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Bioscience Research and A Healthy Nigerian Environment: Niger Delta Basin In View

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Abstract

Niger Delta Basin's rich biological diversity stemmed from its bio-geographical attributes, including complex and rich habitats. It is one of the most extensive wetlands in the world and the largest Delta in Africa. The mangrove ecosystem provides a habitat for the spawning of various kinds of fish and as a nursery ground, and its destruction results in the loss of habitat, biodiversity, and breeding/nursery grounds for fish and other aquatic animals. Industrial activities, especially, oil exploration, are a significant source of environmental pollution and degradation, as their infrastructure modifies the environment, and their effluents and emissions adversely affect the environment. Bioscience research lay solid foundation for sustainable new approaches and solution to health and environmental challenges, as it is providing hope for combating these environmental challenges, including adjustment to life in a warmer areas occasioned by climate change. and in helping in resource conservation, biodiversity loss and pollution abatement, poverty and climate change reduction, creating climate resistant crop and resource conservation projects, which help inform decisions on the best location for areas to be protected from human activity, helping farmers grow more productive, climate-friendly crops and livestock, as well as working to improve food security, make diets more nutritious, and reduce food spoilage and waste. Bioscience research holds great promise for enhancing a healthy and sustainable environment in the Niger Delta Basin, Nigeria and globally. Given the transboundary nature of several environmental issues, collaboration among local research personnel and their counterparts elsewhere is most desirable.

Key words: **Bioscience, Research, Healthy ,Environment, Niger- Delta- Basin**

1.Introduction

Science in general and bioscience in particular can help to create a sustainable world as they are critical to tackling very complex challenges for humanity, including:Climate Change, Biodiversity loss, Pollution abatement; and Poverty reduction.Science also lays the foundation for new approaches and solutions, and without question, bioscience research is critical to these endeavors in support of the 2030 Agenda for sustainable development. It provides the framework for effective decision-making about global sustainability since health**,** environmental, **social** and cultural systems are closely linked.

Having worked for thirty years in the Niger Delta Basin, and participated in researches that involved some parts of the country, I have observed that, most of the environmental degradation and pollution issues are traceable to oil and gas exploration and exploitation, and to some extent, mining activities in some areas of the Country. It is pertinent, to put into perspective, critical components of this paper, followed by an overview of the global environmental status, with emphasis on the Niger Delta Basin, and conclude by setting an agenda for bioscience research to address some of the critical environmental challenges faced.

1.1 Balance of nature

The central theme of this paper "**Balance of Nature** (Healthy environment)," is controversial. Simply put, it is a theory that says "ecological systems are usually in a state of equilibrium (homeostasis)." That is to say, a change in one component will be corrected by some negative feedback that would bring that particular component back to its original state. This presupposition has been used to describe how populations depend upon each other. For example, the relationship between prey-predator systems and that of the Earth's ecosystem, the atmosphere's composition, and weather/climate (Werth and Allchin, 2020). Unfortunately, the above theory has been disputed by many ecologists in recent times. They contend that the ecosystems experience constant disturbances leading to chaotic and dynamic changes (Simberloff, 2014). Consequently, during the latter half of the 20th century, it was replaced by the catastrophe and chaos theories (Zimmerman, 2007).

Despite these developments, the idea of a balanced (homeostatic) ecosystem has remained popular among the general populace. However, it would become apparent in this discussion that the catastrophe theory obtains in nature given the global record of catastrophic events and the response of the ecosystems generally. A schematic representation of the major anthropogenic activities that may cause environmental change in terms of biodiversity is presented in Figure 1.

Figure 1: Anthropogenic activities that may cause biodiversity loss and ultimately lead to an unbalanced ecosystem. Adapted from: My Green World.

