rearranged and convert into useful enterprise. These resources should be coordinated, directed and controlled in such a manner that enterprise work towards attainment of goals.

ICBM approach will promote optimal utilization of physical and human resources productively at all the three levels (top, middle and bottom levels) of management of cultural landscape. This will lead to efficiency in management, in such a way that there is maximum provision of utilization of scarce resources by selecting its best possible alternate use ICBM approach makes use of experts, professional and these services leads to use of their skills, knowledge, and proper utilization and avoids wastage. If employees are producing in its maximum capacity there will be no under employment of any resources.

Sound management practice will ensure proper planning through the use of minimum input and getting maximum output. ICBM approach uses physical, human and financial resources in such a manner which results in best combination. This helps in cost reduction.

ICBM approach will eliminate overlapping of efforts but rather ensure smooth and coordinated functions. It will establish effective authority and responsibility relationship at the levels of management. All jobs are explicitly stated to everyone. ICBM approach will enable the organization of Cultural Landscape in Nigeria to survive in changing political and economic environment. It keeps in touch with the changing environment.

CONCLUSION AND RECOMMENDATIONS

In view of the continuous onslaught on our collective patrimony, there is a compelling need to devise viable strategies or better ways of sustaining its preservation else our generation will be adjudged a colossal failure. Thus, Integrated Community Based Management approach proposed in this paper is considered as alternative management approach. This will allow involvement and participation of community in nthe management of the site in conjuction with staff from the Government and Non-Governmental Organization. The fact is, if older generation with only native intelligence and traditional technology available to them were able to fashion, protect, preserve and successful handed over these priceless objects and sacred places to us using traditional methods, the onus is on us to use and exploit the level of our technological attainment and development to better protect, preserve these National heritage for posterity (Eluyemi 2002).

Recommendations

Conservation education, awareness campaign, sensitization, workshop and community engagement should be intensified.

Fire tracing mechanism should be put in place to safeguard against bush burning and incidence of fire consuming some parts of the site.

Perimeter fencing, demarcation and geographical delineation of the site should be carried out to prevent encroachment and illegal entry from other ends.

Preservation of both the tangible & intangible Heritage must be pursued simultaneously Funding: Money should be channeled towards development and effective management of the site for conservation and ecotourism.

The establishment of basic infrastructural and public facilities necessary to describe the ancient town as an attractive ecotourism destination and that will enable the visitors to have a longer stay.

Creation of additional facilities will generate employment opportunities for the unemployed and vulnerable groups in the adjoining communities. This will translate to improved better standard of living.

Public Private Partnership (PPP) should be encouraged in the development of the site and provision of infrastructural facilities.

Proper signage, standard accommodation facilities, maintenance of public convenience and, updated information centres should be established. Proper maintenance of the existing ecotourism attractions and provision of scintillating facilities will attract foreign tourist thereby generating tourism dollars.

REFERENCES

Archibong M. (2010). Museum in Nigeria and other lands. Blast forward Enterprises. Port – Harcourt. Pp 186-187.

Austin, N. K. (2002). Managing heritage attractions: marketing challenges at sensitive historical sites. *International Journal of Tourism Research* , 3(6): 447-57

Cimadomo, G. and Labadi, N (2015). Community participation for heritage conservation.

Eluyemi O. (2002). The preservation of Nigerian Cultural and Natural Heritage: challenges and prospects. Text flow Nigeria Limited Ibadan. Pp. 1-22.

Fayol, H. (2001): Administrative theory of the 14 Principles of Management Jokilehto, J. (2017). Communities, place and capacity building. In Chitty, G. (Ed.). Heritage, conservation and communities: engagement, participation and capacity building (pp.17–33). London: Routledge

Gazaneo, J. O. (2003). A quest for preservation ... for what identity? *The Journal of Architecture*, 8: 411-19.

Huong, P.T.T. (2016). Living heritage in Hoi An. In Labadi, S., and Logan, W. (Eds.). Urban heritage, development and sustainability: international frameworks, national and local governance (pp.274–290). London: Routledge.

Labadi, S. and Logan, N. (2016). Impacts of culture and heritage programmes. In Labadi, S., and Logan, W. (Eds.). Urban heritage, development and sustainability: international frameworks, national and local governance (pp.137–150). London: Routledge.

Lee, E (1996): Principles of marketing. http://www.businessdictionary.com/definition/management

McKercher, B., & du Cros, H. (2002). *Cultural tourism: the partnership between tourism and cultural heritage management.* New York: The Haworth Hospitality Press.

Ogunmola, D. N (2016):Threats and Strategies for the Preservation of Museum Collections andOkeIdanre Heritage Site: Proceedings of International Conference of Association of Critical Heritage Studies, Federal University of Technology, Akure, 27th- 28th September, 2016, Oladeji, S.O and Akinde, C. O (eds).

Oladeji, S.O and Olupinla, J (2016). Significance of traditional ecological knowledge to heritage resources management: Case Study of Igbo-Olodumare, sacred grove Ondo-State, Nigeria: Proceedings of International Conference of Association of Critical Heritage Studies, Federal University of Technology, Akure, 27th- 28th September, 2016. Oladeji, S.O and Akinde, C. O (eds)

Oladeji, S.O. and Akinrinola, O.O (2010).Potentials of Cultural Heritage Tourism as Basis for Sustainable Heritage Site Development in Nigeria. *App. Trop. Agric*. Vol 15, Nos 1 & 2, Pp 6-11.

Timothy, D. J. (2011). *Cultural heritage and tourism: an introduction.* Bristol: Channel view publications

Timothy, D. J., and Nyaupane, G. P. (2009). *Cultural heritage and tourism in the developing world: A regional perspecitve.* London: Routledge.

UN World Tourism Organisation (2005) Tourism 2020 Vision, UNWTO: Madrid (www.world-tourism.org/facts/eng/vision. htm).

UNESCO (2012): World Heritage Resource Manual. Managing Natural World Heritage, June 2012 United Nations Educational, Scientific and Cultural Organization, Paris France.

UNESCO World Heritage (2002): Cultural landscape : the challenges of conservation (2003) edition pg 60-69

Van Empel, C. (2007). The effectiveness of community participation in planning and urban developments. In Gospodini, A., Brebbia, C.A. and Tiezzi, E. (Eds.). The Sustainable City V (pp.549–556). Ashurst: WIT Press.

Verdelli, L. (Ed.). Sustainability in heritage protected areas. Wrocław: Association of European Schools of Planning, Secretariat General.

Yung, E.H.K. and Chan, E.H.W. (2011). Problem issues of public participation in built-heritage conservation: two controversial cases in Hong Kong. Habitat International, 35, 457–468.

ASSESSMENT OF GREEN LANDSCAPES IN HOSPITALITY INDUSTRY FOR SUSTAINABLE LANDSCAPING DEVELOPMENT IN ONDO, NIGERIA.

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Abstract

The emergence of modern technology is taking over our environment hence there is need to focus on sustainable management of our natural resources with respect to our green environment. More attention is needed because we are compromising future generations and their needs is fading away. The economic, environmental and social development has discontent over a long time in Nigeria. The study is to assess green landscapes in hospitality industry for sustainable landscapes development in Ondo, Nigeria. To objectively look into this; secondary and primary data were taken in which oral interview were conducted and questionnaire was also administered with other literatures and studies. Response to interview shows that majority are not fully aware of the importance of the green landscapes to economic wellbeing. Also, from questionnaire administered the respondent were strongly disagreed that environmental right are given a due consideration in Ondo (x-1.79) and the respondent strongly agreed that space are not considered for green landscapes facilities in hotel industry (x-4.81). This paper however recommends that consideration must be given to green landscapes design in sighting, planning and constriction of hotel facilities that would enhance avoidance of the destruction of ecological system in order to guarantee sustainable landscapes development.

Keywords: *Green Landscaping and Sustainable development*

INTRODUCTION

The sustainability of green landscaping facilities have been observed dilapidating and insufficient in infrastructures hospitality facilities. This has become worrisome in the development of Nigeria economy because it posed serious threat to the development of the country, Nigeria. According to Lazar, C and Lazar, M (2008), Sustainable development is a global concept, which is related to the environment and possessions as well as to the inhabitants and business and agricultural production. It is regretted that some of the government initiated infrastructure and private own amenities roads, water system, water fall, hotels, recreation centers, sewages and drainage system, security, electricity, tourism center and museums and artifacts are not sustained and maintain well. According to Tijani, Adeyemi. Omotehinshe (2016) The pattern of recurrently and regularly keeping a building, facilities, equipment, machine infrastructures etc. in good and working condition is referred to as Maintenance culture. Suwaibatul, Abdul-Hakim, Syazwina, & Eizzatul (2012) supported this statement, posited that maintenance culture is the values, way of thinking, conduct, sensitivity and the principal expectations of any person or organization or society that considers maintenance as a problem that is essentially required and applies as a way of ending it.

The green environment encourages relaxation and makes man closer to nature for their wellbeing. There can be active drivers of sustainable green environment if there is proper awareness of the importance of landscaping for the health of the guest and human environment sustainable development.

The process of Landscaping in a modern way is by making a changes to an area of land in one or all are in these three (3) classes; Plants – (ornamentals, edible, native or other types of landscaping plants), Terrain –(Changing the shape of the land through grading, backfilling, mounding, terracing) and Structure- Construction fences, patio (hardscape), covers, walls, decks, raised planters or other built features. Hotel facilities are expected to boost aesthetics and economy value of which in the long run it could not serve the purpose as a result of proper maintenance.

Eti, Ogoji, **and** Probert (2006) and Omotehinshe, Dabara, **and** Guyimu, (2015) postulated that the deteriorating nature of public facilities in terms of street lights, bridges, roads and road signs that were erected some years back by the past and present governments that would have served as means of beautification, improvement to economic wellbeing and illumination in our society, but due to lack of maintenance in terms of bulbs replacement, removing dirties of packed sound from erosion to the drainage or fixing minor faults has turned our roads to death traps and hubs of illicit games, such as arm robbery stations, this show the level of sustainable of social amenties in the country, Nigeria. According to Suwaibatul et al. (2012), Maintenance is the way of thinking, an attitude, perception and regulation or guide of any person or an organization that gives priority to maintenance and practices as their daily etiquettes. It is usually derived or learns through a person making maintenance a natural daily practice that can be followed and emulated by others. Developing and embracing maintenance culture through effective leadership, sound policy, attitudinal development among others would not only enhance national development but also enlist our country among the comity of developed.

Eti, Ogoji, **and** Probert (2006) and Omotehinshe, Dabara, **and** Guyimu, (2015) postulated that the deteriorating nature of public facilities in terms of street lights, bridges, roads and road signs that were erected some years back by the past and present governments that would have served as means of beautification, improvement to economic wellbeing and illumination in our society, but due to lack of maintenance culture in terms of bulbs replacement , removing dirties of packed sound from erosion to the drainage or fixing minor faults has turned our roads to death traps and hubs of illicit games, such as arm robbery stations.

According to Bukola and Samuel (2012) The obtained results of their findings on on the assessment and the evaluation of maintenance culture, carried out in the Akure metropolitan, using mathematical models to assess the performance of maintenance personnel in the targeted prominent manufacturing industries in Akure, Nigeria indicated that production machines are already getting old, thereby resulting to frequent breakdown. Maintenance analysis was generally poor due to poor review or monitoring of maintenance performance, improper execution of preventive maintenance, low degree of planning, inadequate maintenance personnel, lack of necessary spare parts and high demand of professionals. Eke , Musa Fashuba and Abass (2107) recommended in their finding that there is need for proper structure of schedule and distribution of responsibilities for maintenance worker for sustainability of public building. If facilities are kept with good maintenance attitude optimally a full potential service life assets would be archive and prevent deteriorating in appearance and aesthetics. Maintenance gives good performance and prevents failure of services. Poor Maintenance may lead tohe patronages of the tourist are reducing as result poor maintenance, It incurred more cost to rehabilitate the business, It increases unemployment in our society, government lost revenues when the Hotels close down and It discourages investors into hospitality industries in Nigeria.

