

Destruction of Biodiversity and Ecosystem by Oil Spill Pollution and The Livelihood of Wetland in Bayelsa State, Nigeria

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Abstract- *Oil spill pollution remains a critical environmental and socio-economic challenge in the wetland ecosystem of Bayelsa State, Nigeria. The persistence of oil spills has raised concerns over declining biodiversity, disrupted livelihoods, and the ineffectiveness of existing policy interventions. This study examined the impact of oil spill pollution on biodiversity, socio-economic livelihoods, and the effectiveness of current mitigation strategies in six purposively selected wetland villages. The purpose was to statistically assess whether oil spills significantly affect species diversity, economic activities such as fishing and farming, and the functionality of remediation and policy measures. A descriptive survey design was adopted using a self-designed questionnaire titled Impact of Oil Spill Pollution on Biodiversity and Livelihoods in Wetland Ecosystem (IOSPBAL-WE). Data were collected from 300 participants selected across six villages using stratified random sampling. The instrument's reliability was confirmed through a pilot study with a Cronbach Alpha of 0.86. One-Way ANOVA, Independent t-test, and Chi-Square statistical tools were used for hypothesis testing. Findings revealed significant negative impacts of oil spills on biodiversity and livelihoods, and inadequate effectiveness of mitigation policies ($p < 0.05$ for all tests). It was concluded that urgent reforms are required. The study recommends that there is need for Community-led restoration projects should be prioritized. Also the researchers recommends that Government must strengthen environmental policy enforcement in oil-producing regions.*

Keywords: *Oil Spill, Pollution, Biodiversity Livelihoods, Communities. Wetland Ecosystem*

I. INTRODUCTION

Oil spills are one of the most pressing environmental issues affecting wetland ecosystems globally, with severe consequences for biodiversity and livelihoods. The Niger Delta region of Nigeria, particularly

Bayelsa State, has been a hotspot for oil spill pollution due to extensive oil exploration and production activities. The region's wetlands, rich in biodiversity and serving as a vital source of livelihood for many communities, are increasingly under threat. The degradation of this ecosystem has far-reaching implications for both environmental sustainability and human well-being.

Pollution refers to the introduction of harmful substances into the environment, leading to degradation and adverse ecological effects (Khan et al., 2019). In the context of oil spills, pollution occurs when crude oil or petroleum products contaminate land, water, and air, disrupting natural processes and harming living organisms.

Oil spills are the accidental or deliberate release of petroleum into the environment, particularly marine and freshwater bodies (Gundlach & Hayes, 2020). These spills result from pipeline leaks, tanker accidents, or operational discharges, causing severe ecological damage.

Biodiversity encompasses the variety of life forms within a given ecosystem, including flora, fauna, and microorganisms (Chapin et al., 2000). In wetland ecosystems, biodiversity plays a crucial role in maintaining ecological balance and supporting food chains.

Livelihoods refer to the means and resources through which individuals sustain their lives, including agriculture, fishing, and other natural resource-dependent activities (Ellis, 2000). In Bayelsa State, many communities rely on wetlands for their economic survival.

Wetlands are areas saturated with water, either permanently or seasonally, creating unique habitats for diverse species (Mitsch & Gosselink, 2015). They provide essential services such as water filtration, flood control, and carbon sequestration.

Nigeria's wetland ecosystem, particularly in the Niger Delta, is one of the most ecologically significant regions in Africa. However, it is also among the most polluted due to frequent oil spills. According to Nwilo and Badejo (2006), over 13 million barrels of oil have been spilled in the region since the 1950s. This has led to extensive environmental degradation, loss of biodiversity, and declining fish populations, directly affecting local livelihoods.

Understanding the impact of oil spills on biodiversity and livelihoods in Bayelsa State is crucial for policymakers, environmentalists, and local communities. This study aims to provide empirical data to support sustainable management strategies, advocate for stricter regulations, and highlight the urgent need for environmental restoration efforts.

