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The impacts of climate change on biodiversity in Nigeria

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Abstract

Climate change is a growing threat to biodiversity in Nigeria. Climate change affects individual species and the way they interact with other organisms and their habitats, which alters the structure and function of ecosystems and the goods and services that natural systems provide to society. Understanding the direction and magnitude of ecological responses to climate change allows human communities to better anticipate these changes and adapt as necessary. This study identifies that periodic assessments of current and future climate change impacts on biodiversity are important for developing and updating natural resource management plans and evaluating adaptation actions. It further highlights the great need to understand the ecological dynamics of these climate impacts, to identify hotspots of vulnerability and resilience and to identify management interventions that may assist biosphere resilience to climate change. This study explores novel perspectives on how biodiversity responds to climate change and further presents an up-to-date assessment of climate change impacts on biodiversity in Nigeria and implications for natural resource management.

Keywords: Biodiversity, climate change, ecosystems, Nigeria, sustainable development

Introduction

The concept of biodiversity has provoked considerable debate and misunderstanding among the general public, decision-makers, and even the scientific community. Much has been published on the subject since its first appearance at the National Forum on Biodiversity in September, 1986, the proceedings of which became the best-seller “Biodiversity” (ESA, 2012) [8]. But what is biodiversity, what threatens it, why is it important, and what are ecologists doing to better understand it? Biodiversity is all the different kinds of life you'll find in one area—the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world. Each of these species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life (Hancock, 2022) [9]. Biodiversity supports everything in nature that we need to survive: food, clean water, medicine, and shelter (Hancock, 2022) [9]. Biodiversity includes all organisms, species, and populations; the genetic variation among these; and all their complex assemblages of communities and ecosystems. It also refers to the inter-relatedness of genes, species, and ecosystems and their interactions with the environment (ESA, 2012) [8]. Biodiversity protection and maintenance are important for the elimination of poverty and sustainable development (Shukla *et al.*, 2021) [20]. Usually three levels of biodiversity are discussed—genetic, species, and ecosystem diversity. Genetic diversity is all the different genes contained in all individual plants, animals, fungi, and microorganisms. It occurs within a species as well as between species. Species diversity is all the differences within and between populations of species, as well as between different species. Ecosystem diversity is all the different habitats, biological communities, and ecological processes, as well as variation within individual ecosystems (ESA, 2012) [8]. Biodiversity, however, is important both to climate change mitigation and to adaptation by its supportive ecosystem services. Climate change has a major effect on the availability of numerous earthly resources, especially water that supports the life of the earth. Local climate conditions, such as rain, temperatures and the sun and the wind, along with the locally adaptable plant diversity, cropping systems and soil quality, can optimize food production so long as plants can be regulated by plant conditions (Shukla *et al.*, 2021) [20]. As humans put increasing pressure on the planet, using and consuming more resources than ever before, we risk upsetting the balance of ecosystems and losing biodiversity (Hancock, 2022) [9].

The loss of biodiversity is a significant issue for scientists and policy-makers and the topic is finding its way into living rooms and classrooms. Species are becoming extinct at the fastest rate known in geological history and most of these extinctions have been tied to human activity (ESA, 2012) ^[8]. These human activities such as bush burning, gas flaring, etc are also bringing about global warming and climate change. Climate change has been discovered as a great threat to biodiversity in Nigeria and all around the world. The diversity of life enriches the quality of our lives in ways that are not easy to quantify. Biodiversity is intrinsically valuable and is important for our emotional, psychological, and spiritual well-being. Some consider that it is an important human responsibility to be stewards for the rest of the world's living organisms. Humans have always depended on the Earth's biodiversity for food, shelter, and health (ESA, 2012) ^[8]. The most successful way of promoting swift improvements required for human populations to respond to future climate change is by maintaining biological diversity on all levels, from genes to biomes (Shukla *et al.*, 2021) ^[20]. Intrinsically dependent on the environment are biodiversity and biodiversity based ecosystem resources. Climate change faced substantial environmental threats to biodiversity in the twentieth century, with a rise in effects as climate change progresses and could even intensify. Over the past 400 years, the exponential rise in human repercussions on the natural climate has prompted scientist to identify a new age in the geological history of the Planet—the Anthropocene phase (Cruzen, 2002) ^[6]. The considerably greater human impact on major bio-geochemical processes on land, the seas and the atmosphere (Lewis and Maslin, 2015) ^[16] separates this modern era from its ancestor, The Holocene. For example, nitrogen amounts are considerably higher in the earth and carbon in the atmosphere than at any point in the past million years, if not longer (Lewis and Maslin, 2015) ^[16]. One of the distinguishing characteristics of the Anthropocene is its continuing shifts in earth conditions which, due to industrial activity, fossil fuel use and deforestation, are caused primarily by accumulation of carbon and other heat-trapping greenhouse gas at a pace unparalleled (IPCC, 2014) ^[13]. WWF's 2018 ^[26] Living Planet Report found an average 60% decline in global populations of mammals, fish, birds, reptiles, and amphibians since 1970 (WWF, 2018) ^[26]. The 2019 landmark Global Assessment Report by the Intergovernmental Platform on Biodiversity and Ecosystem Services reported one million animal and plant species are now threatened with extinction – the highest number in human history (Hancock, 2022) ^[9]. Three-quarters of the land-based environment and roughly 66% of the ocean environment have been significantly altered. More than a third of the world's land surface and nearly 75% of freshwater resources are now devoted to crop or livestock production (Hancock, 2022) ^[9]. Climate change worsens the impact of other stressors on nature and our wellbeing. Humans have overfished the oceans, cleared forests, polluted our water sources, and created a climate crisis. These actions are impacting biodiversity around the world, from the most remote locales to our own backyards. Even the most important biodiversity hubs around the world are not immune from human pressures. Nigeria is a nation rich in biodiversity however climate change now poses as a threat to her rich heritage. Nigeria's climate has been