Landscaping modifies the visible features of an area of land, sustaining living element such as flora and fauna with a goal of creating a aesthetics landscape in an environment. Lee , Honda, Ren and Lo (2016) concluded in their findings that , the concept of green tourism, with the success stories, will establish a complete management of the green tourism market, it will build a quality environment and service industry for our children and work towards a sustainable development of future world. The addition of plants, rearrangement of terrain and the edifice of structure give out good position of element of nature for ambient environment. Landscape management is the art of service required to retain and maintain the aesthetics features of landscaping design. Landscape maintenance which may include; lawn moving, fertilizer and weed control, bed maintenance, pruning, bark mulch, spring and fall clean up. Applications of fertilizer, weeding and broad leaf control and ensured grass to be greener throughout the year for the dry and wet season. The spring and fall cleaning, pool cleaning and hygiene of the pool water, top dress or new look with a landscape design or replacement of plant and ornament. (Fadamiro 2006)

According to Lee , Honda, Ren and Lo (2016) Green tourism can be referred as the term that can be functional to any form of tourism that relates to the natural environment and cultural heritage of an area or that accepts good environmental controlling or green practice. The wellbeing of man has a significant role in the wise use of resources such as raw materials, water and energy, prevention of pollution (air, land, and water) and protection and where possible the enhancement of conservation of life. Theobald (2005) postulated that energy consumption in the services sector of hospitality industry is accounted for 8% . The industry reports annual capital investments of $685 billion and industry is one of the world's largest employers and represents more than 19.5 million jobs and 10.2% of the world's GDP.

In the 2010 Conservation International, the World's first publication on sustainable hotel siting, design and construction guiding principles forecasted that there will be more hospitality facilities and they see to the need to regularized the sustainability of the green lives and the Industry participants recognize that new hotel construction must occur in a manner to incorporate sustainability issue. A plan was developed for implementation of sustainability in hotel planning and development the by International Business Leader Forum (IBLF) and Conservation International to guide investors, hotel owners, planners and developers on site selection, building design, and construction. (IBLF. 2010). Hotels Nigeria required effective and holistic hospitality facility sustainability.

Current State of the art

During my survey, it was observed that, Ondo City is the second largest city center in Ondo State and well-populated next apart from Akure the capital city. Ondo is a beautiful city in the southwest part of nation, Nigeria. The Ondo people are generally fun and party loving people. The survey revealed information on the visit to some of these facilities in the cause of my studies among which are Leisure Spring Hotel, Sunny Skye, Afinju Resort and Hotel Limited, De Love Hotel, Kay Fela Hotel, Sunview Hotel, Esporta Hotel (RKY), Polak Hotel, Akiavic Blue Roof Hotel, Adesuper Hotel and among others with are amenities, WiFi Internet, Swimming Pool, Air Conditioning, Breakfast, Restaurant, Bar / Lounge, Room Service, Gym, Business Center, Property Types, Hotels, Spa & resorts, Apartments, Guesthouses, Camps, Lodges ,Villas and others with or without green landscapes facilities.

MATERIALS AND METHODS

The research method adopted was oral interview and administered structured questionnaires to collect data and with five point Likert Scale were used respondent provided answer by ticking the items according to their views and measure range used were; Strongly agreed(1) Agreed (2).Fairly agreed(3), Disagreed (4) and Strongly disagreed. One hundred and twenty (120) questionnaires were administered with one hundred and five (105) completed and returned. A twelve item questionnaire was used for data collection. The instrument consisted of 12 items on issues relating to maintenance of green landscapes for sustainable tourism development. Also, personal observation, various secondary sources such as journals, thesis, research papers and textbooks were used. Numbers of these hotels were visited to ensure the green facilities conditions which served as a basis for the questionnaire design. The results from the survey exercise shows that there was poor maintenance on green landscapes, need to educate people about the eminent importance of green landscapes for our wellbeing and most of the hotel are fully residential without any element and traces of green landscaping.

RESULTS AND DISCUSSION

Interviews:

This section discusses the findings from the interviews, It is pertinent to believe that most of hotel refuse to implement green landscapes environment because; lack of infrastructural amenities water and electricity supply the bedrock for green landscapes sustainability, green landscapes is not benchmarks for the establishment of hospitality business and cost of man power on the maintenance and absence of green landscapes has not really affect their business or sales. More so, ecological landscaping or green landscaping is essential to our daily living and for our wellbeing. It is of greater potentials as plant fulfill dual roles; the form eye-pleasing scene and reducing energy use and protecting our natural resources, shrubs plants provides background element for flowers, sculpture and fountains. Roses, honeysuckles and lilacs use to enhance natural fragrance from the landscape quality and trees reduce wind velocity by reducing the strong wind to soft wind.

However, Lee, Honda, Ren and Lo (2016) suggested that, there is need to consider the ecosystem as the home to creatures and plants and involved in environmentally friendly eco-vacation by learning from our environment. Learning is a benefit of what can be done to our environment and Adedokun 2011) concluded in her findings that there in need to emphasize on educating Nigerian, so that maintenance would not be alien to any citizen.

Questionnaires:

The survey research design was used for this study. The targeted respondents are directors and managers of the hotels, guest/customer and other hotel users from Ondo city. One hundred and twenty (120) questionnaires were administered with one hundred and five (105) completed and returned. The demographic information of the respondent shows that the mean result shows that sex (x-1-28), age (x-306), marital status (x-2.15) and educational background (x-2.62). and result of the twelve(12) items as shown Table 2.0, on maintenance of Green landscapes and sustainability of Hotel facilities shows that the respondent were strongly disagreed that environmental right are given a due consideration in Ondo (x-1.79) and the respondent strongly agreed that attitude of Nigerians towards maintenance and sustainability of facilities was poor (x-4.81)

Demographic information of the respondent. Table 1

	Sex		Age					Marital Status					Educational Background		
	M	F	1	2	3	4	5	SI	M	D	W	SP	A	B	C
Percentage%	69.1	26.4	5.5	105	59.1	15.5	5.5	7.3	73.6	8.2	5.5	0.9	53.6	24.5	17.3
Mean	1.28		3.06					2.15					2.62		
Std. Deviation	0.449		0.853					0.676					0.777		

Description of the Table

Sex- M; Male ,F;- Female, Age- (1);- 15-24, (2);- 25-34, (3);- 35-44, (4);- 45-54, (5);-55-64. Marital Status- (SI);- Single (M);- Married, (D);- Divorce, (W);- Widow (SP);- Separated. Educational Background- (A);- BSc/HND, (B);- MSc/MTech, (C);- PhD

Table 1.0, shows the background information of the respondent; sex, age, marital status and educational back ground. The result shows that majority of the respondent were male with 69.1%, adult 59.1%, married 73.6% and at least graduate 53.6%.

Table 2: Assessment of Green landscapes and sustainable of Hotel facilities

S/N	Items	Standard Deviation	Mean	Remark
1	Space are not considered for green landscapes in the planning and construction of hotels in Ondo.	0.395	4.81	**Very High**
2	Nigerians awareness of the importance green landscapes is poor.	0.450	3.76	**High**
3	There is policy that enhance the sighting, planning and constriction for sustainable green landscape in hotel facilities in Ondo	0.516	2.57	**Medium**
4	Irregular power and water supply and other amenities hindered green landscapes in hotel facilities in Ondo	0.488	2.62	**Medium**
5	Environmental right are given a due consideration in Ondo	0.428	1.76	**Very Low**
6	Generally, cost of Maintenance and labour has negative effect maintenance Culture in Nigeria	0.414	1.90	**Very Low**
7	Hotel business make sales with or without green landscapes facilities in Ondo.	0.477	2.34	**Low**
8	Green Landscapes encourages more customer on patronage	0.648	4.06	**High**
9	There is global development on consciousness about nature protection and appreciation, fuelled largely by the environment's higher media profile	0.590	4.49	**High**
10	Guest/ Visitors are indifferent to the green landscapes facilities in hotels in Ondo	0.611	2.05	**Low**
11	The hazard effect of the green landscapes prevent the implementation of green landscapes into hotel planning and construction	0.409	1.21	**Very Low**
12	Green landscapes have no relationship with hotel facilities.	0.170	1.99	**Very Low**
	Weighted Average		2.79	**Medium**

Table 2.0 Assessment of Green landscapes facilities and sustainable development of Hotel facilities as indicated by the respondents. The result shows that all the listed Twelve (12) items yielded a highly low mean between (x-1.21) and(x- 1.76).and very high value of (x-4.81). The weighted average of 2.79 attested to the facts that generally, green landscapes are averagely assessable in the hotels in Ondo. Majority of the respondent were of the opinion that the hazard effect of the green landscapes prevent the

implementation of green landscapes into hotel planning and construction (x- 1.21), while others responded that green landscapes encourages more customer on patronage (x-4.06) and Guest/ Visitors are indifferent to the green landscapes facilities in hotels in Ondo (x- 2.05) Conclusively, all this indices and the facts show that the weight average was 2.79 indicate that assessment of green landscapes for sustainable development of hotel industry in Ondo is averagely low, because it is slightly above average.

CONCLUSION AND RECOMMENDATIONS

In summary, this research reveals that the assessment of green landscaping for sustainable landscaping development of Hotel industry in South West (Ondo City) Nigeria is worrisome. This is arguably due to inherent lack of compliance to the policy for landscaping design in the planning of hospitality infrastructures for sustainable ecological system, nonchalant attitude, lack of proper orientation about the importance of green landscaping enhanced preservation and reduce direct solar energy effect and protect our natural resources.

According to the empirical data available for this research and after a careful descriptive analysis of the collected data, my recommendations are follows. There should be sensitization on the importance of green environment, preservation and the increase in the natural value of green landscape. This supported by Kaoru I, Rokkodai, Nada-ku, Kobe and Hyogo (2019) that 80% and 40% of the local residents voluntary accepted to participated in tree planting and forest management respectively. In planning or designing of hotel, green landscaping must be given proper consideration towards conservation for the benefit of social economic wellbeing; a good maintenance policy should be implemented for sustainability of the hospitality facilities.

REFERENCE

Adedokun, M. O. (2011). Education for maintenance culture in Nigeria: Implications for community development. International Journal of Sociology and Anthropology Vol. 3(8), pp. 290-294.

Bukola Olalekan Bolaji and Samuel Babatope Adejuyigbe (2012). Evaluation of Maintenance Culture in Manufacturing Industries in Akure Metropolitan of Nigeria. Journal of Information Engineering and Applications ISSN 2224-5782 (print) ISSN 2225-0506, Vol 2, No.3, 37

Conservation International (2010). World's first publication on sustainable hotel siting, design and construction guiding principles.

Eke E.C., Musa S., Fashubaa T.O, Abass J.O, (2107). An Assessment of Maintenance Culture on Public Buildings in Nigeria (A Case Study of osun State) DOI: 10.9790/1684-1405035357 www.iosrjournals.org.

Environmental development (2010). International Business Leaders Forum (IBLF).

Eti, M.C., Ogaji, S.O.T & Probert S.D (2004). Impact of corporate culture on plant maintenance in the Nigerian electric-power industry. Applied Energy, Vol. 83, No. 4, pp. 299-310.

Fadamiro J.A (2006) Landscape Design and the environmental, Adeyemo Publishing House, ISBN;978-076-731-2, Pp ,8,10 14.

Kaoru I, Rokkodai, Nada-ku, Kobe, Hyogo (2019). Evaluation of Forest Preservation in Cambodian Rural Villages Journal of Sustainable Development Vol. 12, No. 1; 2019

Lazar, C.; Lazar, M. The Quantification of the Sustainable Development at Local Level. *WSEAS Trans. Bus. Econ.* 2008, *5*, 310–319.

Lee SM, Honda HC, Ren G, Lo YC (2016) The Implementation of Green Tourism and Hospitality. J Tourism Hospit 5: 233. doi: 10.4172/2167-0269.1000233

Omotehinshe, O. J., Dabara, I. D. & Guyimu, J. (2015a). Design Inadequacies and the Maintenance of University Buildings in Ile Ife, Nigeria. Journal of Environment and Earth Sciences. 5(2), 175187.

