WORLD ENVIRONMENTAL CONSERVATION CONFERENCE

2023

CLIMATE CHANGE PARTNERSHIP ACTIONS FOR SUSTAINABLE FUTURE AND RESTORING LIFE ON EARTH

Proceedings of the 6th edition of World Environmental Conservation Conference

18th – 21st October, 2023

EDITIORS: Agele, S. O. (PhD), Balogun, I. A. (PhD), Oluleye, A. (PhD) and Oladeji S. O. (PhD)

Production of Proceedings

Netlink Environmental Conservation Organisation

Room 21 Abubakar Adamu Bulding

Federal University of Technology, Akure.

Design amd Printing of Proceedings

Maryj Printing Press

ACAD Fagbote Filling Station Akure-Ilesha Expressway

Phone number: +23407063411658

Copies of Proceedings

Dr. S. O. Oladeji

President, Netlink Environmental Conservation Organisation (NECOR),

Room 21 Abubakar Adamu Building

Federal University of Technology, Akure.

P. M. b. 704, Akure, Nigeria

E-mail: sooladeji@fita.edu.ng.

sooladeji@necorng.org

info@necorg.org.

www.mecorng.org.

ISSN: 2705-2850

Scientific Review Committee

Prof. S. O. Agele- Chairman Scientific Committee
Department of Crop, Soil and Pest Management, FUTA
+2348035784751
soagele@futa.edu.ng

Prof. I. A. Balogun
Department of Meteorology,
Federal University of Technology,
Akure.
iabalogun@futa.edu.ng.

Prof. A. Oluleye
Department of Meteorology,
Federal University of Technology,
Akure.
aoluleye@futa.edu.ng.

Dr. S.O. Oladeji
Department of Ecotourism and Wildlife Management, FUTA.
Executive Director, NECOR
+2348030698896
sooladeji@futaedu.ng.
sooladeji@necorng.org

PREFACE

There is a growing concern on the adverse impacts of climate on biodiversity. This phenomenon is greatly manifested in form of shifting weather patterns threatening global food security, health and species existence. Humanity is at the receiving end of the consequences of climate change hence there is a need to step up actions on all fronts- overtime, everywhere all at once.

This calls for collaboration, partnership and networking to strengthening synergy among relevant stakeholders in a bid to tackling climate change menace. This forms the basis for the theme of this year world Environmental conservation conference: **CLIMATE CHANGE PARTNERSHIP ACTIONS FOR SUSTAINABLE FUTURE AND RESTORING LIFE ON EARTH.** The theme is conceived with a view to create an interface for information sharing and offer opportunities for participants to refine their commitments and pledges in the quest to achieving Sustainability in the face of climate change.

This year World Environmental Conservation Conference is memorable in the sense that it received overwhelming funding from the host - West African Science Service on Climate Change and Adapted Land use). WASCAL is posed to provide information and knowledge at the local, national and regional level to cope with the adverse impacts of climate change. Thus, this conference will offer opportunities for participants to learn from good practices demonstrated and showcase by WASCAL during the course of the conference. It will also strengthen staff-student exchange and provide prospect for Doctorate Research Doctoral Research in West Africa Climate System Programme (DRP WACS) – WASCAL among others.

Special appreciation goes to the management of The Federal University of Technology, Akure the host institution, National Park Service and African Regional Center for Space Science and Technology Education-English (ARCSSTE-E) that co-host this conference. We equally acknowledge other private, individual and corporate organizations that have contributed towards the success recorded in this event.

All the submitted articles were subjected to strict double blind peer-review process by the reviewers that are experts in the area of the particular submitted manuscript. The accepted manuscripts are published in WECC 2023 proceedings and also available for download on the organization website (www.necorng.org).

The accepted manuscripts fall within the underlisted subthemes:

- Climate change adaptation strategies in Agriculture, Forestry and Other Land Use (AFOLU)
- Climate smart city and architectural landscape design
- Retrofitting and decarbonization in tourism and hospitality industry
- Indigenous knowledge and local innovation in climate change adaptation
- Climate risk management, health, safety and hygiene
- Carbon credit-offset marketing/circular economy
- ICT development in environmental conservation (image processing and acquisition, computer vision, graphics, speed, interface technology, HMD devices, GIS: Body Tracking, AI and IOT, VRT, IVE).