changing which is witnessed in: variable rainfall, rise in sea level and flooding, increases in temperature, drought and desertification, land degradation, deforestation, more frequent extreme weather events, affected fresh water resources and loss of biodiversity. There is a great need therefore, to adapt and mitigate the impacts of climate change on biodiversity in Nigeria to achieve sustainable development.

Methodology

This paper examined the impacts of climate change on biodiversity in Nigeria through existing literature review. The main purpose of this research work was to survey theoretical backgrounds and previous studies on the impacts of climate change on biodiversity in Nigeria and the current progress with the implementation of the adaptation and mitigation strategies in Nigeria in ensuring sustainable economic growth and development in Nigeria.

The periodic assessment of current and future climate change impacts on biodiversity in Nigeria

One of the defining issues facing our world today is climate change. According to The Intergovernmental Panel on Climate Change (IPCC) 2007 ^[12], Climate change is a change in the state of the climate that can be identified by changes in the mean and /or the variability of its properties and that persists for an extended period typically decades or longer. Evidence abounds to show that the climate has been changing over the years. Biodiversity plays a vital role in the ecosystem services which include regulation of climate and reducing its impacts and enhancing societal wellbeing. The impacts of climate change on people and nature has been on the increase. Nigeria is recognized as being vulnerable to climate change (Idowu, Ayoola, Opele, and Ikenweibe, 2011) ^[11]. Thus, keeping records of the trend is very important. This does not only concern climate change impacts, but also their evidences, causes, and how biodiversity responds to the changing climate. Keeping records of periodic assessment of current and future climate change impacts on biodiversity in Nigeria will aid understanding of the issue and also form input in planning and decision making process. Some of the pertinent questions to be answered by data on periodic assessment of current and future climate change impacts on biodiversity include:

- What are the major causes of climate change?
- How much of the climate change scenario is as a result of human activities or feedback processes?
- What is the evidence on climate change effects on Nigeria?
- What are the historical and projected impacts of climate change in Nigeria?
- What mitigation and adaptation efforts have been undertaken in Nigeria?
- What is Nigeria's capacity to deal with these impacts and challenges?
- By how much will the climate change over the next couple of years (10, 20, 30, etc)?
- What will be the magnitude and extent of the impacts of climate change on biodiversity?
- What will be the adaptive or survival measures to be adopted by biodiversity?
- At what time of the year and in which regions do we have peak climate change event?

These questions and more can only be answered if current climate change scenarios are monitored and their results used to make projections for future occurrences. Appropriate identification and categorization of biodiversity are essential for proper monitoring and evaluation of the impacts of climate change on them. This will ensure their sustainable use for posterity. There is a scientific consensus that the gradual increase in the average temperature of Earth has risen between 0.4°C and 0.8°C in the last 100 years. The increased volume of global carbon dioxide and other GHGs released from the burning of fossil fuels, deforestation, agriculture and other human activities are sources of global warming that have occurred in the last 50 years (Idowu, *et al*, 2011)^[11]. As scientific evidence continues to be gathered around the world, some things have become clearer and new insights have emerged. For example, the period of slower warming during the 2000s and early 2010s has ended with a dramatic jump to warmer temperatures between 2014 and 2015 (The National Academy of Science, 2020)^[22]. These records can help in projecting future climate change effect on biodiversity and ways to best adapt to the changing climate. Related environmental issues likely to occur alongside climate change within the next couple of years can be projected. This will include plans on mitigation, adaptation, and other ways to tackle climate change. It is necessary to monitor climate change trends and take actions against it. Else Nigeria and the world at large will be faced with environmental and public health challenges such as increase in water borne, vector borne and heat aggravated diseases.