Omotehinshe, O.J., Okunola, A. S., Akinola, T. G., Ojo G. O. (2015b). Review of Planning Laws and its Level of Implementation in Nigerian Communities – A Case Study of Ede Town in Osun State. A Paper accepted for Publication in "International Journal of Sciences, Engineering and Environmental Technologies (IJOSSET), IJOSEET-01- 2015.

Suwaibatul-Islamiah, A.S., Abdul-Hakim, M., Syazwina, F.A.S. & Eizzatul, A.S. (2012). An Overview Development of Maintenance Culture. Proceedings from 3rd International Conference on Business andEconomic Research. Pp. 2206-2217.

Theobald W.F (2005) Global Tourism, Burlingame (3rdedn) Elsevier Science.

Tijani S.A., Adeyemi A.O. Omotehinshe O.J. (2016) Lack of Maintenance Culture in Nigeria: The Bane of National. Journal of Civil and Environmental Research. Vol.8, No.8, 2016.

PERCEPTION AND FACTORS INFLUENCING BUILDING OF RESILIENCE AND MITIGATION MEASURES FOR CLIMATE CHANGE BY SMALLHOLDER ARABLE CROP FARMERS IN ANAMBRA STATE, NIGERIA

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Abstract
This study examined the perception and factors influencing the building of resilience mitigation measures for climate change by small holder Arable Crop farmers in Anambra State, Nigeria. Primary data were collected using structured interview guide administered to 120 farmers. Purposive multi- stage sampling technique was used to select twelve communities in the study area. Data collected were analyzed using descriptive and inferential statistics. The results reveal that the mean age of farmers in the study area was 46 .8%, and that 66.7% of farmers were married. Most farmers were educated. Majority of the respondents were males (73.3%), with an average household size of 7 persons, respondents perceived that the climate is changing causing problems for small holder farmers with severity level index > than 4.01 indicating high negative effects. The study identified factors affecting farmer's adoption of coping strategies for climate change.. Planting different varieties of crops, changing cropping patterns, mulching and planting of trees were some of the adopted coping strategies by respondents. The study recommended that current knowledge on adoption methods be communicated to the farmers in addition to provision of information on early warning systems access to loan and credit.
***Keywords**: Climate change, consequences, small folder farmers, coping strategies*

INTRODUCTION

Agricultural activities relied greatly on climate. It determines the pattern of vegetation, types and yields of crops and animals as well as the length of cropping seasons. Oriakhi, Ekunwe,Erie . and Ososogie (2017) Climate determines to large extent, the type and quality of agricultural activities a community would engage in (Apata, et al., 2009) . Climate change is expected to influence crop and livestock production, hydrologic balance, input supplies and other components of agricultural systems. Global warming will change the face of farming, and is already doing so in some parts of the world. Increases in temperature, changing patterns of rainfall, more extreme droughts and floods, the shifting distribution of pests and diseases: all can be attributed in part to the increase in emissions of greenhouse gases resulting from human activities.

Moreover, the impact of climate change on agriculture has repercussions that extend far beyond the supply of food. Agriculture accounts for 29% of the gross domestic product (GDP) in developing countries and provides jobs for 65% of their populations. All will have an impact on food production in the future. In many countries, economic health is closely linked to the fortunes, or misfortunes, of farming communities It follows therefore that any change in climate may affect the production and supply of food and raw materials thereby enhancing or limiting the capacity of agriculture to play its major role as supplier of food and industrial raw materials. Climate change has been fairly rapid in many regions around the world in the last few decades, while greenhouse gas emission keeps on increasing. The uncertainty as to how the trend of climate change and greenhouse gas emission will continue in the future raises many questions related to food security, one of which is whether the aggregate productivity of global agriculture will be affected. According to FAO, 2014 climate change is likely to cause considerable crop yield losses thereby adversely affecting small holder livelihoods in Africa. As a result, food security and income generation opportunities for the farming households that are most reliant on agriculture may be in jeopardy (FAO, 2014)

Adverse climatic effects would influence agricultural outputs at any stage from cultivation to harvest. Even if there is sufficient rain, its irregularity can affect yields adversely especially if rains fail to arrive during the crucial growing stage of the crops (Molua and Lambi, 2007; Rudolf and Hermann 2009). The effects of climate change on agriculture have generated much interest and have motivated a lot of research on the subject; all in a bid to mitigate shortage in food supply and boost food security. However, the nature of these biophysical changes and the human responses to them are complex and uncertain. Oriakhi et al, (2017)

Climate change is a global phenomenon, as those rural farmers in the tropics face greater risks (Low-External Input Sustainable Agriculture, 2008). The ability of small -holder farmesr to cope with stress and drastic change arising from variation in climatic patterns is predicated on the interplay between the factors. Thus it is believed that climate change will have a strong impact on Nigeria particularly in the areas of agriculture, land use, energy consumption, biodiversity health and water resources (Apata, et al, 2009, Ekweanya, 2015). Arable crop production is highly sensitive to variations in climate factors from hours of sunshine to rainfall, soil condition, and particularly to temperature due to effects of evapotranspration Ekweanya et al(2017). Climate change could alter stages of rate of development of crop pest and pathogens, modify host résistance and results to change in physiology of host, pathogen and pest interaction. These will alter crop yields and trigger arable crop losses which will impact on socioeconomic variation such as farm income, farm level decision making, marketability and farmers livelihood (Oyerinde and Osanteande, 2012). To approach the issue appropriately, one must take into cognizance rural communities understanding of climate change and the various coping strategies they employ in responses to environmental stress, poverty, food insecurity and communal conflict which are compounded by climate change and variability (Berman et al, 2012, Ekweanya and Ifenkwe (2016). There are two responses to global climate change namely mitigation and adaptation. Mitigation refers to intervention or policies to reduce the emissions or enhance the absorption of greenhouse gases while adaptation refers to responses to the changing climate and policies to minimize the predicted impacts of climate change (Sari Kovats, nd in Women and Children Development Initiative (WACDI), 2011 .The rural farmers, whose livelihoods depend on the use of natural resources, are likely to bear the brunt of adverse impacts of climate change. This makes the need for farmer to adapt to climate change very imperative for optimum output. Adaptation measures to climate change have to do with living with climate change, for example agroforestry, conservation agriculture, inter-cropping, biodiversity and collection of rainwater for agricultural use referred to as rainwater harvesting (Okoroh. et al 2012)

STATEMENT OF THE PROBLEM

Due to its significant reliance on weather patterns, as well as other environmental factors, agricultural production is particularly vulnerable to changes in climate. Adoption of climate change mitigating strategies are key to coping and building resilience against the vagaries of climate change and hence, increasing agricultural poverty, and lifting rural smallholder farmers out of poverty and food insecurity, noted that the vulnerability of agriculture is not determined by the nature and magnitude of environmental stress like climate change per se, but by the combination of the societal capacity to cope with and/or recover from environmental change.

In Anambra state for instance agriculture is the major occupation of its inhabitants. The perception of the average Small holder farmer on the vagaries of climate change impacts is vague, as we recall Anambra state is one of the state prone to flooding from 2012-till date The awareness of climate problems and the potential benefits of taking action is important determinant of adoption of climate change mitigating measures Iheke,2014 argued that farmers awareness of change in climate attributes (temperature and precipitation) is important to adaptation decision making. Innovation adoption is key to increasing farm productivity. There need to examined the perception and factors influencing the building of resilience of climate change mitigating measures by smallholder arable crop farmers in Anambra State, Nigeria is therefore pertinent in this study.

Specifically the objective are to i describe the socio- economic characteristic of the small –holder arable crop farmers; ii assess the respondent's perception of the effects of climate change on arable crops; and ii identify conditions influencing farmers adoption of coping strategy

Hypothesis of the study

There is no significant relationship between perception on climate change and the coping strategies adopted.

MATERIALS AND METHODS

Multi-stage sampling procedure involving purposive and random sampling techniques was used in the selection of the respondents (arable crop farmers). In the first stage, two Local Government Areas were purposively selected from the four agricultural zones of the state. They were Awka North and Anambra West Local Government Area. In the second stage, three communities were randomly selected from each local government area; the Communities were Awba Ofemili, Mgbakwu,and Ugbenu, for Awka North L.G.A., while Umueze Anam, Nzam and Igbedor,were for Anambra West LGA, making it six communities. In the third stage, two villages were selected from each Community, the villages were, Umuoshite , Orieagu, Ama Ezike, Umu Oturu, Agu-Eke, Ugbenu Ime, Abor, Nsire, Etakolo, Urubi, Odah Anam, and Amekeme; making it twelve villages and in the last stage; ten respondents were randomly selected from each village, giving a total of 120 respondents. Objectives 1 2 and 3 were analyzed using descriptive statistics while the null hypothesis was analyzed using Pearson Product moment correlation

RESULTS AND DISCUSSION

Table 1: Distribution of respondents by personal and socioeconomic characteristics

Socio-Economic Variables	Frequency	Percentage
Age		
21-30	13	10.8
31-40	37	30.8
41-50	28	23.8
51-60	39	32.5
≥ 60	3	2.5
Total	120	100.0
Mean	46.75	100
Marital status		
Single	18	15.0
Married	80	66.7
Divorced	9	7.5
Widowed	8	6.7
Separated	5	4.2
Total	120	100
Educational Qualification		
No formal education	23	19.2
Primary education uncompleted	3	2.5
Primary education competed	21	17.5
Secondary education uncompleted	5	4.2
Secondary education completed	62	51.7
Tertiary education uncompleted	6	5.0
Total	120	100

Gender		
Female	32	26.7
Male	88	73.3
Total	120	100
Household Size		
4-5	19	15.8
6-7	27	22.5
8-9	58	48.3
10-11	12	10.0
12-13	4	3.3
Total	120	100
Mean	6.5	

Source: field survey, 2017.

Distribution of respondents by personal and socioeconomic characteristics Table 1 shows the socio-economic characteristics of respondents. The mean age of the respondent was 46.75 years, indicating that most of the farmers were still in their active working ages and are well positioned to observe notable changes in climatic conditions. Majority of the farmers (66.7%) were married. Similarly, majority of the farmers had attained one form of education or the other, with 17.5%, and 5.0% for primary education completed, secondary education completed and tertiary education respectively. This implies that a good proportion of the respondents had the capacity to read and comprehend the issues raised in the questionnaire without much assistance or being dependent on the Field Officer for interpretation Majority of the farmers (73.3%) were males, with an average household size of seven persons. The large household size may have a positive implication in terms of having more hands to assist in the farms, thus reducing the amount spent on hired labour. Majority (68.3%) of the respondents had over ten years of farming experience with a modal year of farming experience at 10-12years, while the mean years of farming experience was 11.4years

Table 2: Conditions affecting the farmer's adoption of coping strategies for climate change.

Factors	*frequency	percentage	severity level index
Lack of improved seed varieties	103	85.8	3.7
Lack of access to water for irrigation	100	83.3	4.9
Lack of current knowledge on adaptation methods	120	100.0	4.9
Lack of information on weather techniques	109	90.8	4.1
Lack of access to loan or loan credit	117	97.5	4.7
Governments' irresponsiveness to climate risk	106	88.3	4.1
Management in the area			
High cost of access to weather forecast technologies	98	81.7	3.7
Limited income	107	89.2	4.0
Poor information and absence of early warning system	12	93.3	4.5
Lack of information on how to build resilience	104	86.7	3.6

Source:field survey, 2017. *multiple responses recorded.

Factors affecting the farmers' adoption of coping strategies for climate change Table 2 shows factors affecting adopting of coping strategies such as lack of access to water for irrigation, lack of current knowledge on adaption methods, lack of information on weather techniques, lack of access to loan or credits. Respondents agreed that all the factors identified affected farmers' adoption of coping strategies for climate change. Of all the factors identified, lack of current knowledge on adaption methods, lack of access to loan or credit and poor information, and absence of early warning systems were the most severe factors that affected the farmers coping strategies.