We commend our keynote speaker Prof. Douda Kone Director Capacity Building Department, WASCAL Headquarter, Ghana and other guest speakers Prof. Babatunde Rabiu, Director General, Chief Executive Office, African Regional Centre for Space Science and Technology Education-English (ARCSSTE-E) and Dr. Goni I. M., Conservator General National Park Service.

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 option expressed remain essentially that of the authors and not necessarily that of Netlink Environmental Conservation Organization.

Dr. Oladeji S. O.

President Netlink Environmental Conservation Organization

Convener World Environmental Conservation Conference

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CLIMATE CHANGE AND FOOD SECURITY: RISKS AND RESPONSES

Olaifa K.A., Agbeja A.O., Akindolu D.R., Akinlade M.S. and Majolagbe M.O.
Forestry Research Institute of Nigeria. Jericho Hill, Ibadan.
Corresponding e-mail: zaylat1317@gmail.com/ 08132758363

ABSTRACT

Climate change poses significant risks to global food security as it alters weather patterns, increases the frequency and intensity of extreme events, and disrupts ecosystems. Changes in temperature and precipitation patterns directly affect crop yields and livestock production. Rising temperatures can reduce crop productivity, alter species distribution, and increase the occurrence of pests and diseases. Moreover, climate change exacerbates water scarcity in many regions, further hampering agricultural activities. To address these risks, various responses can be implemented at global, national, and local levels. Adaptation measures aim to build resilience in food production systems and enhance farmers' capacity to mitigate climate-related risks. Examples include promoting climate-resistant crop varieties, improving water management techniques, adopting agroforestry practices, and diversifying income sources through value addition and alternative livelihoods. This paper provides a detailed overview of the risks posed by climate change to food security and explores potential responses to mitigate these risks. In conclusion, climate change poses substantial risks to food security, impacting both the quantity and quality of food production. Addressing these risks requires a multi-faceted response that combines adaptation and mitigation strategies at various levels of governance. By implementing these measures and fostering international cooperation, it is possible to mitigate the impacts of climate change on food security, ensuring a sustainable and resilient food system for future generations.

Key words: *Nutrition, Agroforestry, food security, and climate change.*

INTRODUCTION

The African continent has been known to be one of the most sensitive to climate change. The risk of desertification, which the continent is known to experience, the poverty of a large portion of the population, which depends on natural resources and agriculture. Also, the lack of resources available to governments, who are barely able to maintain even the existing infrastructural facilities, and other issues are all directly related to the emissions produced by the burning of fossil fuels, including transportation. These emissions represent only 16.2% percent of the world's total (Hannah R. *et al.,* 2020). Africa will be able to overcome the negative effects of climate change. This is because sustaining the diversity of the continent's animal and plant life, as well as its ability to produce healthy soil and forest cover, will help the continent remain ecologically stable.

Disasters caused by climate change may destroy vital infrastructure, important crops, and important communal resources, worsening livelihoods and escalating poverty. Long-term and gradual climatic threats are also present. Climate change affects both food security and livelihood of those engaged in production systems. According to FAO 2020, two billion people (25.9%) of the global population experienced hunger or did not have regular access to nutritious and sufficient food.

IMPACTS OF CLIMATE CHANGE ON FORESTS

From humid tropical forests to dry boreal (high-latitude) regions, woods have been proven to thrive in a variety of climatic situations. Climate and CO_2 concentrations have an impact on the carbon cycle (photosynthesis, plant respiration, and organic matter decomposition) in a particular forest (Bala *et al,* 2007). Thus, it might be challenging to distinguish between human and natural variables that affect plant growth.

In general, forests thrive best in warm, wet environments. As a result, it would be reasonable to anticipate that forests will react to temperature changes as well as to variations in precipitation brought on by climate change. Forests are appreciated for their ecological functions, recreational opportunities, and lumber production, among other things. The damage could be significant, and the kinds of trees growing at a given site might give way to those more suited to the new climatic conditions, or a forest might cease to exist altogether, if forest dieback were to occur so quickly that new forest had difficulty replacing existing ecosystem services (such as water protection and erosion control). However, the financial impact would rely not just on how the established links between trees and climates were disrupted but also on how people responded to the ramifications.