1.2 The emergence of bioscience

The study of the living world dates back to the ancient. However, the emergence of biology as a coherent field of study arose in the 19th century from traditions of medicine and natural history. By the early 20th century, the rediscovery of Mendel's work in botany led to the rapid development of genetics, and by the 1930s, the combination of population genetics and natural selection. New disciplines developed rapidly, and by the late 20th century, new ones like genomics and proteomics emerged with organismal biologists using molecular techniques and molecular and cell biologists investigating the interplay between genes and the environment, as well as the genetics of natural populations of organisms (*http://www.britannica.com).*

Specifically, while biology refers to the study of living things, bioscience is concerned with studying any life science, including Biology. Its main thrust is on

- Biological processes
- Devices
- Diagnostics or Systems,

with the objective of developing products intended to improve agriculture and the quality of human life/environment. It includes biofuel and life sciences research, among others.The above can be differentiated from Biotechnology, which means "any technological application that uses biological systems, living organisms, or derivatives thereof, to make modified productions or processes."

The environment, on the other hand, has many definitions. However, in its primary meaning and relation to the topic of my address, it is: "the complex of physical, chemical, and abiotic factors (such as climate, soil and living things) that act upon an organism or an ecological community and ultimately determine its form and survival."

1.3 Global environmental outlook

Globally, 2000 to 2009 is the warmest decade since record-keeping began in 1850. The average temperature near the earth's surface has risen by approximately 0.75oC since 1900. Most Scientists believe that if we continue to emit greenhouse gases at current rates, global temperature may rise between 1.1oC and 1.40oC above 1980 to 1999 levels by the end of this century. This phenomenon could cause floods, droughts, and tropical storms. Nigeria has already witnessed several such disasters, as shown below, in the last 30 or 80 years:

• Number of disasters	94
• Number of people killed	21,002
• Average killed per year	677
• Average affected per year	203,434
• Economic damage (USD)	188,025,000.00

Similarly, a number of other natural disasters have been recorded yearly in the Country including:

• Drought	0.03
• Epidemics	1.58
• Extreme temperature	0.06
• Flooding	1.13
• Storm	0.06

In addition, changes in rainfall patterns induced by climate change would adversely affect many plants and animals. Those species which may not be able to adapt may become extinct. It is estimated that if global temperatures increase by 2^{o}C, 30 percent of all land animals and plants may be threatened by increased risk of extinction. The International Union for the Conservation of Nature, IUCN reported that:

i. One out of eight birds;
ii. One out of four mammals;
iii. One out of four conifers;
iv. One out of three amphibians; and
v. Six marine turtles out of seven are threatened with extinction.

The report further stated that:

i. 75% of genetic diversity of agricultural crops has been lost;
ii. 57% of the world's fisheries are fully or over exploited
iii. Up to 70% of the world's known species risk extinction if global temperatures rise by more than 3.5^{o}C;
iv. One third of reef-building corals are threatened with extinction; and
v. A parcel of rainforest, the size of a football field disappears every second.

2.The Niger Delta Environment

To put the subject of this discussion in perspective, Nigeria is Africa's most populous country and a leading producer of oil and Gas. The Niger Delta region of Nigeria produces some 2.2 million barrels per day. A recent survey of the current status of the Niger Delta environment by the UNDP;4090 revealed the striking global significance of biological divert at the genetic, species, and ecosystem levels. The Niger Delta is home to Global 200 Eco-region 155 and part of the Guinean Forest Hotspot (Myers *et al.,* 2000). It harbors many locally and globally endangered species, and approximately 60-80% of all plant and animal species found in Nigeria. It is believed that the Delta's rich biological diversity stemmed from its biogeographical attributes, including complex and rich habitats.

It is one of the most extensive wetlands in the world and the largest Delta in Africa. It is home to (i.) all endemic and near-endemic mammal species and (ii) six IUCN Red List mammals, including the red colobus monkey (*Procolobus epieni*), which is one of the world's 25 most endangered primates *(*Mittermaier *et al.,*2010). Similarly, the Delta is home to some 314 species of fish, nearly all indigenous. Some 165 species have been recovered in the freshwater zone, of which at least 20 are endemic species. It is also believed that the unique environmental conditions must have favored the highest so far recorded, in any freshwater eco-region in the world.

