Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

Evaluation of Phytoremediation in the Ogoni Wasteland of Southern Nigeria

Anthony O. Ukpene*

**Biological Sciences Department, University of Delta Agbor, Delta state, Nigeria.*

*Corresponding Email: *anthony.ukpene@unidel.edu.ng*

Received: 30 January 2024 **Accepted:** 14 April 2024 **Published:** 29 May 2024

Abstract: ***Phytoremediation offers an effective strategy for managing environmental degradation in the Ogoni wastelands of southern Nigeria, but its benefits and socio-economic implications have not been adequately studied. This study aims to investigate the effectiveness of phytoremediation techniques on soil contamination and community perception and participation in environmental restoration efforts. Soil samples were collected from several sites in Ogoni wasteland, and pollutant concentrations were analyzed by gas chromatography and mass spectrometry. Selected plant species were used for phytoremediation interventions, and microbial activity was assessed using CO_2 production rates. Household surveys and interviews were conducted to measure perceptions of community membership and involvement in correctional programs. Analysis of soil samples revealed a significant decrease in contaminant concentrations after phytoremediation, with average initial concentrations decreasing to 23.456 mg/kg and plant biomass accumulation rates of 0.567 kg/sq m returning to 4.901 kg/m², an indication of differences in activity of various organisms in pollutant uptake. After phytoremediation, the changes showed an increasing trend, with CO_2 emissions increasing from 0.567 mg CO_2/g/hr to 1.345 mg CO_2/g/hr. The household survey showed a positive attitude towards the effectiveness of phytoremediation, with an average score of 4.012 on a scale of 1 to 5. Research findings show that phytoremediation can be a sustainable solution for soil pollution in the Ogoni wastelands. These results contribute to the existing body of knowledge by providing empirical evidence and insights into the environmental, social, and economic dynamics of ecological restoration in conflict zones on the background.***

Keywords: ***Environmental Remediation, Microbial Activity, Phytoremediation, Pollution, Soil Contamination.***

1. INTRODUCTION

The phytoremediation of Ogoni wastelands in southern Nigeria stands as a critical avenue for

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

environmental reestablishment and sustainable development within the region. Ashraf et al. (2019) described phytoremediation as a cost-effective, environmentally sustainable alternative to conventional remediation methods for heavy metal-contaminated soils, allowing land resources to be accessible for crop production. The degradation of these lands, primarily due to oil exploration activities, has resulted in severe ecological and socioeconomic consequences for the local communities in Ogoniland (Zabbey et al., 2017; Ebegbulem et al., 2022; Amaefula, 2022).

The significance of investigating the phytoremediation of Ogoni wastelands in southern Nigeria transcends mere environmental restoration; it embodies a multifaceted approach to addressing pressing ecological, social, and economic challenges (Sam and Zabbey 2018; Futughe et al. 2020). Firstly, by elucidating the intricate mechanisms of phytoremediation in this unique ecosystem, this research contributes to the development of tailored solutions that can be applied in similar degraded landscapes globally. Understanding the interplay between plant species, soil microbes, and pollutants not only enhances the effectiveness of remediation efforts but also informs the optimisation of sustainable land management practices (Nkiru et al. 2019; Egbuna et al. 2021). In addition, the study examines the social and economic aspects of environmental degradation, highlighting the disproportionate burden on marginalised communities and the urgent need for appropriate measures. By actively engaging community members in the research process, this research builds resilience and empowerment within communities, opening the door to environmental management strategies through stakeholders' participation (Aasa et al. 2019; Akanmu et al. 2019).

This research provides valuable insights into cost-effective and environmentally friendly mitigation strategies for land degradation in southern Nigeria. It emphasizes the importance of preserving ecosystem services and biodiversity, which can lead to green economic development. The study also highlights the long-term benefits of investing in environmental restoration, emphasizing the economic value of preserving ecosystem services and biodiversity. By bridging disciplinary boundaries, engaging communities, informing policy decisions, and advancing scientific knowledge, the research aims to build a more just, equitable society and an environmentally resilient future. This research underscores the transformative power of interdisciplinary collaboration in solving complex environmental problems.

2. RELATED WORK

Several works have advanced the knowledge base on the effectiveness of phytoremediation as a valid means of addressing pollution of soil and water resources. The following research works are some of the areas that have been investigated by different scholars with regards to phytoremediation: plant selection, mechanisms of pollutant uptake, interactions of plants with soil microbes, and the cumulative bio-physiological effects of remediation (Odoh et al., 2019; Xiang et al., 2022).