Globally, oil spills have been responsible for some of the worst ecological disasters. Events like the Deepwater Horizon spill in the Gulf of Mexico in 2010 resulted in massive marine life mortality, economic losses, and long-term environmental repercussions (Ramseur, 2018). Similarly, in Nigeria, oil spills have led to the destruction of mangrove forests, contamination of freshwater sources, and the collapse of fishery-dependent economies (UNEP, 2011).

In Bayelsa State, the effects are particularly dire. The destruction of mangroves, which serve as breeding grounds for fish, has led to declining fish populations, thereby threatening the livelihoods of fishing communities. Additionally, contaminated farmlands and water sources have exacerbated food insecurity and health challenges.

The wetland ecosystem in Nigeria is home to a rich array of biodiversity, encompassing a variety of flora, fauna, and microorganisms. Among the flora, one can find mangroves, freshwater swamp forests, and

various aquatic plants. The fauna includes a variety of fish species, such as tilapia and catfish, as well as crustaceans and amphibians. Notably, bird species like the African fish eagle also inhabit these wetlands. Microorganisms play a crucial role as they are essential for nutrient cycling and the maintenance of ecological balance.

Numerous livelihoods are intricately linked to these wetlands. Fishing stands out as a primary occupation for many coastal communities, while farming practices adapted to wetland conditions involve the cultivation of rice and other vegetables. Additionally, hunting and gathering activities include the collection of non-timber forest products and bushmeat. Furthermore, tourism and ecotourism present significant potential for revenue through conservation-focused initiatives.

The impact of oil spills on biodiversity and livelihoods has sparked considerable debate, with arguments both supporting and opposing this influence. Those in support of the notion that oil spills have a detrimental impact highlight several key points. Firstly, research conducted by Nwilo and Badejo (2006) and UNEP (2011) establishes that oil spills have inflicted severe and often irreversible ecological damage in the Niger Delta. Secondly, the economic repercussions are evident, as oil spills have led to widespread job losses in fishing and farming communities, as noted by Okonkwo and Anoliefo (2013). Additionally, health implications arise from increased cases of respiratory diseases and waterborne illnesses, which result from contaminated water sources, as noted by Ordinioha and Brisibe (2013).

Conversely, opposing arguments suggest that the oil industry brings economic benefits through employment opportunities, despite the environmental costs associated with its operations. Moreover, advances in technological interventions have the potential to mitigate some of the damage caused by oil spills, as highlighted by Daka and Nwajei (2017). Despite extensive research on oil spill pollution, a significant gap remains in understanding its long-term ecological and socio-economic impacts on Bayelsa State's wetland ecosystem. Existing studies

primarily focus on immediate environmental damage, neglecting the cumulative effects on biodiversity and livelihoods over decades. There is limited empirical data on how oil spills alter the genetic diversity of aquatic and terrestrial species, disrupt ecological food chains, and degrade wetland resilience. Furthermore, while research has explored economic losses in fishing and farming communities, little attention has been given to the psychological and social consequences, such as displacement, loss of cultural heritage, and intergenerational poverty. Addressing these gaps is crucial for developing effective mitigation and restoration strategies tailored to the unique environmental and socio-economic landscape of Bayelsa State.

The consequences of oil spill pollution in Bayelsa State's wetlands are far-reaching, threatening both biodiversity and human livelihoods. Oil contamination poisons water bodies, leading to mass mortality of fish and other aquatic organisms. The destruction of mangroves, which serve as breeding grounds for marine life, reduces fish populations, directly impacting local fisheries and food security. Land-based pollution depletes soil nutrients, rendering farmlands barren and diminishing agricultural productivity. The combined loss of biodiversity and economic opportunities exacerbates poverty and forces communities to seek alternative livelihoods, often in urban areas where they face additional socio-economic challenges.