Respondent's perception of general problems caused by weather elements

Statements	SA	A	DK	DA	SDA	$\bar{X}$
The environment in this village is changing due to humans activites	50 (41.7)	20(16.)	10 (8.3)	30(25,0)	3,42	
The climate is changing and crops are dying	40 (33.3)	37(30.8)	20(16.7)	10(8.3)	13(10.8)	3.68
Temperature is rising causing illness	56(46.7)	40(33.3)	3(2,5)	1(0.8)	20(16.7)	3.9
The yearly rains are not supporting crop production as before.	90(75.0)	27(22.5)	0	3(2.5)	0	4.70
Climate change has led to crop infestation and diseases.	105(87.5)	12 (10.0)	0	0	0	4,80
Climate change has led to change of livelihood system .	71(59.2)	27(22.5)	0	0	2218.3)	4.04
Climate change has led to decline of natural resources.	41(34.2)	70(58.3)	6(5.0)	3(2.5)	0	4.24
Grand mean						3.59

Source ;field survey,2017

Mean below the bench mark,mean of 300.SA =Strongly Agreed; A= Agreed; DK= Don't know; DA =Disagreed; and SDA =Strongly Disagreed

Most of the respondents in the study area identified various perceived general problems climate change causes .the respondent had positive perception of all the problems identified and classified above. The grand mean of X 3,59 showed that the respondents perceived climate change to be causing many problems and would like to adopt adaptive measures to that will enhance arable crop production in the study area, whivthis findings is in tanderm with Umoh and Eketekpe(2010) which states that farmers are now aware of changing climate.

Table 4: Correlation Estimate of the Relationship between the Farmers Perception on Climate and the Coping Strategies for Climate Change

Variables	Correlation coefficient(r)	Coefficient of determination (r^2)
Cultivating different crops	0.867***	0.752
Changing cropping patterns	0.878***	0.771
The use of chemical fertilizer	0.904**	0.817
Changing to irrigation/ Fadama farming	0.613**	0.376
Changing the portion of land put into crop production, land rotation/bush fallowing	0.639**	0.408
Shading and shelter	0.783***	0.613
Adoption of new technologies	0.892***	0.796
Regular monitoring of air, water, land and vegetation	0.665**	0.442
Routine checkup at health centre or general hospitals	0.589**	0.347
Attending seminar on climate change issues (sensitization programmes)	0.783***	0.613
Extension services enlightenment campaign about agricultural matters	0.901***	0.812
Minimizing of application of chemicals	0.856***	0.733
Shortening length of growing period	0.694**	0.482
Proper waste management	0.680**	0.462
Soil conservation	0.685**	0.469
Mulching and planting of trees	0.775***	0.601

Source: field survey, 2017; ***significant at 1% probability level`

Test of hypothesis The result in Table 3 shows that a positive relationship existed between farmers' perception of climate change and all the coping strategies adopted by the farmers for climate change. The correlation coefficient(r) of 0.867 recorded for the relationship between farmers' perception on climate change and cultivating different crops revealed a strong positive relationship between them. Table 3 Furthermore, the coefficient of determination (r2) value of 0.752 indicated that 75.2% of the increase in farmers' perception on climate change was mitigated through the adoption of the practice of cultivating different crops by the farmers in the study area.The relationship between farmers' perception on climate change and changing cropping patterns was positive and significantly related.

The result in Table 4 shows that a positive relationship existed between farmers' perception of climate change and all the coping strategies adopted by the arable crop farmers for climate change. The correlation coefficient(r) of 0.867 recorded for the relationship between farmers' perception on climate change and cultivating different crops revealed a strong positive relationship between them. Table 4 Furthermore, the coefficient of determination (r2) value of 0.752 indicated that 75.2% of the increase in farmers' perception on climate change was mitigated through the adoption of the practice of cultivating different crops by the farmers in the study area.The relationship between farmers' perception on climate change and changing cropping patterns was positive and strong with correlation coefficient value of 0.878 and coefficient of determination (r2) value of 0.771. This implies that 77.1% of the increase in farmers' perception on climate change was mitigated through the adoption of the practice of changing cropping patterns by the farmers in the study area.The correlation coefficient(r) of 0.904 recorded for the relationship between farmers' perception on climate change and the use of chemical fertilizer revealed a strong positive relationship between them. Furthermore, the coefficient of determination (r2) value of 0.817 indicated that 81.7% of the farmers perceive climate change as being mitigated by the adoption of the practice of using chemical fertilizer by the farmers in the study area. strong with correlation coefficient value of 0.878 and coefficient of determination (r2) value of 0.771. This implies that 77.1% of the increase in farmers' perception on climate change was mitigated through the adoption of the practice of changing cropping patterns by the farmers in the study area.The correlation coefficient(r) of 0.904 recorded for the relationship between farmers' perception on climate change and the use of chemical fertilizer revealed a strong positive relationship between them. Furthermore, the coefficient of determination (r2) value of 0.817 indicated that 81.7% of the farmers perceive climate change as being mitigated by the adoption of the practice of using chemical fertilizer by the farmers in the study area.

CONCLUSION AND RECOMMENDATIONS

The study concluded that several communities in Anambra Sate experienced climate change in the form of high rainfall, high temperature, and high humidity. Farmer's perceived that there has been an increase in the irregularity in the startup and end of rains, temperature intensity, increasing early rain. The extreme climate change affected arable crop production in the area resulting in increasing cost of production, extinction of food resources, crop infestation and disease that reduces the output level of the farmers loss and decaying of farm produce due to excess rainfall that does not allow for rapid drying of farm produce. Some of the coping strategies adopted by the farmers with a relatively high PI include multiple/intercropping, agro-forestry/aforestation, mulching, purchase/harvest of water for irrigation and use of resistant varieties Factors such as lack of improved seed varieties lack of access to current knowledge on adaptation, lack of access to loan, lack of weather forecast technologies, limited income, and poor information and absence of timing early warning system on weather events, also information on how to build resilience for climate and their socio-economic variables affected farmers adoption of coping strategies in the study area.

Hence, the study recommended the need for farmers' education, awareness creation, poverty alleviation and the provision of more efficient inputs to them as potent tools for climate change adaptation in the area, that current knowledge on adoption methods be communicated to the farmers as early as possible and that farmers should be given access to loan and credit, as well as giving information on early warning systems

REFERENCES

Aune, J. 2012. Sustainable Agriculture and the Environment: Introduction to Agricultural Systems in Developing

Ekweanya, N. M (2015). Farmers' Coping and Adaptation Strategies for Climate Change in Anambra State, Nigeria.International Journal of Applied Research and Technology. 4(6):8 -13

Ekweanya, N. M. and Ifenkwe , G. E. (2015). Farmers' Perception of Effect of Climate Change on Arable Crop Production in Anambra State, Nigeria .International Journal of Applied Research and Technology. 4(6):39–44

Ekweanya, N.M, Iyang,N.U and Okiringbo,J.I (2017)) Factors Affecting Farmer's Adoption of Coping Strategies of Climate Change in Anambra State, Nigeria .Journal of Community and Communication Research (JCCR) ISSN (Online):xxx-xxxx,,ISSN (print):xxxx-xxxx Volme 2 No 2s December,2017 Acessble online at :http ;//www.jccr.ng

FAO (2007), National Programmes for Food Security: FAO's vision of a world without hunger, Rome. Pp 87 -90

FAO (2008), Climate change and Food Security: a frame work document 2008, Rome. Pp 10 Forest Resources Management. The way forward proceedings of the 2nd `Biennial conference of the forest and forest product society 26th 29th April, 233- 237.

Intergovernmental Panel on Climate Change (IPCC) (2007). Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Available at http://www.IPCC/cly/spnibavr.pdf. 13/11/07

Okoroh J. P. Olaolu Michael. And Igbokwe Edwin. M (2012) Climate Change Mitigation and Adaptation Strategies Used by Farmers in Imo State, Nigeria, Journal of Agricultural Extension

Okringbo, J. I., Ominikari, A. G. and Gbede, O. I (2017) , Adaptation Strategies to Climate Variability beingPracticed by Farmers' in Bayelsa State, Nigeria.CARD International Journal of Agricultural Research and Food Production (IJARFP

Oriakhi, L. O., Ekunwe, P. A.,Erie, G. O. and Ososogie, D. I(2017) Socio-economic determinants of farmers' adoption of climate change adaptation strategies in edo state, Ngeria. Nigerian Journal of Agriculture, Food and Environment. 13(3):115-121, 2017

Oyerinde O.V. and O.U Osantande (2010), Farmers' Adaptation Strategies a1'd Perception to Climate Change.presented at the stakeholders workshop on Assessment of impacts and Adaptation to climatic change,Research Institute, Center for Climate Change, Economics and Policy

Women and Children Development Initiative (WACDI), (2011). Gender Dimensions and Indigenous Knowledge for Adaptation to Climate Change in South East Nigeria. A Research Report. www.imostate.gov.ng

ARCHITECTS PERSPECTIVE ON THE USE OF TIMBER FOR BUILDING DESIGN AND CONSTRUCTION IN ONDO STATE, NIGERIA

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Abstract

Towards achieving environmental sustainability, there has been an improved demand for the use of renewable materials such as timber. The aim of the study is to assess the perception of architects on the barriers and drivers of using timber in building design and construction within Ondo state, Nigeria, towards improving the database of sustainable building materials. Primary data was obtained through survey method by administering a structured questionnaire to a simple random sample of 52 architects resident and practicing in Ondo State. Architects working in Ondo state are usually involved in various specialization: educational institutions, state ministries and independently practicing architects. Using rank sum for the analysis, it was deduced that susceptibility to termite attacks and low fire resistance are the top two barriers towards the use timber, while on the lowest rung of the ladder is lack of adequate programme for timber seasoning in the building industry within Ondo State. Timber is an acceptable construction material and has uses in roof trusses of buildings and furniture works in building interiors. It is mainly used for construction of residential buildings while their usage is generally low in industrial building construction.

Key words: *Architects, buildings, timber, perspective*

INTRODUCTION

Timber is one of the greatest resources on earth used for building construction (Wright, 1928; Fadamiro and Ogunsemi, 2008; Brophy and Lewis, 2011). There is identified low patronage of the use of timber in residential buildings in Nigeria, for example, wood based flooring material is used in an estimated 0.3% of residential buildings in Nigeria (National Population Commission, NPC and ICF, 2014) despite the high sustainability credential of timber and the potential to reduce the housing demand of the population. There is a renewed call to focus on improving local materials that have regard for sustaining the environment in the Nigerian context (Olaniyan, 1985; Alli, 2010; World bank, 2018).

Architects are the focus of this study because the profession is in a vantage position within the building industry and are usually considered as prime consultants in building projects (Architects Registration Council of Nigeria, ARCON, 2009). The research is delimited to Ondo State because the state is one of the highest producers of timber in the country since it is located in the forest region of the country (Oluyege, 2007). Making close comparison between timber and cement based products in Ondo State, Nigeria: 9.56% of residential buildings have walls made from timber as against 60.93% of cement based product. Timber floors within the state amounts to 8.87% of the total residential housing population, while cement based flooring amounts to 63.23% according to NPC (2006). While the NPC demography and other studies provides a general background, this study provides a deeper understanding of using timber in buildings, breaking the applications down to building sections: interior design, furniture, roof truss system, ceiling, doors, windows, flooring and staircase in the research area.

Some of the qualities of using timber in building construction have been identified by Ikudayisi and Omoyajowo (2016) in a cross sectional survey of users in Ibadan, Nigeria. Durability, strength, aesthetics, reusability, cost effectiveness, affordability, environmental friendliness and ease of maintenance where some of the characteristics discussed in the study. It was discovered that there is high prevalence of the use of timber in the roofing structural system in Oluyole Local Government Area of Oyo State, Nigeria.