On the socio-economic front, the condition of the people is most pathetic. Naturally, every index of the economic condition is poor. Despite its oil wealth, per capita income in the region is below the national average of USD1950, and most communities lack essential services. In every index, the region is below the national coverage, as it lacks basic social services such as water, schools, and health care facilities.

2.1. Habitat Degradation

It has been estimated that some 50 percent of mangrove trees in the coastal zone have been felled (World Resources, 1990). The results have been increased erosion and flooding in addition.As the mangrove ecosystem provides a habitat for the spawning of various kinds of fish and as a nursery ground, its destruction results in the loss of habitat, biodiversity, and breeding/nursery grounds for fish and other aquatic animals

2.2. Industrial Activities

Industrial activities are a significant source of environmental pollution and degradation. Their infrastructure modifies the environment, and their effluents and emissions adversely affect the environment. In this regard, the oil industry significantly contributes to resource depletion and environmental degradation.

As reported Babatunde and Sikoki(2012), in the Bonny estuary, environmental perturbations influenced average annual sediment mass accumulation in 1971, 1975, 1979, 1987, 1995, 2003, 2005, and 2008 (Figure 2).

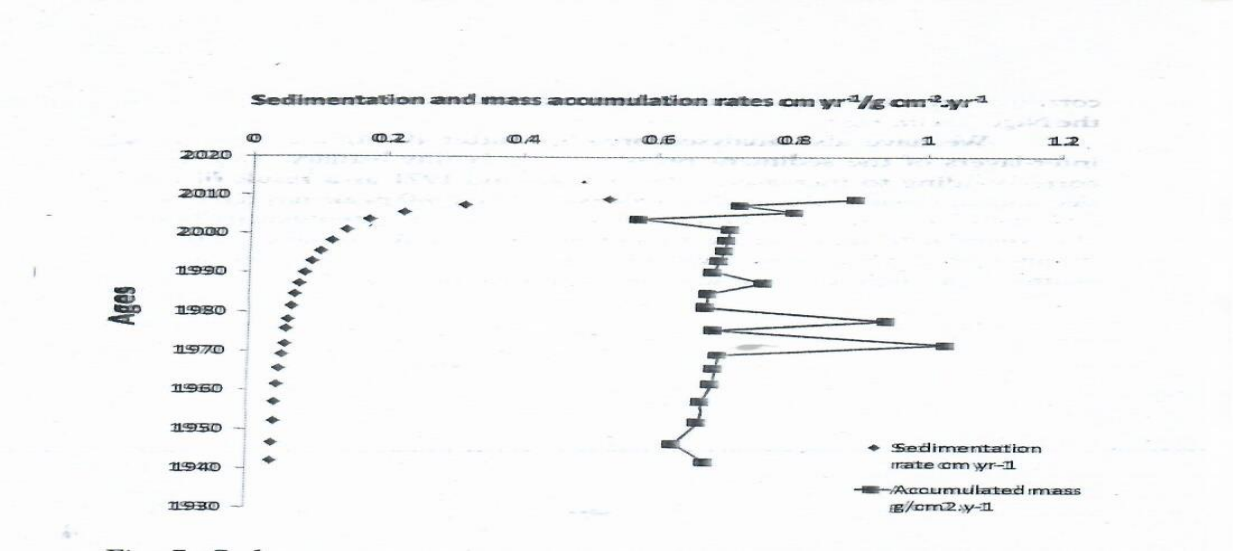

Figure 2: Sediment accumulation rates and sedimentation rates in the Bonny estuary of last 66 years

These periods corresponded to increased oil and Hebraization activities in the Niger Delta, following the construction of the East-West Road and the Arab Oil embargo in the early 1970s.

The average sediment rate in the Bonny estuary was very low and increased by 40 percent between 2006 and 2008. It is predicted that sediment rates will be high and may lead to complete reclamation of shallow areas in the next 100 years (Babatunde and Sikoki, 2017), as well as a steady increase in pH values and heavy metals of the sediment of the Bonny estuary from 1971, with peak values occurring in 1979, 1987, 1995, 2005, and 2008, corresponding with heightened oil and gas production activities in the Niger Delta would be expected.