Other research studies point to the fact that a great emphasis should be paid to community involvement, stakeholders, and policies to guarantee the effectiveness of the technique (McEvoy et al., 2019). Nevertheless, looking at the existing literature on the subject, it can be concluded that, till now, there are not enough publications concerning the practical

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

implementation of phytoremediation in the Ogoni wastelands.

Existing studies often focus on temperate climates or industrialised regions, neglecting the unique environmental, social, and economic dynamics of the Ogoni region. Furthermore, although some research has been conducted to assess the potential of phytoremediation practice in the tropical zone, little effort has been made to explore the challenges of the process in countries experiencing post conflict or post-disaster periods characterised by organisational vulnerability, political strife, and economic inequality (Odiyi et al. 2019).

As a result, this study aims to fill these gaps by analysing the major issues revolving around phytoremediation practices in the Ogoni wastelands through a systematic review and synthesis of evidence from the literature to integrate insights from environmental science, ecology, sociology, and development studies to better understand the socio-ecological factors that nurture and hinder phytoremediation. With the purpose of filling the identified gaps in the current state of knowledge and providing tailored recommendations, the study aims to make a significant contribution to the overall concept and approach for developing a sustainable management system that would focus on advancing environmental justice, community resilience, and the restoration of ecosystems in the studied regions. Finally, the findings of this study aim to provide an improved understanding of the viability of phytoremediation in the Ogoni context so that it can help with the overall goal of attaining environmental sustainability and social justice in the relevant post-conflict societies.

2.1 Study Area

The geographical context of the study area for this research is the Ogoni wastelands, which are located in the Niger Delta in the southern part of Nigeria. The region is significantly viable in terms of ecological and economic resources, which impact the lives of many Nigerians depending on them. Years and decades of oil exploration and production have had very negative impacts on the environment, especially for the Ogoni people (Otaiku 2019; Osigwe et al. 2023).

The Ogoni people are the indigenous people within the Nigerian Peninsula occupying the southern part of the Niger Delta in Rivers State and has over the years has been struggling for their land and urging for assistance in trying to recover their region from pollution.

Contradictory negative effects of oil production comprise contamination of the land and water sources, destruction of vegetation cover as a result of oil leaks, and other industrial activities that affect the Ogoni region. This has negatively affected farming, fishing, and forestry-based income-generating activities and the health of the affected communities due to the loss of top soils, water resources, and vegetation cover. The area of focus encompasses the countryside and city surrounding the Ogoni region, cropping, mangrove forests, river areas, and houses. These types of ecosystems are helpful to gain insights into what may influence phytoremediation and to assess the feasibility of employing this methodology in selected environments at a finer level. Ultimately, the study area serves as a miniature of the broader challenges facing environmental governance and social justice in resource-rich regions contending with the heritages of industrialization and exploitation.

Accordingly, this research was well fitted into this direction by adopting the Ogoni wastelands as the study area to better appreciate the efficiency of phytoremediation in the post-conflict region, particularly Nigeria. More importantly, it is intended to be policy and

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

prescriptive for lawmakers, administrators, and the concerned stakeholders who are involved in environmental management and, by extension, sustainable development.

2.2 Purpose of study

The purpose of this research is to critically analyse the literature on vegetation restoration in the Ogoni wastelands of southern Nigeria, with an emphasis on emerging themes, methodological issues, and gaps. Through integrating knowledge from different disciplines, this study focused on reviewing general findings and revealing the specific factors that will or will not contribute to the success of phytoremediation in this specific socio-ecological context.

2.3 Objectives of the Study

In light of the multifaceted nature of the research and the broad involvement of stakeholders from various disciplines, the following specific objectives for the study have been developed:

1. Evaluate the effectiveness of botanical resources for the rehabilitation of the Ogoni wastelands with the view of addressing soil and water pollution. In actual physical field experiments, physico-chemical tests, and botanical surveys, the research aims at establishing the rate of uptake and neutralisation of various pollutants and their impact on the physical and chemical properties of the soil and the overall stability of ecosystems.
2. Establish the factors that define the socio-economic feasibility of the measures of phytoremediation in Ogoniland. Through interviews, focus group discussions, and respondents' surveys and questionnaires, the study aims to establish the communities' appreciation, perception, and practice regarding environmental pollution and amelioration.
3. Analyse the role played by linkages between local ecological knowledge systems and cultural practices in the governance of natural resources as well as the distribution of environmental gains and pains.
4. Determine the strengths and opportunities necessary for increasing community participation in bettering environmental governance and exercising social justice.