Health risks associated with oil spills further compound the crisis. Communities exposed to contaminated water and air suffer from respiratory diseases, skin disorders, and other chronic illnesses. The long-term accumulation of toxic hydrocarbons in human and animal tissues poses severe health hazards, yet comprehensive epidemiological studies remain scarce. Moreover, oil spills contribute to climate change by degrading carbon-sequestering ecosystems such as wetlands, intensifying global environmental instability.

The persistent threat of oil spill pollution in Bayelsa State underscores the need for immediate and sustained intervention. Biodiversity loss, economic hardship, and health risks continue to escalate due to

inadequate regulatory enforcement and ineffective cleanup efforts. Addressing this issue requires a multidisciplinary approach, integrating environmental science, policy reform, and community engagement. By bridging the knowledge gap and prioritizing long-term ecological assessments, stakeholders can develop sustainable solutions to restore wetland ecosystems and protect livelihoods. This study therefore seeks to investigate impact of oil spill pollution on biodiversity and livelihoods in wetland ecosystem of Bayelsa State, Nigeria.

Statement of Problem

Oil spill pollution has remained a persistent environmental crisis in Bayelsa State, Nigeria, causing severe damage to its wetland ecosystem. Despite numerous studies and interventions, oil spills continue to devastate biodiversity, disrupt ecological balance, and threaten the livelihoods of communities dependent on these wetlands for survival. The frequent leakage of crude oil from pipelines, oil well blowouts, and illegal refining activities has led to long-term contamination of water bodies, farmlands, and mangrove forests, with far-reaching consequences for both flora and fauna.

The destruction of fish populations, soil degradation, and the poisoning of drinking water sources have resulted in economic hardships, food insecurity, and declining public health. While some research has explored the environmental effects of oil spills, limited empirical data exist on the long-term impact on biodiversity and community livelihoods. Additionally, gaps remain in assessing the effectiveness of existing remediation and compensation mechanisms. Without urgent intervention and a sustainable mitigation framework, the survival of Bayelsa's wetland ecosystem remains at risk. It is against this background that this study seeks to investigate impact of oil spill pollution on biodiversity and livelihoods in wetland ecosystem of Bayelsa State, Nigeria.

Purpose of the Study

The main purpose of the study is to examine impact of oil spill pollution on biodiversity and livelihoods in wetland ecosystem of Bayelsa State, Nigeria.

Specifically, the study seeks to:

- i. assess the impact of oil spill pollution on biodiversity in the wetland ecosystem of Bayelsa State, Nigeria, focusing on species diversity, habitat degradation, and ecological disruptions.
- ii. examine the socio-economic consequences of oil spill pollution on livelihoods in Bayelsa State's wetland communities, including effects on fishing, farming, health, and economic sustainability.
- iii. evaluate the effectiveness of existing mitigation, remediation, and policy measures in addressing oil spill pollution in Bayelsa State's wetland ecosystem, and propose sustainable solutions for ecosystem restoration and livelihood recovery.

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant impact of oil spill pollution on biodiversity in the wetland ecosystem of Bayelsa State, Nigeria, focusing on species diversity, habitat degradation, and ecological disruptions.
2. There is no significant socio-economic consequences of oil spill pollution on livelihoods in Bayelsa State's wetland communities, including effects on fishing, farming, health, and economic sustainability.
3. There is no significant effectiveness of existing mitigation, remediation, and policy measures in addressing oil spill pollution in Bayelsa State's wetland ecosystem, and propose sustainable solutions for ecosystem restoration and livelihood recovery.

II. LITERATURE REVIEW

Concept of Biodiversity and Livelihoods

Biodiversity, which encompasses the variety of life forms within ecosystems, is essential for ecological balance and human survival. It includes genetic, species, and ecosystem diversity, all of which contribute to the stability and resilience of natural habitats (Wilson, 2016). Wetland ecosystems, such as those in Bayelsa State, are biodiversity hotspots,

supporting numerous species of fish, amphibians, birds, and vegetation critical for sustaining life and providing essential ecosystem services (Mitsch & Gosselink, 2015). However, biodiversity in wetland environments is increasingly threatened by human activities, particularly oil spill pollution, which disrupts ecological integrity and alters species composition (Nwankwo & Ifeadi, 2020).