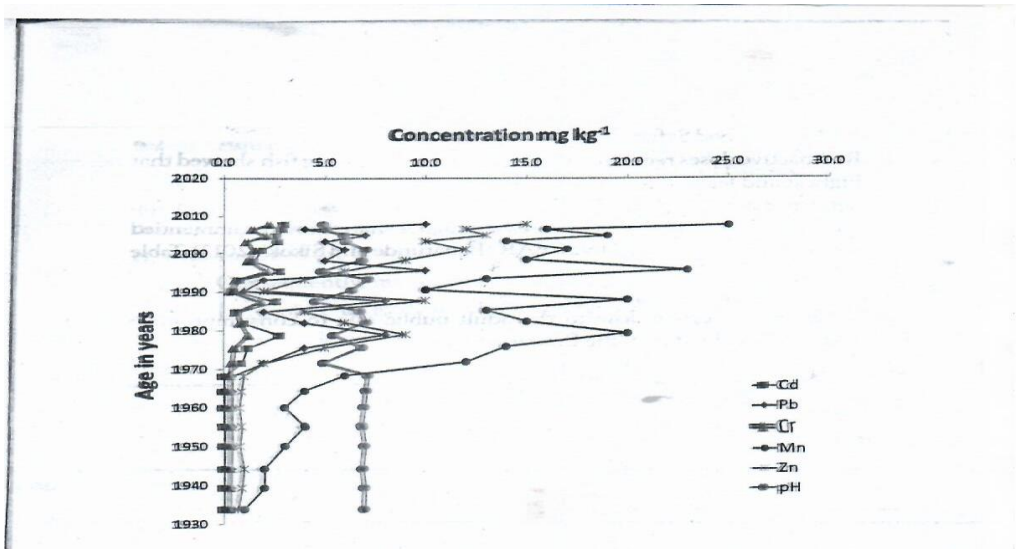

Figure 3: Heavy metals profile and pH of core sample from Bonny estuary over 74 years.

3.0 Bioscience Research For A Sustainable Environment

Bioscience research is providing hope for combating several environmental challenges, including adjustment to life in a warmer world occasioned by climate change, among others. It is estimated that using models, bioscience research alone can help remove three gigatons of carbon dioxide from the atmosphere annually by 2030 (Griscom *et al*., 2017).
In addition to the above, bioscience research is helping in resource conservation, pollution abatement, and Climate change, among others.

3.1 Research to Mitigate the Effect of Climate Change

Research from many different sub-disciplines of biology is helping us prepare for the effects of climate change on human health and well-being. Bioscience researchers are at the heart of new strategies for managing natural resources that will help sequester carbon, improve biodiversity, and reduce the impact of climate change, and they are developing greener ways to fuel the planet's energy requirements, replacing petrochemicals and emission-heavy materials like concrete with next-generation bio-fuels and bio-based materials. Research from across the life sciences will be vital in developing bio-products with as small a water, carbon, and land footprint as possible.

Nigeria's agricultural sector, produces far more GHG emissions than developed nations due to its use of traditional agricultural practices (Okorie and Lin, 2022). The good news is that agricultural biotechnology can help Nigeria respond to climate change issues. As extensive research proves, gastric methane emissions can be reduced by incorporating feedstuff that regulates methanogenic bacteria in ruminant animals' gut (Palangi & Lackner, 2022). Also, research efforts are being directed to reduce methane emissions from rice fields by improving irrigation techniques, increasing fertilizer use efficiency, and developing new high-yielding rice varieties (IPCC, 2014).

3.2 Climate-Resistant Crop

Advances in our understanding of the chemistry of life and the application of gene-editing technology, allow scientists to grow organisms adapted to a changing climate or with characteristics that could help us fight climate change. Current biotechnologies have provided limitless opportunities to expand the capacity of plants by sourcing genes for desired traits. Leveraging these technologies, scientists have created resilient crops with improved adaptation to environmental stresses, which can also help remove pollutants from our environment. Crop cultivars that can tolerate heat, cold, drought, sub-mergence, salinity stress, pests, and diseases can be found from Sokoto down to Bayelsa. Nigerian researchers in IITA and research-focused institutions are helping to develop biotech crops to help weather climate challenges. However, the development of these technologies in Nigeria still needs to be improved. For the place of trees in climate change adaptation and mitigation, we may recognize the effort of researchers at the Rubber Research Institute of Nigeria in their efforts with the rubber tree (*Hevea brasiliensi*).