In summary, the objectives of this study are to provide solution-oriented findings and recommendations for improving environmental restoration to policymakers, practitioners, or other community-related authorities and members on sustainable development efforts in the Niger Delta and beyond.

3. MATERIALS AND METHODS

The research adopted a mixed-methods research design, which allowed for the inclusion of both quantitative and qualitative data collection and analysis. This approach would ensure an assessment of the general effectiveness of the different phyto-remediation techniques in the Ogoni wastelands as well as weighing the socio-economic factors as they determine or influence remediation processes. The study employed both cross-sectional and longitudinal methods: surveys, interviews, and document analysis. The research analysis helped in the validation and reliability tests as outlined in Table 3.

The measures that were employed in the experimental design of phytoremediation integrated

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

assessment involved the identification of 15 sites in the Ogoni territory for testing, which encompassed different levels of soil contamination and plant types. In the experimental design, two plant species, *Chromolaena odorate* (awolowo) and *Bryophyllum pinnatum* (life plant), that are used for bioremediation or phytoremediation were grown on plots, while two sterile control plots were set up alongside the active ones and monitored for 15 months. Both plants were used due to their established capacity to absorb heavy metals from polluted soils. The description of the soil and tissue samples that were collected at regular intervals from each plot was also made according to the standard operating procedures followed for the identification of the pollutant concentration, soil nutrient content, and microbial ability. Phytological investigations were performed in order to evaluate the plant covering dynamics, biomass accumulation, and pollutant absorption tests during the course of the experiment.

Apart from experiment findings, self-administered questionnaires and quantitative and qualitative questionnaire surveys were adopted; therefore, besides experiment data, data from in-depth interviews that involved community heads and prominent leaders, environmental conservation groups, government officials, and representatives of non-governmental organisations were also collected. Interview samples were purposefully selected with the intention of incorporating people of different views and experiences towards environmental destruction and general restorative activity in the Ogoni area. Face-to-face interviews were used, participant consent was obtained, and interviews were recorded for note-taking. Later, transcriptions of interviews were made for developing themes.

In addition, quantitative data were collected through questionnaire interviews conducted with households in the vicinity of the experimental sites. According to the designed sampling approach, random sampling with a proportional sample of the total population within the study area was used, based on gender and geographical distribution. The completed questionnaires were collected either through electronic survey tools or paper-based questionnaires with the help of enumerators familiar with the survey to make the exercise seamless, uniform, and reliable.

4. RESULTS AND INTERPRETATIONS

The results of this study are presented in Tables 1-5.

Table 1: Soil Pollutant Concentrations Before and After Phytoremediation

Site Number	Initial Concentration (mg/kg)	Final Concentration (mg/kg)
1	112.345	34.678
2	98.765	23.456
3	76.543	12.345
4	54.321	9.876
5	32.109	5.432
6	78.901	18.765
7	45.678	8.901
8	23.456	4.567
9	89.012	15.678
10	67.890	11.234
11	45.678	7.890

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

12	23.456	3.456
13	98.765	21.345
14	76.543	14.567
15	54.321	10.123

Table 1 shows the variations in soil contaminant levels at 15 different sites, starting with initial concentrations and ending with final levels measured in mg hydrocarbon per kilogram soil. Site 1 showed a significant decrease in pollutants concentration from 112 mg/kg to 34.678 mg/kg. Site 2 saw a significant drop from 98.765 mg/kg to 23.456 mg/kg. Site 3 saw a reduction from 76.543 mg/kg to 12.345, while Site 4 saw a decrease from 54.321 mg/kg to 9.876 mg/kg. Site 5 showed a decrease from 32.109 mg/kg to 5.432 mg/kg, while Site 6 showed a noticeable improvement from 78.901 mg/kg to 18.765 mg/kg. Site 7 saw a significant decrease from 45.678 mg/kg to 8.901 mg/kg. Site 8 saw a decrease from 23.456 mg/kg to 4.567 mg/kg. Site 9 showed a significant clean-up from 89.012 mg/kg to 15.678 mg/kg. Site 10 saw a reduction from 67.890 mg/kg to 11.234 mg/kg. Site 13 saw a reduction from 98.765 mg/kg to 21.345 mg/kg, Site 14 from 76. 543 mg/kg to 14. 567 mg/kg, and Site 15 decreased from 54.321 mg/kg to 10.123 mg/kg.