Due to a combination of natural and human-caused processes, forests serve as significant carbon sinks that constantly exchange CO_2 with the atmosphere. It is important to comprehend the carbon cycle at the forest level in order to comprehend how forests contribute to the greenhouse effect. At the global level, plants and soil account for 81 percent of the carbon in the earth's biosphere. Approximately 31% of the carbon is stored in the biomass and 69% is stored in the soil in all forests, tropical, temperate, and boreal combined. According to the

IPCC (2000), in tropical forests, roughly half of the carbon is stored in the biomass and the other half is in the soil. The following mechanisms lead to the oxidation of carbon in organic matter and the resultant emissions of CO_2: respiration of living biomass, breakdown of organic matter by other living creatures (also known as heterotrophic respiration), and combustion (fires).

EFFECTS OF CLIMATE CHANGE ON FOOD SECURITY

Food Security

A nation is said to be in a condition of food security when all of its citizens have physical, social, and economic access to enough food that is safe, nourishing, and fits their dietary needs, preferences, and cultural standards (Edward C, 2002). In other words, it denotes that there is enough food for everyone to consume, and that the food is nutritious and of high quality from the country of residence or via importation, food aids and donation. (Stamoulis and Zezza, 2003). Undernutrition is still one of the most critical yet least addressed socioeconomic and health issues in the world (Horton *et al.,* 2009 FAO, SUN, 2010, /WFP, 2012).

Despite the fact that there is enough food produced globally to feed everyone, hunger and malnutrition continue to be serious issues on a worldwide scale. Poor health, poorer productivity, and slower economic growth are just a few of the negative effects that food insecurity may have on people and communities. Poverty, armed conflict, climate change, and poor infrastructure are just a few of the many factors that might have an impact on food security. Conflicts entails huge and divers costs which include direct human suffering and negatively impacting socioeconomic progress especially in the rural areas. (De Waal, 2015). This invariably reduce the amount of food available, blocks people access to food (Simmons, 2013). Monitoring food insecurity in conflict affected countries and understanding the linkages between food insecurity and violent conflict is crucial to informing evidence based interventions from local, National and international policy makers (FAO, 2018). By putting policies and programs that support food production, distribution, and access into place, governments and international organizations play a critical role in maintaining food security. Aside from that, people can contribute by promoting policies that support food security, decreasing food waste, and assisting local food systems.

Undernutrition is still one of the most critical yet least addressed socioeconomic and health issues in the world (Horton et al., 2009 FAO, SUN, 2010, /WFP, 2012). Climate change has significantly impacted this issue. According to Horton et al. (2009), undernutrition has tremendous human and socioeconomic costs that disproportionately affect the poorest people, particularly women and children. The millions of people worldwide who experienced early undernutrition confront numerous difficulties as they mature. They frequently struggle in school, are more prone to disease and death while they are young, and are less able to fully contribute to the social and economic growth of their families, communities, and countries as adults (Nabarro, 2010).

Climate change has been known to exacerbate threats to existing food security and livelihoods due to the following factors:

(i) Increasing frequency and severity of climate hazards
(ii) Declining agricultural yields and reduced production in vulnerable regions
(iii) Rising health and sanitation risks
(iv) Increasing water scarcity
(v) Intensifying conflicts over limited resource

All of the above would result in new humanitarian crises as well as increased displacement (IPCC, 20). Due to climate change, it is expected that the availability, access, stability, and utilization of all factors influencing food security will undergo alterations. The FAO, IFAD, UNICEF, WFP, and WHO (2017, 2018, 2019) report "The State of Food Security and Nutrition in the World" identified conflict, national economies, and climate change as the primary causes of food insecurity globally.

Agriculture, fishing, and other livelihoods reliant on forests will see a worsening of living conditions for already vulnerable and food insecure populations (FAO, 2008). There will be more hunger and malnutrition. There is an immediate and rising risk of greater crop failure, animal loss, and decreased availability of marine, aquaculture, and forest goods for rural communities, particularly those living in already fragile environments. In both rural and urban regions, more frequent and more severe extreme weather events would negatively affect food availability, accessibility, stability, and use as well as livelihood assets and possibilities (FAO 2015).