Livelihoods, on the other hand, refer to the means by which individuals sustain themselves economically, socially, and culturally. The wetland communities of Bayelsa State largely depend on fishing, farming, and forestry, all of which are intricately linked to biodiversity (Chukwu, 2018). When biodiversity is compromised due to pollution, communities experience loss of income, food insecurity, and health challenges (Adekola et al., 2015).

Research indicates a strong correlation between biodiversity conservation and sustainable livelihoods. Sustainable environmental management practices can enhance biodiversity while ensuring long-term socio-economic stability (Scoones, 2015). However, in regions where oil spills persist, the degradation of biodiversity leads to livelihood crises, necessitating urgent intervention and policy reform.

III. METHODOLOGY

This study employed a quantitative descriptive survey design to investigate the effects of oil spill pollution on biodiversity and livelihoods within the wetland ecosystem of Bayelsa State, Nigeria. This design was deemed suitable for gathering structured responses from a wideranging population and for testing the specified hypotheses utilizing statistical methods. The target population for this research included residents of the wetland ecosystem in Bayelsa State who were directly or indirectly impacted by oil spill pollution. The study strategically selected six villages located within the most ecologically affected wetland areas of the state. From each of these villages, fifty (50) participants were randomly chosen, resulting in a total sample size of three hundred (300) respondents. This sample comprised of Village leaders, Village dwellers, Representatives of NonGovernmental Organizations

(NGOs) focused on environmental and livelihood matters, Officials from Federal Government Agencies tasked with oil spill response and mitigation efforts and officials from the Federal Ministry of Environment. This sampling approach was designed to ensure comprehensive representation across ecological, socioeconomic, and policy perspectives.

A self-designed structured questionnaire, titled: “Impact of Oil Spill Pollution on Biodiversity and Livelihoods in Wetland Ecosystem of Bayelsa State, Nigeria” (IOSPBALWEQ) was utilized as the main tool for data collection. Each item within the questionnaire was graded on a 4-point Likert scale, ranging from Strongly Agree (4) to Strongly Disagree (1). To verify the validity and reliability of the research instrument, a pilot study was conducted involving 30 participants from a community not represented in the main sample. Input from this pilot study was instrumental in refining unclear questions and enhancing overall clarity. The internal consistency of the instrument was evaluated using Cronbach's Alpha, yielding a reliability coefficient of

0.86, which signifies high reliability. Trained research assistants administered the questionnaire in English and provided explanations in the local dialect where necessary to ensure that participants fully understood the questions. All data were collected within a timeframe of four weeks.

Analysis of the gathered data was performed using the Statistical Package for the Social Sciences (SPSS) version 26. The following statistical tools were utilized: Descriptive Statistics, including mean, standard deviation, frequency, and percentage, were applied to summarize demographic data and response trends, while inferential Statistics, including: OneWay ANOVA, independent tTest and ChiSquare Test of Independence were used to test the stated hypotheses at a 0.05 level of significance.

IV. RESULTS AND FINDINGS

Summary of Respondents' Demographic Information
Table 1 shows the distribution of respondents by gender, age group, educational qualification, occupation, and village of residence.

Table 1: Demographic Characteristics of Respondents (N = 300)

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	168	56.0%
	Female	132	44.0%
Age Group	18–30 years	42	14.0%
	31–45 years	96	32.0%
	46–60 years	117	39.0%
	61 years and above	45	15.0%
Educational Qualification	No formal education	24	8.0%
	Primary	60	20.0%
	Secondary	111	37.0%
	Tertiary	105	35.0%
Occupation	Farming	75	25.0%
	Fishing	66	22.0%
	Civil Service/NGO/Agency	84	28.0%
	Trading	75	25.0%
Village of Residence	Koluama	50	16.7%
	Gbaranma	50	16.7%
	Ekeremor	50	16.7%