There are seven main barriers affecting the use of timber in Latvia, a European country: stereotypes, legislation, specialist qualification, lack of knowledge, lack of experience, lack of information, inaccessible consultancy - meaning combination of lack of information and lack of experienced consultants (Viluma and Bratuskins, 2017). Results from the focused discussion group was used as inputs for a survey. Architects views were analysed using descriptive statistics like tables and graphs. It was discovered that stereotypes and legislation were the most mentioned barriers in Latvia. Wooden buildings are limited to country side or small building projects. Furthermore, Latvian construction standard, LBN 201-15, was reported to be restrictive, especially for non-residential buildings and multi apartments. It often requires extra time, calculations and finance to support design and construction using timber

Some of the advantages of timber is that it simple, safe, quick and easy to construct and deconstruct. It is generally available in forest areas, usually considered to be aesthetically pleasing, durable when it is protected and well installed. It is also versatile and used for dry construction especially when compared to concrete (Adedeji and Ogunsote, 2005; Forest Products Laboratory, 2010). Perception of Architects and Engineers based in the US and Canada towards using timber for building specification in non-residential buildings was analysed by Kozak and Cohen (1999), it was discovered that timber was not perceived as a suitable construction material in non-residential buildings, the use of wood decreases, with increase in building height.

***Plate 1*. Use of wood as a wall finish at St. Matthew's Catholic Church, Ondo, Ondo State, Nigeria. Retrieved from Author's Archives**.

The challenges associated with wooden construction includes inflammability, termite infestation, water proofing issues and security (Koenigsberger, Ingersoll, Mayhew and Szokolay, 1973). Other challenges include weathering leading to decay of the wooden member, dimension instability through changes in moisture content across the seasons (Churdley and Greeno, 2010; Roos, Woxblom and McCluskey, 2010). Although wooden members allows sound to be transmitted, it can also be used for sound buffering and aesthetics as it is used on the walls of St. Mathews Catholic Church Ondo, Ondo State, Nigeria (See Plate 1). It can also be used successfully as a structural floor (Plate 2).

***Plate 2*. Use of well-seasoned hard wood as a floor slab in a vernacular building in Akure, Nigeria. Retrieved from Prucnal – Ogunsote (n.d.).**

Twelve major characteristics considered in analysing the preference for the use of timber in buildings within Ondo State are: cost, time, fire retardation capabilities, insulation properties, susceptibility to termite attack, energy saving capabilities in terms of embodied energy and energy in use, compliance to local government regulations, adequate seasoning, ease of maintenance, availability of skilled workers (carpenters) and aesthetics. Various application of timber in building types (residential, commercial, institutional, recreational, industrial and educational) was also carried out in terms of number of floor capabilities of timber, use as roof truss, walls and staircases. Further opinions were tested in using timber for interior decoration, ceiling, doors and windows. Finally, acceptability of the use of timber was tested from the perspective of architects' in Ondo state, Nigeria. This study focused on perception of architects on the key capabilities of timber and its uses within the building construction industry in Ondo state, Nigeria, towards improving the database of sustainable building materials in the research area.

MATERIALS AND METHOD

The use of survey research method using structured questionnaire was adopted for this study because it is useful in analysing trends of issues (Creswell, 2009; Babbie, 2013). In this paper studying trends of architects' perspective on the current use of timber within the building industry in Ondo State is invaluable towards increasing the critical discourse of the use of timber as part of sustainable housing development policy in Ondo State, Nigeria.

The Research Area

Ondo state is one of the six south west states in Nigeria. The population of the state is 3,460,877 according to the 2006 Census Final Results (Federal Republic of Nigeria, 2009). It has a land coverage area of 15, 500 Sq. Km. Akure is the capital of the state, located on latitude 7° 15'N and Longitude 5°

17’E at an altitude of 370m above sea level. It has a hot – wet equatorial climate. The state has all year type of rainfall with double maxima in June and September. Mean annual temperature in Akure is 27^{o}C (the average daily temperature ranges between 25^{0}C and 35^{0}C). The maximum mean global radiation which occurs around (14:00hrs LT) varies in the course of the year from 512 W/m^2 in the wet season to 543 W/m^2 in the dry season (Falodun and Ogolo, 2007).

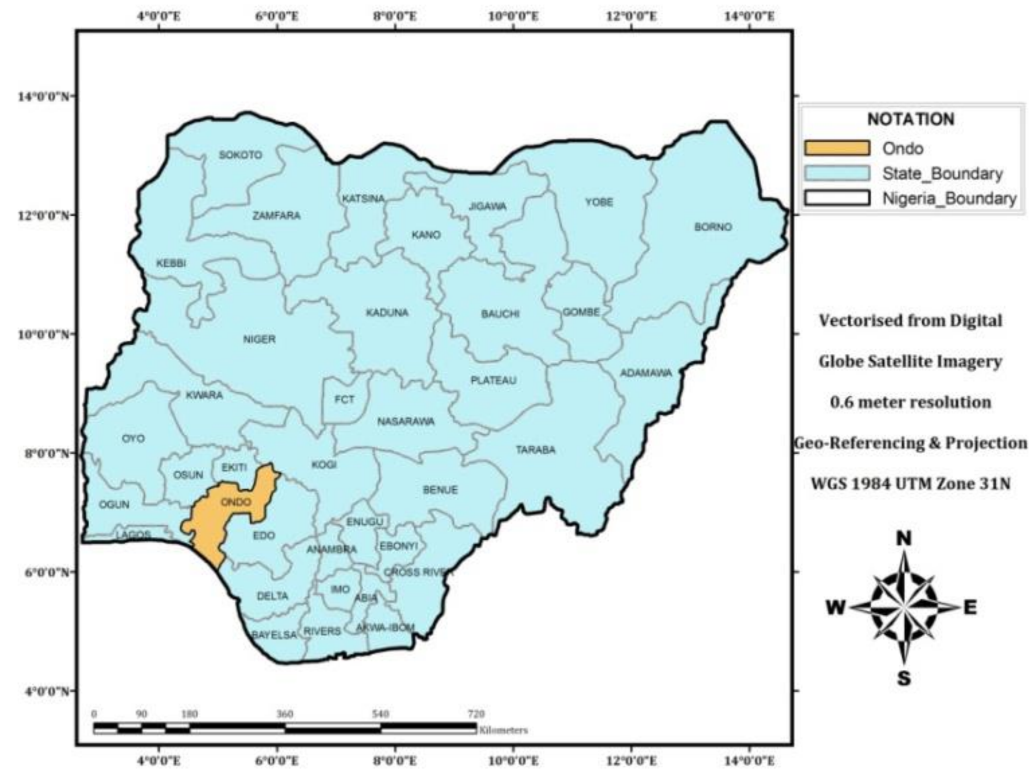

***Figure 1*. Map of Ondo State in the National Settings. Retrieved from Olamiju and Oyinloye (2015).**

RESULTS AND DISCUSSION

Adopting Krejcie and Morgan (1972) sample calculator, @ 95% confidence level, a sample of 52 architects was drawn from a population of 60 architects practicing in Ondo State, Nigeria (The contact addresses and other relevant information of Architects living and working in Ondo state was collected during the interview with Ogunro, Oluwasegun at the Secretariat of the Nigerian Institute of Architects, NIA, Ondo State Chapter, 5th November, 2018). The analysis was based on the response from 52 architects in the state chapter of the NIA. Descriptive statistics of the sample shows that 90.38% of the respondents are male while 9.62% are female (See Table 1). The sample statistics shows that respondents with the highest percentage (59.62%) falls within the age bracket of 37-54 years. Also, 34.61% of Architects sampled were within 18-36years of age, while 5.77% of the respondents were within the age 55-72 years. Descriptive statistics further reveals that 61.54% of the respondents are associate member of the architects' professional body with M.Sc. Arch or equivalent, while 38.46% of the respondents indicated that they are fully registered member of the Institute. The frequency distribution shows that 36.54% of architects in Ondo state are engaged in the educational sector. Followed by 23.08% working with the State Government in different capacities. A further 21.15% is engage in consultancy services, 19.23% of the architects sampled are into contracting.

Table 1. ***Socio economic characteristics of Architects in Ondo State, Nigeria retrieved from analysis of survey (2018)***

S/n	Category	Questionnaire Item	Quantity	percentage
	Socio economic characteristics of respondents			
1	**Gender**	male	05	90.38
		female	47	9.62
	Total		52	100
2	**Age**	18 – 36	18	34.61
		37 - 54	31	59.62
		55 - 72	03	5.77
	Total		52	100
3	**Professional qualification of the respondents**	Associate member	32	61.54
		Fully registered	20	38.46
	Total		52	100
5	**Respondent type of organization**	Consultancy	11	21.15
		Contracting	10	19.23
		Educational institution	19	36.54
		Government establishment	12	23.08
	Total		52	100

Years of Experience of the Respondents

The sample statistics reveals that the highest percentage (38.5%) of the respondents have had about 10 years of post-graduation experience. Architects with fifteen years' experience were up to 26.9%, closely followed by architects with five years' experience with 17.3%. Also, 13.5% of Architects in Ondo State have had about 20 years of experience, while 3.8% of the respondents indicated that they have had 25years experience in the field. Summarily, 83% of respondents have between ten and twenty five years on the field. This goes a long way to show that the sample of Architects in Ondo State are well experienced to give feedback from the field on the use of timber in the building industry within Ondo State, Nigeria.

Figure 1. Pie charts showing the relevant working experience of architects in Ondo state retrieved from analysis of survey (2018)

Consideration of Timber Construction for Various Building Construction

Comparison of Architects perspective on the consideration of timber for building construction in Ondo State shows that using timber for residential buildings was ranked first, with a rank sum score of 208 (Table 2). Followed by Commercial, Recreational and Educational Buildings, having a rank sum score of 186, 177 and 169 respectively. The level of adoption of timber construction for governmental and industrial building construction are at the lower rung having the fifth and sixth position with a score of 156 and 138 respectively. The position of residential building is in line with the NPC, ICF (2006) outlook, where 9.56 % of walls in residential buildings are made of timber.

Table 2. *Comparison of architects' perspective on the application of timber in different categories of buildings in Ondo State, Nigeria. Retrieved from analysis of survey (2018).*

Type of building	VI	I	NA nor IA	A	VA	Rank sum	Rank
Residential	0	6	4	26	16	208	1
Commercial	3	6	7	30	6	186	2
Recreational	1	9	19	14	9	177	3
Education	3	12	14	15	8	169	4
Governmental	5	12	18	12	5	156	5
Industrial	6	21	13	9	3	138	6

Note: 'VI' means very inappropriate, 'I' means inappropriate, 'NA' nor 'IA' means neither appropriate nor inappropriate, 'A' means appropriate, 'VA' means Very appropriate

Critical factors influencing the Specification of Timber as a Building Material for Construction in Ondo State

Analysis of data in table 3 shows the respondents' assessment on the level of acceptance of timber as a building construction material in Ondo State, Nigeria. It reveals that susceptibility of timber to termite and fire attacks is ranked first and second respectively, with a rank sum score of 230 and 229. Some of the advantages of using timber in buildings: Insulation properties and low cost were rated third with both having a rank sum score of 218. Other qualities of timber rated are: Aesthetics, availability of skilled workers to work with timber, time implications for timber based construction, ease of maintenance, compliance to local government regulations were rated fifth, sixth, seventh, eighth and ninth correspondingly on the scale by Architects in Ondo State as being important considerations when choosing timber for construction works. The energy saving capabilities of timber in terms of embodied energy was slightly rated higher with a rank sum score of 195, compared to energy saving capacity in terms of energy in use with a score of 184. Finally, adequate seasoning was rated the least, this may be so because the timber industry as a whole is not fully developed. Trees may not fully mature before harvesting. Also, wooden sections are usually not seasoned before marketing.