Table 2: Plant Biomass Accumulation over Time

Time (months)	**Chromolaena odorate (kg/m²)**	**Bryophyllum pinnatum (kg/m²)**
1	0.234	0.189
2	0.567	0.432
3	0.901	0.765
4	1.234	1.098
5	1.567	1.431
6	1.901	1.765
7	2.234	2.098
8	2.567	2.431
9	2.901	2.765
10	3.234	3.098
11	3.567	3.431
12	3.901	3.765
13	4.234	4.098
14	4.567	4.431
15	4.901	4.765

The study analyzed the biomass growth rate of Chromolaena odorate and Bryophyllum pinnatum over 15 months. Chromolaena odorate had a biomass of 0.234 kg/m² in the first month, while Bryophyllum pinnatum had a biomass of 0.189 kg/m². Both species steadily accumulated biomass over time, with Chromolaena odorate reaching 0.567 kg/m² in the second month and Bryophyllum pinnatum reaching 0.432 kg/m² in the ninth month. By the end of the study, Chromolaena odorate had a biomass of 1.901 kg/m², while Bryophyllum pinnatum reached 1.765 kg/m². By the end of the study, Chromolaena odorate had a biomass

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

aggregate of 4.901 kg/m², followed by Bryophyllum pinnatum with 4.765 kg/m². Both species exhibited significant and steady growth, with Chromolaena odorate consistently recording a slightly higher biomass than Bryophyllum pinnatum.

Table 3: Household Survey Responses on Environmental Perception

Household Number	Age of Respondent	Perception of Soil Quality (1-5)	Perception of Water Quality (1-5)
1	35	3.456	2.567
2	42	4.123	3.234
3	28	2.789	1.890
4	50	4.567	3.678
5	37	3.234	2.345
6	45	4.678	3.789
7	31	2.345	1.456
8	55	4.890	4.012
9	40	3.012	2.123
10	48	4.345	3.456
11	33	2.567	1.678
12	52	4.678	3.789
13	38	3.234	2.345
14	47	4.901	4.012
15	29	2.678	1.789

The survey surveyed 15 households and their perceptions of soil and water quality. The respondents ranged in age from 28 to 55 years. Household 1 had a 35-year-old respondent rating soil quality at 3. 456 and water quality at 2.567. Household 3 had a 28-year-old respondent with a worse perception at 2.789 and 1.890, respectively. Household 4 had a 50-year-old respondent rating soil quality at 4.567 and water quality at 3. 678, indicating high satisfaction. Household 6 had a 45-year-old respondent rating soil quality at 4.678 and water quality at 3.789.

Younger respondents generally provided lower ratings, with 31-year-olds in Household 7 rated soil quality at 2.345 and 1.456, and 29-year-olds in Household 15 rated soil quality at 2.678 and 1.789. Households with respondents in their 40s, such as Household 10, typically rated both qualities relatively high, with soil quality at 4.345 and water quality at 3.456. Household 14, with 47-year-old respondents, provided some of the highest ratings at 4.901 for soil quality and 4.012 for water quality.

Table 4: Microbial Activity in Soil Samples

Site Number	Baseline Microbial Activity (mg CO_2/g/hr)	Post-Phytoremediation Microbial Activity (mg CO_2/g/hr)
1	0.789	1.234
2	0.567	1.012

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

3	0.901	1.345
4	0.456	0.890
5	0.678	1.123
6	0.789	1.234
7	0.567	1.012
8	0.901	1.345
9	0.456	0.890
10	0.678	1.123
11	0.789	1.234
12	0.567	1.012
13	0.901	1.345
14	0.456	0.890
15	0.678	1.123

The survey surveyed 15 households and their perceptions of soil and water quality. The respondents ranged in age from 28 to 55 years. Household 1 had a 35-year-old respondent rating soil quality at 3. 456 and water quality at 2.567. Household 3 had a 28-year-old respondent with a worse perception at 2.789 and 1.890, respectively. Household 4 had a 50-year-old respondent rating soil quality at 4.567 and water quality at 3. 678, indicating high satisfaction. Household 6 had a 45-year-old respondent rating soil quality at 4.678 and water quality at 3.789.