3.3 Resource Conservation

Biodiversity is now being lost at a rate unprecedented in human history, and this loss, rather than slowing, is accelerating (Butchart *et al*., 2010). For decades, ecologists have been monitoring the impact of a changing climate on the natural world to help understand and predict future effects on wildlife, ecosystems, and human health. This research underpins efforts to protect the ecosystems that support us, and informs the best ways to manage natural carbon sinks.

Precision agriculture can also achieve another critical aspect of resource conservation, where the right amount of water and nutrients are used to conserve resources. Measures to combat drought have been studied, and tools to increase the efficiency of soil and minimize the anthropogenic impact on soil, such as Mini-till, exist in the market (Suleimenova *et al.*, 2021).

Conservationists worldwide work tirelessly to restore and stabilize populations endangered by habitat loss or impacted by climate change, and protecting or restoring natural habitats can also help sequester vast amounts of carbon. Research from conservation projects helps inform decisions on the best location for areas to be protected from human activity.

3.4 Agriculture and Food

Global food production accounts for one-quarter of all global greenhouse gas emissions (IPCC, 2014), and bioscience researchers are helping farmers grow more productive, climate-friendly crops and livestock, as well as working to improve food security, make diets more nutritious, and reduce food spoilage and waste.

3.5 Pollution Abatement

In pollution abatement, microorganisms are being used for the bioremediation of polluted soil and water. Natural and engineered microbes, their enzymes, and other biomolecules are being used to treat various contaminated matrices (Jimenez-Diaz *et al*., 2021). These are sustainable natural approaches that can help guarantee a healthy environment.

Researchers have shown that interactions between plants and surrounding built-up environments, could reduce local air pollution exposure, where plants serve as green infrastructure. Apart from possible air pollution reduction, urban green infrastructure also provides benefits such as urban heat island mitigation, noise pollution reduction, and climate change mitigation. Every locality has suitable plants that can be adopted for air pollution reduction.

The phytoremediation potential of the aquatic weed water hyacinth has been demonstrated in several studies. This plant is a nuisance in our waterways, and is available for various biotechnological applications, including clean-up of hydrocarbon-polluted water and soil. However, in association with microorganisms attached, they have proven a new green model for bioremediation (Sun *et al*., 2021).

Bioscience researchers are exploiting earthworms' biological , chemical, and physical actions to promote biodegradation of organic contaminants. The most studied species in soil bioremediation has been *Eisenia fetida,* which inhabits the soil surface, feeding on decomposing organic residues (Hickman and Reid, 2008). Evaluating earthworms as candidates for remediating soil is a viable area of research.

Enzymes are the most efficient bioremediation tools (Jimenez-Diaz *et al*., 2021). Different enzymes from microorganisms and plants have been used to bioremediate various pollutants. However, much work still needs to be done in understanding enzymatic processes and producing enzymes for environmental applications.

At this point, let me mention a few of the bioscience research we are championing at the University of Africa for a healthier environment. We are pioneering research in plastic waste management, by exploiting the ability of insect larvae to feed on plastics. We are studying the microbiome of insects that survived entirely on a plastic diet, and we are getting to know more about the interaction of the gut microbiota and the larvae. We now know that the gut microbiota includes specialist organisms that produce cellulases and a battery of other enzymes that can be useful in bioremediation and bioethanol production. These organisms can also accumulate polyhydroxyalkanoate, which is valuable for bioplastic production. This will not only reduce the use of synthetic plastics, but will lead to the production of biodegradable plastic.

Conclusion

Without question, bioscience research holds great promise for enhancing a healthy and sustainable environment in Nigeria and globally. Given the transboundary nature of several environmental issues, collaboration among local research personnel and their counterparts elsewhere is most desirable.

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