Table 3. *Comparison of architects' perspective on the factors influencing the use of timber in different categories of buildings in Ondo State, Nigeria. Retrieved from analysis of survey (2018).*

Factors	NI	LI	N	VI	EI	Rank Sum	Rank
Susceptibility to termite attacks	0	2	2	20	28	230	1
Fire retardation capabilities	2	0	3	17	30	229	2
Insulation properties	0	3	8	17	24	218	3
Cost implications	1	1	2	31	17	218	3
Aesthetics	0	6	5	19	22	213	5
Availability of skilled workers to work with timber	0	4	6	25	17	211	6
Time implications for construction	1	2	1	35	12	208	7
Ease of maintenance	0	3	9	21	19	203	8
Compliance to local environmental regulations	0	5	13	21	13	198	9
Energy saving capabilities : Embodied Energy	1	7	6	28	10	195	10
Energy saving capabilities : Energy in use	1	5	14	24	7	184	11
Adequate seasoning	0	6	6	18	22	121	12

Note: 'VI' means very inappropriate, 'I' means inappropriate, 'NA' nor 'IA' means appropriate nor inappropriate, 'A' means appropriate, 'VA' means Very appropriate

Application of Timber in Building Design and Construction in Ondo State

Perception of Architects on the acceptability of timber by professionals in Ondo state shows that timber is used more in the construction of roof trusses and as furniture. Both items are ranked first by 17.31% of the respondents. The use of timber for ceiling, windows and doors is rated third by 15.38% of respondents. The use of timber as structural floor and staircase is rated fifth by 13.46% of architects in Ondo State. While using timber for walling is rated 7th with 7.7% of the respondents.

Table 4. Perception of architects practicing within Ondo State on the application of timber in different aspects of building design and construction. Retrieved from analysis of survey (2018).

Application in building	Number of Architects	Percentage (%)	Rank
Furniture	9	17.31	1
Roof truss	9	17.31	1
Ceiling	8	15.38	3
Doors/windows	8	15.38	3
Floor	7	13.46	5
Staircase	7	13.46	5
Walls	4	7.7	7
Total	52	100	

Level of Acceptability of Timber as a Construction Material in Ondo State

Analysis of the responses shows that 30.8% of Architects practicing in Ondo State agree that timber is an acceptable material for building construction. Another 21.2% agree that timber is an acceptable material for construction in Ondo state. Together, the responses for very acceptable and acceptable make 52% of the total responses. Furthermore, 11.4% of the respondents were neither unacceptable nor acceptable. While 21.2% agree that timber in construction is unacceptable and 15.4% of the respondent indicated that application of timber in construction is very unacceptable in Ondo state.

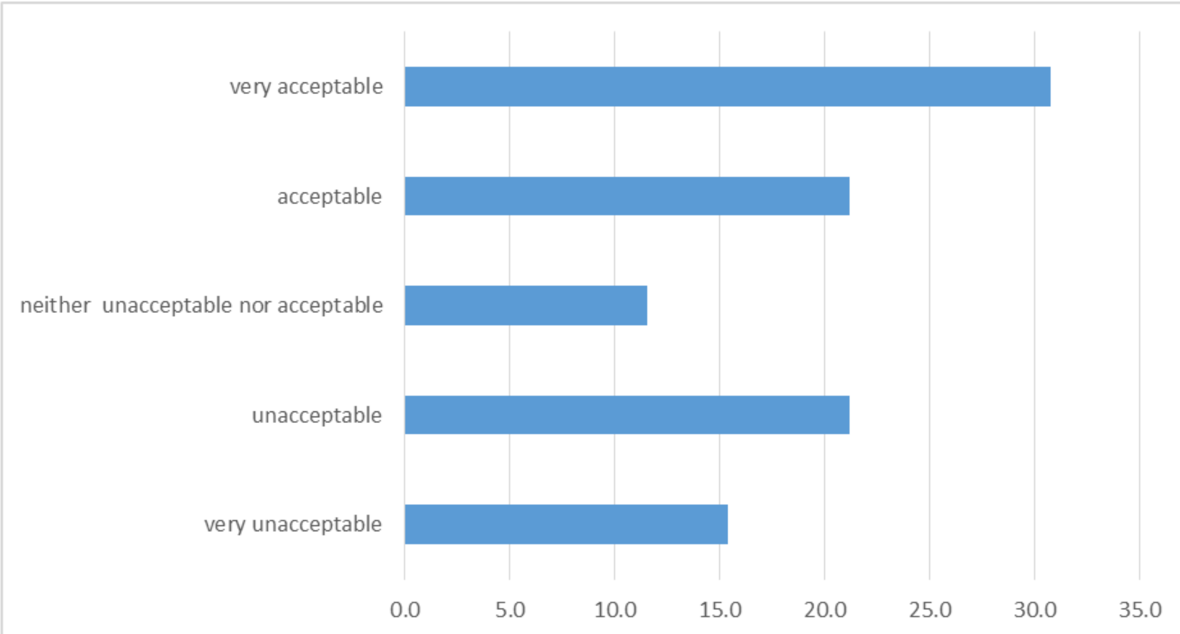

***Figure 2*. Component bar chart showing the possible limits of acceptability of timber in the building industry in Ondo State, Nigeria, retrieved from analysis of survey (2018).**

CONCLUSION

In conclusion, the use of timber for industrial construction is very low, while the use of timber for residential construction was considered the most appropriate. This can be due to some factors related to timber such as aesthetics, lower cost of construction, ease of maintenance and reduced time of construction. It was also reported that timber could be a good material for commercial and recreational buildings. Perception of architects practicing within Ondo State on the application of timber in different aspects of building design and construction follows this order: furniture, roof truss, ceiling, doors, windows, floor, staircase and walls. Responses for timber acceptability shows that very acceptable and acceptable make 52% of the total responses. The implications for building construction within Ondo state, Nigeria is that there should be concerted effort to address such factors as: susceptibility to termite, fire attacks and improve seasoning of timber to increase the acceptability in the state.

REFERENCES

Adedeji, Y. M. D., & Ogunsote O. O. (2005). *Modern Techniques of Using Timber in Building Structures and Components in Nigeria*. Retrieved from http://www.futa.edu.ng.

Alli, J. A., (2010). *Development of buildings and road research in Nigeria, past, present and future*. Annual Lecture, School of Engineering and Engineering Technology, Federal University of Technology, Akure, Nigeria.

Architects Registration Council of Nigeria (ARCON, 2009). *Register of architects entitled to practice in the Federal Republic of Nigeria*. Abuja Nigeria: ARCON.

Babbie, E. (2013). *The practice of social research (13th Ed.)*. Australia: Wadsworth, Cengage Learning.

Brophy, V., & Lewis J. O. (2011). A green vitruvius, principles and practice of sustainable architectural design (2nd ed.). London: Earthscan.

Churdley, R., & Greeno, R. (2010). *Building Construction Handbook*. Oxford, UK: Elsevier.

Creswell, J. W. (2011). Research Design: Qualitative, quantitative and mixed methods approaches (4th Ed.). Thousand Oaks, CA: Sage.

Fadamiro J. A. & Ogunsemi D. R. (2008). *Fundamentals of building design,constructon and materials*. Akure, Nigeria: Adeyemo Publishing House.

Federal Republic of Nigeria, (2009). *Legal Notice on Publication of 2006 Census Final Results*. Abuja Nigeria: Federal Republic of Nigeria

Forest Products Laboratory (2010). *Wood Handbook*. Wood as an engineering material. U.S. Department of Agriculture. Forest Service. Madison, Wisconsin.

Hepner, C. M. & Boser, R. A. (2006). Architects' Perceptions of LEED Indoor Environmental Quality Checklist Items on Employee Productivity. *International Journal of Construction Education and Research*, 2(3), 193-208. DOI: 10.1080/15578770600907156

Ikudayisi, A. E. & Omoyajowo, N. I. (2016). A comparative analysis of sustainable building materials: a focus on perceived qualities of timber versus concrete in Nigeria. In Ebohon, O. J., Ayeni, D. A, Egbu, C. O, and Omole, F. K. *Proceedings of the Joint International Conference (JIC) on 21st Century Human Habitat: Issues, Sustainability and Development* (pp. 459-471), Akure, Nigeria: Federal University of Technology, Akure (FUTA)

Koenigsberger, O. H., Ingersoll, T. G., Mayhew, A. & Szokolay, S. V., (1973). *Manual of tropical housing and building. Part one: climatic design*. London: Longman Group Limited.

Kozak, R. A. & Cohen, D. H. (1999). Architects and structural engineers: an examination of wood design and use in non-residential construction. *Forest Products Journal*, 49(4), 37.

Krejcie, R.V. & Morgan, D.W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, 30, 607-610.

National Population Commission (NPC) & ICF International (2014). *Nigeria Demographic and Health Survey 2013*. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International. Retrieved from https://dhsprogram.com/pubs/pdf/FR293/FR293.pdf

National Population Commission (NPC, 2006). *Housing characteristics and amenities table (Vol. II)*. Abuja, Nigeria: NPC.

Olamiju, I. O., & Oyinloye, M. A. (2015). Characteristics and vulnerability of houses under overhead high tension powerline in Akure, Nigeria. *World Environement*, 5(3), 121- 133. DOI: 10.5923/j.env.20150503.04

Olaniyan, C. I. O. (1985). The balance of nature: live and let live. In: Federal University of Technology, Akure (FUTA, 2004). *In search of the route to technological development: a compedium of foundation day lectures (pp.19 – 31)*. Akure, Nigeria: FUTA.

Oluyege, A. O. (2007). Wood: a versatile material for national development. *Inaugural lecture series 45*. Akure, Nigeria: Federal University of Technology, Akure (FUTA).

Prucnal – Ogunsote (n.d*.). Refelection of culture and climate in the vernacular and modern architecture of Akure*. Retrieved from www.archnet.ng

Roos, A., Woxblom, L. & McCluskey, D. (2010). The influence of architects and structural engineers on timber in construction – perceptions and roles. *Silva Fennica* 44(5), 871–884. Retrieved from https://www.silvafennica.fi/pdf/article126.pdf

Wright, F. L. (1928). In the cause of architecture (iv): the meaning of materials – wood. In H. S. Dunlan & M. Filler (Eds., 1975). *In the cause of architecture, Frank Lloyd Wright* (pp.179 – 186). New York: Architectural Record books.

EFFECTS OF LAND USE AND SOIL DEPTH ON SOIL MICROBIAL PARAMETERS IN AKURE NIGERIA

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Abstract
The abundance, distribution and activities of microorganisms in the soil largely depend on the quality and quantity of substrate available to them. The latter is in turn determined by the land use pattern. Soil samples were collected from 0-15, and 15-30 cm depth in the oil palm plantation, and from arable farmlands in the Teaching and Research Farm of the Federal University of Technology, Akure Nigeria (7°16'N,5°12'E) to assess the combine impacts of landuse patterns on soil microbiological parameters. The microbiological parameters of the soil samples were determined in the laboratory using standard analytical methods. Results showed that total microbial population was higher under the arable land use, but fungi count was higher in the oilpalm plantation. The arable land also supported higher microbial respiration but lower microbial biomass than the plantation land. All the microbiological parameters were found to reduce with soil dept.
Keywords: *Land use, plantation, arable land, soil respiration, microbial biomass.*

INTRODUCTION

Management practices greatly affect soil quality (Larsen & Pierce, 1994), and deterioration caused by management amounts to roughly 40% of the world's agricultural lands. Decrease in soil quality is regularly an aftereffect of management practices that cause loss of organic matter, nutrient depletion and loss of species diversity of soil microbial biomass (Tilman et al., 2002).
Concerns about management-induced soil deterioration began in the 1980s (Brundtland, 1987; Bentley & Leskiw, 1984), and this has led to intensive research on soil quality, which is the ability of the soil to resiliently and sustainably support crop growth leaving no or minimal adverse effects to the environment (Gregorich & Acton, 1995).

Land-use simply refers to the specific use to which a given piece of land is used for, and changes in land-use is associated with changes in vegetation type and management practices. The changes in vegetation can alter above-ground biomass, soil organic matter content, soil microbial communities, and the plant growth microenvironment, and thus affect soil respiration and temperature fluctuations (Han *et al.,* 2014).
Soil microorganisms play an important role in the decomposition of organic matter, in nutrient cycling and energy transfer in terrestrial ecosystems (Li et al. 2012).
Particularly important among the indicators of soil quality are soil microbiological parameters, principally soil microbial activity, biomass and population. (Andres-Abellan*et al*, 2011). These soil parameters are sensitive indicators of soil quality (Bastida *et al.*, 2008) and could have implications for the establishment of native plant communities and cover (Vance and Entry 2000).