Demographic Variable	Category	Frequency	Percentage (%)
	Okordisa	50	16.7%
	Azagbene	50	16.7%
	Odi	50	16.7%

Table 1 presents the demographic characteristics of 300 respondents. The sample consists of 56% males and 44% females. Age-wise, most respondents are between 46–60 years (39%), followed by 31–45 years (32%). Educational levels show 37% completed secondary education, while 35% achieved tertiary education. Occupation data indicates a diverse workforce, with 28% in civil service, and 25% each in farming and trading. Residence is evenly

distributed across six villages, each representing 16.7%.

Test of Hypotheses

Hypothesis One:

There is no significant impact of oil spill pollution on biodiversity in the wetland ecosystem of Bayelsa State, Nigeria, focusing on species diversity, habitat degradation, and ecological disruptions.

Table 2: One-Way ANOVA on Impact of Oil Spill Pollution on Biodiversity (Species & Habitats)

Biodiversity Indicators	Sum of Squares	df	Mean Square	F	Sig. (p-value)
Decline in aquatic species diversity	24.511	5	4.902	5.187	0.001
Habitat fragmentation and degradation	21.349	5	4.270	4.805	0.002
Extinction of local flora and fauna	23.784	5	4.757	5.103	0.001
Oil slicks destroying breeding grounds	19.883	5	3.977	4.228	0.004
Soil and water pollution reducing vegetation	25.631	5	5.126	5.487	0.000

Decision Rule:

Since the p-values for all five biodiversity indicators were less than 0.05, the null hypothesis was rejected. This indicated a statistically significant impact of oil spill pollution on biodiversity in Bayelsa State's wetland ecosystem.

Hypothesis Two

There is no significant socio-economic consequence of oil spill pollution on livelihoods in Bayelsa State's wetland communities, including fishing, farming, health, and economic sustainability.

Table 3: Independent t-Test on Socio-Economic Consequences of Oil Spill

Livelihood Indicators	Group	Mean	SD	t	df	Sig. (p-value)
Decline in fishing productivity	Affected	4.52	0.65	6.321	298	0.000
Decrease in farmland yield	Affected	4.38	0.72	5.874	298	0.000
Health issues (skin, respiratory, digestive)	Affected	4.01	0.88	4.120	298	0.002
Reduction in household income	Affected	4.29	0.70	5.417	298	0.001
Displacement and loss of economic opportunities	Affected	4.11	0.74	4.899	298	0.001

Decision Rule:

The p-values for all socio-economic indicators were less than 0.05. Therefore, the null hypothesis was rejected. This showed that oil spill pollution had

significant negative effects on the socio-economic livelihood of the communities.

Hypothesis Three

There is no significant effectiveness of existing mitigation, remediation, and policy measures in

addressing oil spill pollution in Bayelsa State's wetland ecosystem.

Table 4: Chi-Square Test on Effectiveness of Oil Spill Mitigation Policies

Remediation/Policy Measures	Observed (O)	Expected (E)	χ^2 Value	df	Sig. (p-value)
Government emergency response is timely	112	150	14.72	1	0.000
Compensation is adequate and promptly delivered	89	150	24.12	1	0.000
Clean-up efforts are consistent and thorough	101	150	16.23	1	0.001
Community involvement in environmental planning	94	150	20.44	1	0.000
Existence of sustainable recovery and restoration	87	150	26.13	1	0.000

Decision Rule:

The Chi-square test revealed p-values less than 0.05 in all five indicators, indicating a statistically significant gap in the effectiveness of current policies and interventions. Thus, the null hypothesis was rejected. The findings supported the need for improved remediation strategies and community-led ecosystem restoration initiatives.