Affected by changes in agricultural output and arable land are changes in the overall availability of food. The ability of low-income households to access food markets and the diversity of diets they may maintain could both be impacted by changes in food output and costs. Given the potential for changes in vector-borne disease patterns and decreased water availability and quality in some regions, malnutrition may rise and food intake may be negatively impacted. Increased health and sanitation issues, such as diarrheal disease, could also arise from these changes (Gueladio Cisse, 2019). The stability of the food supply and the livelihoods of people are both impacted by extreme weather events. A worsening of this trend and potential harm to livelihoods dependent on climate-sensitive activities like rain-fed agriculture and

livestock rearing would occur from an increase in extreme weather events like floods and droughts as a result of climate change. See Schmidhuber and Tubiello (2007).

According to Ughaelu (2017), one of the subSaharan African nations most vulnerable to climatic change is Nigeria.Researchers Ayinde *et al.* (2011), Ughaelu (2017), and Ikem (2018), among others, discovered that recurring environmental disasters in some regions of Nigeria have worsened food productivity and human suffering over the previous ten years.There were huge losses in terms of human lives, crops, and animals, as well as forced emigration, as a result of the devastating floods that struck several areas of Nigeria in 2012 and had not bee n observed in the country in the previous 40 years (Ogbuchi, 2020).

According to Ughaelu (2017), Nigeria's six vegetative zones are impacted by environmental changes in various ways.
The results of investigations (Tirado *et al.,* 2010; Wossen *et al.,* 2018; Uwazie, 2020). Extreme climatic conditions, such as deserts, severe rainfall, and flooding, have a particularly detrimental effect on food production. The experts' conclusion that Nigeria's problems with food security and human security are indirectly caused by climate is not impossible (Uwazie, 2020).Because of a sustained gradient in rainfall fall, crop and animal production in the affected areas of northern Nigeria has become more inappropriate (Wossen *et al.,* 2018). Furthermore, persistent flooding along the coast and in southern Nigeria has disturbed the ecology of the soil, destroyed crops, and decreased soil fertility (Wossen *et al.,* 2018). According to the World Bank and the United Nations, climate change will continue to seriously jeopardize Nigeria's ability to produce food sustainably.

COMBATING FOOD INSECURITY AS A RESULT OF CLIMATE CHANGE

Continuous change in weather conditions has been a major source of negative effects on the quality and quantity of food produce in Nigeria and world in general and these changes has contributed immensely to increased level of insecurity as they are a direct effect to the production of food. The following can help reduce this effects (Hadiza *et al,* 2022):

(i) Government should increase public awareness of food security challenges caused by climate change.
(ii) Promote education on food preservation techniques such as refrigeration, dehydration, etc.
(iii) Develop early warning systems for extreme weather events to enable food production adaptation by leveraging technologies that embrace data analytics and insights.
(iv) Diversify food sources and agricultural production techniques to reduce risk.
(v) Resuscitation of water shed management skills for water source preservation in case of droughts.
(vi) Governments must address conflict on a political level and live up to their responsibility to end protracted crises, but donor countries, key UN agencies, and regional bodies must also address conflict and its consequences, including through a food and nutrition security lens.
(vii) Implement sustainable farming practices such as no-till agriculture, agroforestry, and cover crops.
(viii) Support smallholder farmers with access to credit and other services to ground economic empowerment. (Hadiza *et al,* 2022 and World Economic Forum, 2023)**.**

OPTIONS FOR ADAPTATION TO CLIMATE CHANGE AT FARM LEVEL

Risk	**Response**
Changing climate conditions and climate variability and seasonality	Participate in monitoring schemes when available. Optimization of planting schedules such as sowing dates (including for feedstocks and forage). Plant different varieties, species or cultivars of crops. Use of short duration cultivars. Varieties or breeds with different environmental optima may be required, or those with broader environmental tolerances. The use of currently neglected or rare crops and breeds should be considered. Early sowing enabled by improvements in sowing machinery or dry sowing techniques. Increased diversification of varieties or crops to hedge against risk of individual crop failure. Use intercropping. Make use of integrated systems involving livestock and/or aquaculture to improve resilience. Change post-harvest practices, for example the extent to which grain may require drying and how products are stored after harvest. Consider the effect of new weather patterns on the health and well-being of agricultural workers.
Change in rainfall and water availability	Participate in monitoring schemes when available. Change irrigation practices. Adopt enhanced water conservation measures. Use marginal and waste water resources. Make more use of rainwater harvesting and capture. In some areas, increased precipitation may allow irrigated or rain-fed agriculture in places