Climate change is most generally considered to rise internationally and sea temperatures, shifting trends of precipitation and an increasing occurrence of severe events such as heat waves, heavy rain and drought (IPCC 2018)^[14]. In fact, a change in climate will provide environmental input and human–environment relationships. Increased global sea concentrations poses a damaging threat to coastal habitats and human livelihood and well-being in heavily developed coastal regions (IPCC 2014)^[13]. Climate change, if left unchecked will cause adverse effects on biodiversity in Nigeria. Scientific information on climate change impacts on biodiversity in Nigeria is a vital component for the country's decision makers to make informed decisions about how to reduce the magnitude of climate change and how to adapt to its impacts as well. Information serves as a key reference document for decision makers, policy makers, educators, and others seeking authoritative answers about the current state of climate-change science (Hansen, Sato, Ruedy, Lacis, and Oinas, 2000)^[10]. This is necessary because there is interdependency between biodiversity, ecosystem, and human wellbeing. Thus, any loss in biodiversity or degradation of the ecosystem will exert negative impact on human livelihood.

Observed trends can be compared with past scenarios to forecast future occurrences. Scientists predicted long-term effects of climate change to include decrease in sea ice and an increase in permafrost thawing, an increase in heat waves and heavy precipitation, and decreased water resources in semi-arid regions (Hansen, *et al*, 2000)^[10]. In Nigeria, the impacts will include adverse effects on livelihoods such as crop production, livestock production, fisheries, forestry and post-harvest activities, altered rainfall regimes and patterns, floods, increase in temperature and humidity, and other

natural disasters like floods, ocean and storm surges, which not only damage Nigerians' livelihood but also cause harm to life and property (Idowu, *et al*, 2011)^[11]. Should it continue, we will experience more episodes of wildfires, floods, drought, and loss of biodiversity? There is a growing consensus in the scientific literature that in the coming decades the world will witness higher temperatures and changing precipitation levels. The effects of this will lead to low/poor agricultural products (Emmanuel, 2014)^[7]. Mutual international cooperation is essential for the successful monitoring, evaluation, and mitigation of impacts of climate change as they could be trans-boundary. Leaders of various countries can study trends in climate change and its impacts on biodiversity and come up with ideas to reduce anthropogenic causes of climate change and adaptive measures. This can include strategies to reduce emissions by a certain percentage in a projected year, increasing the use of renewable energy sources such as solar energy, wind power and biofuels among others.

The ecological interaction between climate change and biodiversity in Nigeria

There is an established dynamic interaction between climate change and biodiversity (ecosystem services and adaptation). Climate could change as a result of natural factors and or human activities. When this occurs, it completely alters biodiversity, agricultural production, food security, and the ecosystem. This has resulted in the migration, extinction and possibly death of endemic species of fauna and flora. The impact of climate change on biodiversity cannot be over-emphasized. Biodiversity reacts in diverse forms in response to a changing climate. However, changes in climatic conditions differ between continental and oceanic environments as well as the effects will differ greatly between different species of plants and animals (Crawfor, 2005)^[5].

Climate change is already having an impact on biodiversity, and is projected to become a progressively more significant threat in the coming decades. Loss of Arctic sea ice threatens biodiversity across an entire biome and beyond. The related pressure of ocean acidification, resulting from higher concentrations of carbon dioxide in the atmosphere, is also already being observed (UN's Global biodiversity outlook, 2010)^[21]. The importance of biodiversity as a nation's natural resource is enormous because of the specific services they provide and needs they satisfy. Ecosystems play an important role in climate change adaptation processes, since some of the services they provide, may reduce the impacts of extreme events and disturbance, such as wildfires, floods, and droughts. This role is important in regions vulnerable to climate change such as the African continent, whose adaptation capacity is limited by many geographic and socio-economic constraints (Walter, Ulisses, Abdul-Lateef, Andréia, Serafino, Desalegn, Edmond, Adeleke, Felix, and Nicholas, 2021)^[24]. Biodiversity indicates abundance of life and its support systems. This is important in countries with increasing population like Nigeria. Biodiversity helps in maintaining the functions of the ecosystem. Nigeria is rich in species diversity and biological resources. Biodiversity and human wellbeing in Nigeria are inseparable. The uniqueness of nutritional support from biodiversity in Nigeria lies in the broad-based ecosystem diversity across the length and breadth of Nigeria: from the south to the north and from the