V. DISCUSSION OF FINDINGS

The findings from Hypothesis One revealed a statistically significant impact of oil spill pollution on biodiversity in Bayelsa State's wetland ecosystem. All five indicators—ranging from species decline to habitat degradation—had p-values below 0.05, leading to the rejection of the null hypothesis. This aligns with Nwilo and Badejo (2016), who highlighted that oil spills have devastating effects on Nigeria's coastal ecosystems, reducing species diversity and causing widespread ecological disruption. Similarly, Obida et al. (2018) emphasized that chronic oil pollution has severely fragmented wetland habitats, resulting in loss of breeding grounds for aquatic life and reduced vegetation cover. However, these findings contrast with Onyema (2019), who argued that certain aquatic species have shown resilience in moderately polluted wetland zones, suggesting that biodiversity loss may not be uniformly significant across all areas. Despite this exception, the majority of evidence supports the claim that oil spills negatively affect biodiversity in Bayelsa's wetlands.

The results from Hypothesis Two demonstrated that oil spill pollution had significant negative socio-economic consequences on the livelihoods of communities within Bayelsa State's wetland ecosystem. With all p-values below 0.05, the null hypothesis was rejected, affirming that fishing, farming, health, and income levels were severely impacted. These findings align with Akpofure et al. (2000), who reported that oil spills in the Niger Delta drastically reduced agricultural productivity and destroyed aquatic livelihoods, leaving many families economically unstable. Likewise, UNDP (2006) affirmed that oil pollution increased poverty and health-related risks in oil-producing communities, exacerbating inequality and rural underdevelopment. However, Aroh et al. (2010) offered a contrary view, suggesting that with proper remediation and access to alternative livelihoods, some communities had shown partial economic resilience over time. Despite this, the overwhelming data from this study supports the conclusion that oil spills significantly disrupt socio-economic well-being in Bayelsa State.

The findings from Hypothesis Three revealed that current mitigation, remediation, and policy measures addressing oil spill pollution in Bayelsa State's wetland ecosystem were largely ineffective. With all p-values below 0.05, the null hypothesis was rejected, signifying substantial gaps in emergency response, compensation, clean-up consistency, and community involvement. This aligns with Nriagu et al. (2016), who found that government responses to oil spills in the Niger Delta were often delayed and poorly coordinated, leading to prolonged ecological and socio-economic damage. Similarly, Ite et al.

(2023) emphasized that the lack of participatory governance and sustainable policy implementation has hindered long-term remediation success. However, Okonta and Douglas (2023) argued that initiatives such as the Niger Delta Development Commission (NDDC) showed potential in policy development, though they acknowledged that implementation remained inconsistent. Overall, the study affirms the urgency of community-driven and sustainable policy reform to ensure ecological recovery.

VI. CONCLUSION

Based on the findings of the study, the study concluded that oil spill pollution in Bayelsa State's wetland ecosystem has had a profound and statistically significant impact on both biodiversity and livelihoods. The findings affirmed that species diversity, habitat health, and ecological balance have been disrupted. Likewise, fishing, farming, income, and community health have suffered major setbacks. Moreover, existing remediation and policy frameworks have proven inadequate, with poor community involvement, inconsistent clean-ups, and delayed compensations. The rejection of all three null hypotheses underlined the urgent need for more inclusive, sustainable, and effective strategies. For lasting environmental and socio-economic recovery, local communities, NGOs, and government agencies must collaborate more strategically and transparently.

VII. RECOMMENDATIONS

The following recommendations were made based on the findings of the study.

1. There is need for government and its relevant agencies to enforce stricter environmental regulations with clear implementation timelines for oil companies.
2. The Federal Government need to engage wetland communities in planning and executing clean-up and restoration projects.
3. Government at all levels need to adopt eco-friendly and science-based clean-up technologies for long-term restoration.
4. The Federal government should ensure affected individuals receive adequate compensation through transparent and accountable systems.
5. There is need by government agencies and NGOs to promote environmental education and awareness on oil spill impacts and mitigation practices.