The characteristics of soil microbial communities have been increasingly used as important indicators of soil fertility (Pereira et al. 2008). Exploring the response and dynamic shifts of these communities in various types of restoration programs can contribute to a more complete assessment of the effectiveness of ecological reconstruction and can provide guidance for the revegetation of fragile ecosystems. Soil microbial communities and their diversity can be affected by the type of vegetation cover (Yoshitake *et al*., 2013; Yang & Zhang 2014).

Over the years, different agronomy practices (tillage and fertilization) have influenced the soil nutrients dynamics, chemical as well as microbiological properties across the soil profile (Gesch et al., 2007; Wright et al., 2007). Researchers reveal that microbial population and diversity of soil biota increases under cultivated soils. Kennedy and Smith (1995) also showed that the diversity of soil biota is greater in cultivated soils than fallow lands.

Soil profiles are many meter deep and soil varies from place to place while microorganism population also varies with the depth. Studies conducted by (Fierer et al. 2013) and (Pandey, 2015) have showed the decreasing microorganism population with increasing soil depth. These and many other researches were however conducted outside the Southwestern Nigeria. The present study was conducted to examine the combined effects of Land Use and Soil Depth on soil microbial activity as well as on soil microbial biomass.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research farm of the Federal University of Technology, Akure (FUTA) Ondo State, South West, Nigeria ($7^0$16'N, $5^0$12'E). The area experiences a tropical climate with distinct wet and dry seasons. Mean annual rainfall is about 1524mm, the annual sunshine hour is about 2000 hours while annual relative humidity is 80 percent. The vegetation is forest mixed with various types of bush regrowth, grasses, and creepers. The major crops grown in the area were arable and tree crops.

Collection of soil sample

Samples were taken from bottom up, with the use of hand trowel after digging. The soil sample was taken at two soil levels within the plough depth: 0-15cm, and 15-30cm in the arable land. The arable land had been cropped with maize, cowpea, pepper, tomatoes and okra for over 20 years. Soil was also sampled from same depth in an oil palm plantation which was established and maintained for over 20 years. A total of 12 samples were collected in the study. Six from each land use at three different spots (in three replicates). The soils were put into plastic bags, labeled and immediately taken to the laboratory for analysis (Subra, 2001; Okonkwo, 2010).

Soil analysis

Soil analysis was done in the laboratory using standard analytical methods. The following parameters were determined: soil pH, carbon % organic carboen (OC), soil respiration (substrate induce respiration and basal respiration), microbial population (bacteria and fungi), and microbial biomass (carbon and nitrogen).

Soil organic carbon (OC) and soil pH were determined by standard methods described by AOAC, (1990).

Enumeration of soil microbial population

Numbers of microflora were estimated by soil dilution technique on Nutrient and Potato Dextrose Agars as isolation media for bacteria and fungi respectively. Serial dilution was done usng 5 grams of soil suspended in 150 ml Erlenmeyer flask containing 95 ml of sterilized distilled water to obtain a 10^{-1} dilution and was kept under shaking conditions at 120 rpm for 15 minutes. From the flask 1 ml of suspension was transferred to 9 ml water blank to make 10^{-2} dilution. In similar manner dilutions were made up to 10^{-8}. The nutrient agar medium was composed of peptone 5 g, meat extract 3 g, agar agar 15 g and 1000 mL distilled water. For bacterial count 0.1 ml aliquot of the dilution to 10^{-8} was spread plated on Nutrient Agar medium petri plates in triplicates. Then the plates were incubated in an inverted position at 28˚C for 2 days. The constituents of the Potato Dextrose Agar (gL^{-1}) were Peptone 5.0, potato extract 5.0 , dextrose 10.0, Agar 20.0, and Distilled water 1000.0 ml at pH 6.5. A mixture of 1g soil and 10mL of saline solution was shaken on a mechanical shaker for 10 minutes to dislodge fungal propagules into the solution. This was followed by serial dilutions to the concentrations of 10^{-5}. 0.5 mL of the aliquot was spread on Potato dextrose extract agars to isolate fungal spores and this was incubated at 28^{0C} for 4 days. Dilution factors of 8 and 5 were used to determine the bacterial colony and fungal spore forming units respectively.

Measurement of Soil Basal and Substrate Induced Respiration (SBR and SIR)

Basal respiration (µg CO_2-C g^{-1} soil) was determined by the alkali sorption and titration method described by Anderson and Domsch (1990). A 10 mL solution of 0.5M NaOH was dispensed into a 50mL beaker and placed inside the glass jars containing soil samples to trap CO_2 evolved from the soil. On the third day, 5mL of 1.0M $BaCl_2$ was added to the NaOH solutions from the jars to precipitate carbonate (as $BaCO_3$), thus facilitating the determination of CO_2 evolution (as µg CO_2-C g^{-1} soil) from the treated soil. The evolved CO_2-C was then determined by titration. NaOH in solution was titrated against 0.5 M HCl using phenolphthalein indicator. Two blanks without soil were prepared to assess the amount of CO_2 trapped without respiratory activity. The substrate induced respiration (SIR) was determined using same procedure as SBR, but in the case of SIR, the 50 g soil was amended with 0.3 g of glucose

Determination of Soil Microbial Biomass Carbon and Nitrogen (MBC and MBN)

Soil microbial biomass C (Cmic) was determined by the fumigation and extraction method described by Vance *et al*. (1987). 10g of unfumigated soil was extracted with 50 mL of 0.5 M K_2SO_4 by shaking for 45 min with a rotary shaker at 180 rpm, and the suspension filtered using a Whatman No. 2 filter paper. A separate portion was fumigated by placing it in a 50-mL beaker inside a desiccator alongside with another beaker containing ethanol-free chloroform. The desiccator was covered and evacuated with a vacuum pump until the chloroform boiled vigorously for 5 min. The evacuation was repeated three times at intervals of 15 min, letting air pass back into the desiccator to facilitate the distribution of the chloroform throughout the soil. The desiccator was evacuated a fourth time until the chloroform boils vigorously for 2 min. 24 hours later, the $CHCl_3$ was removed by vacuum extraction and the fumigated sample was extracted as above. Organic carbon in the extract was determined by the wet combustion method of Walkley and Black. MBC was calculated by the differences between the fumigated and non-fumigated samples divided by the K_2SO_4 extract efficiency factor (Kc = 0.35) (Sparling *et al*., 1990). MBN was also determined using the Kjeldahl distillation methods (Kjeldahl, 1883). The data generated from the laboratory analysis were then subjected to analysis of variance (ANOVA) using MINITAB 17 and means was separated using Tukey test at 5% probability level

RESULTS AND DSICUSSION

Effects of land use and soil depth on organic carbon and pH

The main effects of land use and soil depth on soil organic carbon and pH are presented in table 1. Soil sampled from oilpalm plantation was found to have significantly ($p<0.005$) higher OC and pH than the arable soil. OC and pH were also found to be higher in the topsoil (1-15cm) than in the depth of 15-30, and the differences were also significant.

Table 1. Main effects of land use and soil depth on soil organic carbon and pH

Land use	**Organic carbon(mg/kg)**	**pH**
Plantation	8.10^{a}	6.70^{a}
Arable	1.18^{b}	6.09^{b}
Soil depth		
0-15	5.70^{a}	6.42^{a}
15-30	3.59^{b}	6.38^{b}

Means that do not share the same letter are significantly ($p<0.005$) different

Table 2 shows the interaction effects of land use and soil depth on soil organic carbon content and pH. Significantly differences ($p<0.005$) were recorded among the treatment combinations in the soil organic carbon content. The interaction between plantation (land use) and 0-15 (soil depth) produced the highest soil organic carbon content while the lowest soil percentage OC was observed with the interaction between the arable land at 15-30 cm depth.

Table 2. Interaction effects soil depth and land use on organic carbon and pH

Land use	**Soil depth(cm)**	**Organic C. (mg/kg)**	**pH**
Plantation	0-15	9.80^{a}	6.74^{a}
	15-30	6.41^{b}	6.67^{a}
Arable	0-15	1.59^{c}	6.17^{b}
	15-30	0.77^{d}	6.01^{b}

Means that do not share a letter are significantly ($p<0.005$) different

Effects of land use and soil depth on soil microbial population.

The effects of land use and depth on soil microbial population ($x10^{6}$) are presented in Table 3. Significant difference was recorded between arable and plantation soil with respect to their effects on bacterial population, while fungi population was not significantly affected by land use. Significant differences were also obtained among the microbial population at different soil depth. However, both bacterial (71.31) and fungal (57.77) populations were higher in arable land than in the oil palm plantation. In the effect of soil depth on the soil microbial population, the mean microbial population value was higher at the soil depth of 0-15cm than 15-30cm for both bacterial and fungi (0-15cm {71.03, 61.27} and 15-30cm (65.068, 53.13), respectively.

Table 3. Effects of land use and depth on soil microbial population (x10^{6})

Factors	**Bacteria ($CFUg^{-1}$)**	**Fungi ($SFUg^{-1}$)**
LAND USE		
Arable	71.31^{a}	57.77^{a}
Plantation	64.78^{b}	56.63^{a}
DEPTH		
0-15cm	71.03^{a}	61.27^{a}
15-30cm	65.07^{b}	53.13^{b}

Means that do not share a letter are significantly ($p<0.005$) different

Table 4 shows the interaction effects of land use and soil depth on soil microbial population. Significantly differences ($p<0.05$) were recorded in the microbial population as influenced by the various treatment combinations. The plantation soil at 0-15 depth gave the highest mean value of soil bacterial population plantation soil at 15-30 depth had the least.

Table 4. Combined effects of land use and depth on microbial population (x10^{6})

Land use	Depth (cm)	Bacteria ($CFUg^{-1}$)	Fungi ($SFUg^{-1}$)
Arable	0-15	74.24^{a}	62.12^{a}
	15-30	68.37^{b}	53.40^{b}
Plantation	0-15	67.80^{b}	60.41^{a}
	15-30	61.74^{c}	52.84^{b}

Means that do not share a letter are significantly ($p<0.005$) different

Main effect of land use and soil depth on microbial respiration and biomass

Table 5 shows the main effects of land use and depth on microbial respiration. Neither land use nor soil depth significantly affected microbial respiration. The arable land use had a higher amount of CO_2 produced in both SIR and basal respiration (17.5; 11.30) while plantation had the least (16.1; 10.85). For soil depth, the 0-15cm depth had a higher amount of CO_2 produced in both SIR and basal respiration (18.05; 11.50).

Table 6 shows the interaction effect of land use and soil depth on soil microbial respiration. Significantly differences ($p<0.05$) were not recorded in the microbial respiration. The combined effect of arable (land use) and 0-15 (soil depth) gave the highest mean value of soil microbial respiration parameter measured while the interactive effect between plantation (land use) and 15-30 (soil depth) had the least.

Table 5. Effects of land use and depth on microbial respiration

Factors	SIR (mg C g^{-1})	Basal respiration (mg C g^{-1})
LAND USE		
Arable	17.5[a]	11.30[a]
Plantation	16.1[a]	10.85[a]
DEPTH		
0-15cm	18.05[a]	11.50[a]
15-30cm	15.55[a]	10.65[a]

Means that do not share a letter are significantly ($p<0.005$) different

Table 6. Combined effects of land use and depth on microbial respiration

Land use	Depth	SIR	Basal respiration
Arable	0-15cm	19.3[a]	11.6[a]
	15-30cm	16.8[a]	11.4[a]
Plantation	0-15cm	15.7[a]	11.0[a]
	15-30cm	15.4[a]	10.3[a]

Means that do not share a letter are significantly ($p<0.005$) different

*SIR= Substrate induce respiration

The effects of land use and soil depth on microbial biomass carbon and microbial biomass nitrogen is showed in table 7. There were significant differences in mean microbial biomass carbon and microbial biomass nitrogen for the land use type and soil depth. The plantation land use type had a higher mean microbial biomass carbon value (101.84) compare to arable land use (81.32). For the mean microbial biomass nitrogen value, the arable land gave a higher mean value (11.11) than the plantation (10.49).