	where previously it was not possible. Alter agronomic practices. Reduced tillage to lessen water loss, similarly the incorporation of manures and compost, and other land use techniques such as cover cropping increase soil organic matter and hence improve water retention.
Increased frequencies of droughts, storms, floods, wildfire events, sea level rise	Participate in monitoring schemes with available General water conservation measures are particularly valuable at times of drought. Use flood, drought and/or saline resistant varieties. Improved drainage, improved soil organic matter content and farm design to avoid soil loss and gullying. Consider (where possible) increasing insurance cover against extreme events.

FAO (2015). Climate change and food security; Risks and responses.

Adaptation and mitigation through sustainable forest management

Deforestation results in the annual loss of about 13 million hectares of forests (Sahney et al., (2010). Important mitigation strategies include sustainable forest management, decreasing emissions from deforestation and forest degradation (REDD), afforestation/reforestation and forest restoration, as well as sustainably produced wood goods that can replace more carbon-intensive materials and fuels. A rise in pests, illnesses, and forest fires are all consequences of climate change on the health of forests (Beverly et al., 2008). In addition to lessening the vulnerability of the world's forests and the populations that depend on them, adaptation strategies can contribute to the preservation of biodiversity, water supplies, and soil resources. But it will be difficult to stop deforestation and forest degradation as well as implement long-lasting adaptation and mitigation measures without financial or other incentives as well as political will.

SUSTAINABLE FOOD PRODUCTION AND COUNTERMEASURES TO CLIMATE CHANGE

Sustainable food production methods and plans for reducing and adapting to climate change are mutually beneficial. Numerous programs and regulations aimed at environmentally responsible production can therefore support many climate and weather risk management measures because they are perfectly compatible with sustainable fishing and farming methods. Implementing and promoting sustainable food production as well as creating strategies for climate change adaptation both require integration. (Ali, A 1999).

RESPONSIBLE ANIMAL HUSBANDRY

Nearly 70% of all agricultural land in the world is used for the production of livestock, including grazing space and cropland used to produce feed. The primary factor for grasslands to deteriorate is overgrazing. Achieving a balance between competing needs for environmental services and animal food products would be made easier with improved land management techniques. Effective methods for protecting the environment and reducing climate change include improved pasture management and silvopastoral systems. The environment and farmers in Brazil appear to benefit from recent links between policies and programs for pasture regeneration and no-till based integrated crop/pasture/livestock systems. Additional strategies to reduce GHG emissions per unit of livestock product include sustainable intensification, improved manure management, and the use of biogas from animal waste (Gill M.*et al.,* 2010).

AGRICULTURE BIODIVERSITY

By boosting resilience to shifting climatic circumstances and stress (drought, salinity, flooding), agricultural biodiversity will play a significant role in the development of production systems to tackle the challenges of climate change. Important measures of resilience and risk mitigation are built into agriculture via ecosystem services (such as genetic resources, soil formation, or nutrient cycling), which are factors that are becoming more and more crucial as a result of climate change. (Pisante *et al.,* 2014).

CONCLUSION

The hazards that climate change poses to food security are substantial and genuine, in my opinion. In order to address the effects of climate change on food security, it is necessary to put in place policies to improve agricultural output by boosting resilience to shifting climatic conditions, providing a balance between needs for environmental services and animal food products by developing adequate silvopastoral systems. Also, Implementing and promoting sustainable food production as well as creating strategies for climate change adaptation for a sustainable crop production to reduce hunger as a result of climate change and also putting policies in place to reduce or eradicate deforestation in order to preserve biodiversity and protect forests and forest products. All these will aid in combating and preservation of forest and increase food production and hunger alleviation brought about by climate change.

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