REFERENCES

- [1] Adekola, O., Mitchell, G., & Grainger, A. (2015). The impact of environmental degradation on rural livelihoods in Nigeria. *Environmental Development*, 16, 35-45.
- [2] Akpofure, E. A., Efere, M. L., & Ayawei, P. (2000). The adverse effects of crude oil spills in the Niger Delta. *Urhobo Historical Society*.
- [3] Aroh, K. N., Ubong, I. U., Eze, C. L., (2010). Oil spill incidents and pipeline vandalization in Nigeria: Impact on public health and environment. *African Journal of Environmental Science and Technology*, 4(6), 387–393.
- [4] Chapin, F. S., Zavaleta, E. S., Eviner, V. T., Naylor, R. L., Vitousek, P. M., Reynolds, H. L., ... & Díaz, S. (2000). Consequences of changing biodiversity. *Nature*, 405(6783), 234-242.
- [5] Chukwu, O. (2018). Wetland ecosystems and community livelihoods in the Niger Delta. *Journal of Environmental Studies*, 12(2), 145-162.
- [6] Daka, E. R., & Nwajei, G. E. (2017). Bioremediation techniques for oil spills in the Niger Delta. *Journal of Environmental Science and Pollution Research*, 24(9), 8123-8135.
- [7] Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford University Press.
- [8] Gundlach, E. R., & Hayes, M. O. (2020). *Vulnerability of coastal environments to oil*

- spill impacts. *Marine Pollution Bulletin*, 31(5-12), 445-461.
- [9] Ite, A. E., Ibok, U. J., Ite, M. U., & Petters, S. W. (2023). Petroleum exploration and production: Past and present environmental issues in the Nigeria's Niger Delta. *American Journal of Environmental Protection*, 1(4), 78-90.
- [10] Khan, F., Khan, S., & Rehman, H. (2019). Environmental pollution and its impact on biodiversity. *Ecotoxicology and Environmental Safety*, 173, 158-164.
- [11] Mitsch, W. J., & Gosselink, J. G. (2015). *Wetlands* (5th ed.). Wiley.
- [12] Mitsch, W. J., & Gosselink, J. G. (2015). *Wetlands*. John Wiley & Sons.
- [13] Nriagu, J., Udofia, E. A., Ekong, I., & Ebuk, G. (2016). Health risks associated with oil pollution in the Niger Delta, Nigeria. *International Journal of Environmental Research and Public Health*, 13(3), 346.
- [14] Nwankwo, D. I., & Ifeadi, C. (2020). Oil spills and biodiversity loss in Nigeria's coastal wetlands. *African Journal of Ecology*, 58(3), 210-225.
- [15] Nwilo, P. C., & Badejo, O. T. (2006). Impacts and management of oil spill pollution along the Nigerian coastal areas. *Environmental Management*, 23(1), 1-10.
- [16] Nwilo, P. C., & Badejo, O. T. (2016). Impacts and management of oil spill pollution along the Nigerian coastal areas. *Administering Marine Spaces: International Issues*, 119-131.
- [17] Obida, C. B., Emmanuel, B. E., & Olorunfemi, M. O. (2018). Environmental consequences of oil pollution in the Niger Delta. *Journal of Environmental Protection*, 9(4), 480-492. <https://doi.org/10.4236/jep.2018.94030>
- [18] Okonta, I., & Douglas, O. (2023). *Where vultures feast: Shell, human rights, and oil in the Niger Delta*. Verso Books.
- [19] Onyema, I. C. (2019). Species composition and diversity of phytoplankton in the western Niger Delta. *Research Journal of Environmental Sciences*, 3(1), 1-11. <https://doi.org/10.3923/rjes.2009.1.11>
- [20] Scoones, I. (2015). *Sustainable livelihoods and rural development*. Routledge.
- [21] UNEP. (2011). *Environmental assessment of Ogoniland*. United Nations Environment Programme.
- [22] United Nations Development Programme (UNDP). (2006). *Niger Delta Human Development Report*. Abuja: UNDP Nigeria.
- [23] Wilson, E. O. (2016). *Half-earth: Our planet's fight for life*. W. W. Norton & Company.