The combined effects of land use and soil depth is presented in Table 8. Significantly differences ($p<0.005$) were recorded in the microbial biomass carbon and nitrogen. The combine effect of the plantation (land use) and 0-15 depth gave the highest mean value of microbial biomass carbon (110.96) while the interaction between arable (land use) and 15-30 (soil depth) had the least (74.43). The highest mean microbial biomass nitrogen value was observed in the combined effects of arable (land use) and 0-15 (soil depth) (12.96) while the least was found in (arable land + 15-30cm) (8.02).

Table 7. Sole effects of land use type and soil depth on MBC and MBN

Treatments	Microbial biomass Carbon ($mg\ CO_2$-ckg^{-1})	Microbial biomass nitrogen ($mg\ NH_4^+$-Nkg^{-1})
Land use		
Arable	81.32^b	10.49^a
Plantation	101.84^a	11.11^a
Depth		
0-15cm	99.56^a	13.27^a
15-30cm	83.60^b	8.33^b

Means that do not share a letter are significantly (p<0.005) different

Table 8. Combined effect of land use and soil depth on MBC and MBN

Land use	Depth	Microbial biomass Carbon ($mg\ CO_2$-ckg^{-1})	Microbial biomass nitrogen ($mg\ NH_4^+$-Nkg^{-1})
Arable	0-15cm	88.16^b	12.963^a
	15-30cm	74.43^c	8.024^b
Plantation	0-15cm	110.96^a	13.58^a
	15-30cm	92.72^b	8.64^b

Means that do not share a letter are significantly (p<0.005) different

Discussion

This study has clearly demonstrated that soil microbial parameter change with changes in land use pattern and soil depth. Results obtained from this study also revealed that significant interaction exist between land use pattern and soil depth as reflected in their combined effects on soil microbial parameters. Soils under the two land use patterns were slightly acidic and contained good percentage of organic carbon that can be considered critical for crop production in south western Nigeria (Akinrinade and Obigbesan, 2000).

The significant differences recorded in soil pH, organic carbon, and most of the microbial parameters between the two land use treatments was an indication that vegetation type has a large impact on soil chemical characteristics, which contribute to the structure of soil microbial communities (Menon et al. 2013; Yang & Zhang 2014). There are previous reports of different microbial community composition among cropland, shrubland and grassland (Han et al.,2007). Xiao et al (2016) also found that microbiological parameters were influenced by cropland, broadleaf forest, coniferous forest and grassland. This differentiation may be attributed to the different quantity and quality of litter input and root exudates among different types of vegetation (Marschner et al. 2001), which significantly influence the composition of soil microbial communities (Chen et al. 2007). Microbial population was higher in arable land whereas biomass was higher in oil palm plantation. This is because the arable land contains a large number of bacteria especially with frequent addition of fertilizer and manure, but because of their small size, they have a smaller biomass (Bhattarai, 2015). Bacteria, actinomycetes and protozoa can tolerate more soil disturbance than fungal populations so they dominate in tilled soils while fungal and nematode populations tend to dominate in untilled (Janusauskaite et al., 2013; Silva et al., 2013).

Microorganism population in soil is limited by soil porosity, and since more pore spaces are associated with well tilled soils, microbial count is expected to be higher in the arable soil (Collins, 2010; Grubinger, 2004; Magdoff and ES, 2010). Biomass was however higher in the oilpalm plantation presumably because bacteria and fungi have different decomposition pathways. Although they are both decomposers in soils, fungi assimilate a higher proportion of soil C and are composed of more recalcitrant C compounds relative to bacteria (Hackl et al. 2005).

The decrease in soil pH and OC from 0-15 cm to 15-30 cm depth could be attributed to the abundance of leaves and crop residue usually found on the soil surface. This could also be responsible for the higher microbial population and biomass recorded at the 0-15cm depth as these crop residues serve as food to the soil biota. The availability of C has a large impact on microbial communities (Yoshitake et al. 2013) and may be the main factor determining their structure. Microbial biomass and organic-C contents have been reported to decrease as soil depth increases (Stone et al. 2014).

CONCLUSION

This study reveals that although microbial population was higher in arable land due to the astounding number of bacteria, soil microbial biomass was higher in the oil palm plantation. More agricultural lands should therefore be committed to tree crops plantation, as this will ensure slow, continuous and sustained decomposition of recalcitrant residues to furnish the soil with nutrients for plant growth.

REFERENCES

Akinrinade, E.A and Obigbesan, G.O. (2000) Evaluation of the fertility status of selected soils for crop production in five ecological zones of Nigeria. Proceedings 25th Annual Conference of Soil Science Society of Nigeria, Ibadan, Pp 279 –288

Anderson, T.H. and Domsch K.H., (1990). Application of eco-physiological quotients (qCO2 and qD) on microbial biomass from soils of different cropping histories. *Soil Biology and Bioche.*, 22: 251-255.

Andres- Abellan, M., Wic Baena, C., Garcia Morote, F. A., Picazo Cordoba, M. I., Candel Perez, I. and Lucas-Borja, M. E. (2011). Influence of the soil storage method on soil enzymatic activities in Mediterranean forest soils. *Forest Systems. 20(3), 379-388*.

AOAC. (1990). Official Methods of Analysis. 15th edition. Association of Official Analytical Chemists, Washington, DC, USA.

Bastida, F. Z. A., Hernández, H., García, C. (2008). Past, present and future of soil quality índices: A biological perspective. *Geoderma. 147:159-71.*

Bentley, C. F. and Leskiw, L. A. (1984). Sustainability of farmed lands: current trends and thinking. Canadian Environmental Advisory Council, Environment Canada, Ottawa.

Bhattarai A, Bhattarai B, Pandey S (2015) Variation of Soil Microbial Population in Different Soil Horizons. J Microbiol Exp 2(2): 00044. DOI: 10.15406/jmen.2015.02.00044

Brundtland, G.H. (1987). Our common future.World Commission on Environment and Development. *Oxford Univ. Press, NY.*

Chen MM, Zhu YG, Su YH, Chen BD, Fu BJ, Marschner P. (2007). Effects of soil moisture and plant interactions on the soil microbial community structure. Eur J Soil Biol. 43:31–38.

Collins H (2010) Impacts of Fumigation and Crop Rotation on soil Microbial Populations. USDA-ARS Irrigated Research Center, USA.

Fierer N, Schimel JP, Holden PA (2003) Variation in microbial community composition through two soil depth profile. Soil Biology and Biochemistry 35(1): 167-176.

Gesch, R. W., D. C. Reicosky,R. A. Gilbert, and D. R. Morris.(2007). Influence of tillage and plant residue management on respiration of a Florida Everglades histosol. Soil and Tillage Research 92:156-166.

Gregorich, L .J. and Acton, D. F. (1995).Understanding soil health. In: D.F. Acton & L.J. Gregorich (eds.), The health of our soils- towards sustainable agriculture in Canada, pp. 5-10. Centre for Land and Biological Resources Research, Research Branch, Agriculture and Agri-Food Canada, Ottawa.

Grubinger V (2004) Soil Microbiology: A Primer. University of vermont, Burlington, USA.

Hackl E, Pfeffer M, Donat C, Bachmann G, Zechmeister-Boltenstern S. (2005). Composition of the microbial communities in the mineral soil under different types of natural forest. Soil Biol Biochem. 37:661–671.

Han Sung, O. K. and Peter, B. New. (1994). "Effect of Water Availability on Degradation of 2,4-Dichlorophenoxyacetic Acid (2,4-D) by Soil Microorganisms."*Soil Biology and Biochemistry. 26(12): 1689-1697.*

Han XM, Wang RQ, Liu J, Wang MG, Zhou J, Guo W-H. (2007). Effects of vegetation type on soil microbial community structure and catabolic diversity assessed by polyphasic methods in North China. J Environ Sci. 19:1228–1234.

Janusauskaite D, Kadziene G, Auskalniene O (2013) The effect of tillage system on soil microbiota in relation to soil structure. Pol J Environ Stud 22(5): 1387-1391.

Kennedy A.C. and Smith, K.L. (1995). Soil microbial diversity and the sustainability of agricultural soils. Plant and Soil 170:75-86.

Kjeldahl J. (1883) New method for the determination of nitrogen. *Chem. News* 1883, 48 (1240), 101–102

Larson, W. E. and Pierce, F. J. (1994).The dynamics of soil quality as a measure of sustainable management. In: J.W. Doran, D.C. Coleman, D.F. Bezdicek, & B.A. Stewart (eds.), Definingsoil quality for a sustainable development, pp. 37-51. *Soil Sci. Soc. Am. Spec. Publ. 35, Madison, WI.*

Li Y, Chen YL, Li M, Lin XG, Liu RJ. (2012). Effects of arbuscular mycorrhizal fungi communities on soil quality and the growth of cucumber seedlings in a greenhouse soil of continuously planting cucumber. Pedosphere. 22:79–87.

Magdoff F, ES VH (2010) Building Soils for Better Crops: Sutainable Soil Management. (3rd edn), Sustainable Agriculture Research and Education, USA, pp. 294.

Marschner P, Yang CH, Lieberei R, Crowley DE. (2001). Soil and plant specific effects on bacterial community composition in the rhizosphere. Soil Biol Biochem. 33:1437–1445.

Menon R, Jackson CR, Holland MM. (2013). The influence of vegetation on microbial enzyme activity and bacterial community structure in freshwater constructed wetland sediments. Wetlands. 33:365–378.

Okonkwo C. I. (2010) Effects of burning and cultivation on soil properties and microbial population of four different land use systems in Abaliki. Research journal of agriculture and biological science 6(6): 1007-1014. 2010.

Pereira R, Marques SM, Antunes SC, Marques C, Abrantes N, Pestana JLT, Goncalves F. (2008). Comparison of Portuguese soils from different geographical regions using physicochemical, biological and biochemical parameters. J Soil Sediment. 8:106–115.

Silva AP, Babujia LC, Matsumoto LS, Guimaraes MF, Hungaria M (2013) Bacterial Diversity under Different Tillage and Crop Rotation Systems in an Oxisol of Southern Brazil. The Open Agriculture Journal 7(Supp 11-M6): 40-47.

Subra, R., (2001).Soil microbiology (fourth edition of soil microorganisms and plant growth). P.O. Box, 699s, Enfiela, New Hampshire 03748.United State of America.

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R. and Polasky, S. (2002). Agricultural Sustainability and Intensive Production Practices. *Nature (418) pp. 672-675.*

Vance, E. D., Brookes, P. C., & Jenkinson, D. S. (1987). An extraction method for measuring soil microbial biomass-C. Soil Biol. Biochem., *19*, 703-707. https://doi.org/10.1016/0038-0717(87)90052-6

Vance, N. C., Entry J. A. (2000). Soil properties important to the restoration of Shasta red fir barrens in the Siskiyou Mountains. *Forest Ecology & Management 138, 427-434.*

Wright, A. L., and F. Dou, and F. M .Hons. (2007). Crop species and tillage effects on carbon sequestration in subsurface soil. Soil Science 172:124-131.

Xiao L., Liu G, and Xue S (2016): Effects of vegetational type and soil depth on soil microbial communities on the Loess Plateau of China, Archives of Agronomy and Soil Science, DOI: 10.1080/03650340.2016.1170811

Yang DW, Zhang MK. (2014). Effects of land-use conversion from paddy field to orchard farm on ` soil microbial genetic diversity and community structure. Eur J Soil Biol. 64:30–39.

Yang DW, Zhang MK. (2014). Effects of land-use conversion from paddy field to orchard farm on soil microbial genetic diversity and community structure. Eur J Soil Biol. 64:30–39.

Yoshitake S, Fujiyoshi M, Watanabe K, Masuzawa T, Nakatsubo T, Koizumi H. (2013). Successional changes in the soil microbial community along a vegetation development sequence in a subalpine volcanic desert on Mount Fuji, Japan. Plant Soil. 364:261–272.

Yoshitake S, Fujiyoshi M, Watanabe K, Masuzawa T, Nakatsubo T, Koizumi H. (2013). Successional changes in the soil microbial community along a vegetation development sequence in a subalpine volcanic desert on Mount Fuji, Japan. Plant Soil. 364:261–272