east to the west of the country (Nigeria Fifth National Biodiversity Report, 2015) ^[18]. Nigerians appreciate biodiversity in different ways. The nation's biodiversity constitutes the source of food, raw materials, wide range of goods and services and genetic materials for agriculture, medicines and health-care support, domestic and commercial products, aesthetics and cultural values. These biodiversity also provides ecosystem services that improve the value and knowledge about life. The value of biodiversity to Nigerians is closely linked to the wide range of the various ecosystems found in areas such as Guinea, Sahel, and Sudan Savanna which are rich in wildlife and timber product, Niger delta with diverse sea food sources, southern Nigerian with rainforest belt, providing a huge base for food resources among others (Nigeria Fifth National Biodiversity Report, 2015) ^[18].

The USAID Report on Biodiversity and Tropical Forestry Assessment (2002) reveals that there are numerous environmental threats in Nigeria affecting biodiversity. Nigeria's climate has been changing, evidences are seen in increased temperature and rainfall, rise in sea level, flooding, drought, desertification, land degradation and loss of biodiversity amongst others. Some of the plant and animal species in Nigeria are threatened to extinction and degradation resulting from the changing climate. Biodiversity in Nigeria is under the threat of extinction from climate change, other land use practices and economic development. According to the IUCN Red list of 2013, Nigeria has a total of 309 threatened species in the following taxonomic categories: Mammals (26), Birds (19), Reptiles (8), Amphibians (13), Fishes (60), Mollusks (1), other Invertebrates (14) and Plants (168) (Anwadike, 2020) ^[4]. Temperature across the country is relatively high with a very narrow variation in seasonal and diurnal ranges (22 - 360 C). Changes in the structure and function of given ecosystems, usually from biodiversity degradation and loss can reduce the availability of these vital services and affect aesthetic, ethical and cultural values of human societies. Natural resource scarcity for livelihood support resulting from climate change is evident in many local communities in Nigeria. Biodiversity in Nigeria has been greatly impacted upon by climate change with resultant decline in specie population as they are unable to adapt to the constant change in climatic conditions; hence an increase in biodiversity loss. Areas that were once rich in species diversity and services for life support systems are faced with losses. The interaction between organisms and their local environment has been tampered with, reducing survival and reproduction and posing serious challenge in the distributions of species across geographic regions in the country. World Rainforest Movement (1999) ^[25] records show that 70-80% of Nigeria's original forest has disappeared and presently the area occupied by forests is reduced to 12%.

Recommendation

The impact of climate change is greatly felt on soil fertility in Nigeria (Anabaraonye, Okafor, Ewa & Anukwonke, 2021) ^[1] and also on biodiversity which affects the sustainable development and economic growth of the nation either positively or negatively. Most of the forest reserves established by the Nigerian government for conservation of forest resources have been seriously neglected and underdeveloped in terms of investment and management

(Pelemo, Akintola, Temowo, Akande, and Akom, 2011) ^[19]. The impacts of climate change are expected to exacerbate the impacts of human pressure on biodiversity. There is therefore an urgent need to educate farmers and fishermen in Nigeria especially in rural areas on the impacts of climate change and ways to adapt and mitigate for sustainable development (Anabaraonye, Okafor & Hope, 2018; Anabaraonye, Okafor, & Ikuelogbon, 2019) ^[2, 3]. The need for conservation of biodiversity in Nigeria in response to changing climate is very urgent. This entails a sustainable use of available resources in other not to jeopardize the ability of the future generations from enjoying the services brought about by biodiversity. Establishment of several forest and game reserves across the country by the government is recommended. In addition, International conventions and treaties entered into and signed by the Nigerian government for the preservation of biodiversity should be followed with immediate implementation.

Conclusion

According to The National Adaptation Strategy and Plan of Action for Climate Change in Nigeria (NASPA-CCN 2011) ^[17], Climate change is already having significant impacts on Nigeria. Recent estimates according to the report suggests that in the absence of adaptation, climate change could result in the loss of between 2% and 11% of Nigeria's GDP by 2020, giving rise to between 6%-30% by the year 2050. Consequently, the ability of natural ecosystems to continue to provide ecosystem services will be altered and will result in intrusion of foreign species that can tolerate the changing climate. This implies that many plants, animals, and potentially valuable species are susceptible to extinction if proper natural resource management and timely climate change education is not carried out.

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