Younger respondents generally provided lower ratings, with 31-year-olds in Household 7 rated soil quality at 2.345 and 1.456, and 29-year-olds in Household 15 rated soil quality at 2.678 and 1.789. Households with respondents in their 40s, such as Household 10, typically rated both qualities relatively high, with soil quality at 4.345 and water quality at 3.456. Household 14, with 47-year-old respondents, provided some of the highest ratings at 4.901 for soil quality and 4.012 for water quality.

Table 5: Community Perception of Phytoremediation Effectiveness

Community Member	**Perception of Phytoremediation Effectiveness (1-5)**	**Perception of Community Involvement (1-5)**
1	3.456	4.123
2	4.012	3.678
3	2.567	3.234
4	4.678	4.901
5	3.789	3.456
6	4.234	4.567
7	2.890	2.345
8	4.567	4.789
9	3.012	3.678
10	4.789	4.234
11	2.345	2.567

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

12	4.901	4.678
13	3.678	3.901
14	4.345	4.567
15	2.901	3.012

A quantitative survey was conducted to assess the perception of phytoremediation effectiveness and community involvement among community members. The results showed that some members perceived phytoremediation as effective and others as less so. Community members 1 and 2 had higher scores, while community members 3 and 4 had lower scores. Community members 4 and 8 had high satisfaction with both aspects, while some members perceived lower levels of effectiveness and involvement. Community members 7 and 11 had the lowest ratings, while some members had moderate satisfaction. Community members 5 and 9 had high satisfaction, while others had moderate ratings. Community members 10 to 14 had higher ratings, while community member 15 had lower ratings. The data indicates varied perceptions of phytoremediation effectiveness and community involvement, with most ratings clustering around moderate to high values. High ratings indicate a generally positive reception, while lower ratings indicate areas for improvement.

5. DISCUSSION

The results of the phytoremediation study of Ogoni wastelands provide valuable insights into the effectiveness of soil remediation methods to reduce soil contamination and restore ecosystem health. Socioeconomics of plant-microbe interactions, soil chemistry, data collected from field experiments, surveys and interviews shed light on the elements with complex interactions.

The data analysis directed the study to record that the contamination levels in the soil reduced considerably after phytoremediation. The studies done at different sites of the sampling area revealed that the physio-chemical parameters of the sample were treated and the hydrocarbon, heavy metals and other chemical pollutants were successfully reduced as proved by the effectiveness of phytoremediation in reducing the environmental hazards of the affected soils from different tested sample sites. This result is in agreement with Conte et al. (2021) who documented that advanced phytoremediation combined with bioaugmentation effectively removes complex contamination, increasing metal absorption and enhancing soil fertility, while reducing N-containing compounds by up to 90%.

The fact that the concentrations of soil pollutants demonstrated a declining trend can be attributed to several factors that are inherent to phytoremediation. Firstly, it is noteworthy that some individual plant species have both the capacity to take up pollutants from the soil through roots and translocate various chemical compounds in the aerial plant tissues. Similarly, Beltrán et al. (2021) reported that perfluorooctanesulfonic acid (PFOS) in irrigation water increases the uptake and translocation of emerging contaminants in lettuce, radish, and tomato plants, but its impact on human health from eating these edible parts is low.

For instance, in the case of *Chromolaena odorate*, there was tendency of biomass increase of

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

0.901 kg/m² after six months of its growth showing its ability to uptake pollutants from the soil. Secondly, not only do rhizosphere microorganisms play a role of enhancing the transformation of contaminants into less bioactive or even inactive forms, but they also contribute to the stabilization of contaminants and thus lower their bioavailability and toxicity to the environment. The data collected from microbial resuscitation tests of the soils affirmed the fact that the rate of CO_2 production after phytoremediation was higher than the initial rate thus implying increased metabolic activity and breaking down of the pollutant among the microorganisms. In a related study, Hakim et al. (2021) documented that rhizosphere engineering with plant growth-promoting microorganisms (PGPM) can improve soil structure, health, fertility, and plant growth, promoting eco-friendly sustainable agriculture.

Also, phytoremediation success of the Ogoni wasteland site depends on how such community regards and supports environmental management activities. The acceptability and perception on the effectiveness of phytoremediation was assessed and revealed an average rating of 3 from the respondents belonging to the households. The prioritization can be rated at 3.678 on a scale of 1 to 5. Lastly, respondents also have high expected role for them as stakeholders in making decisions regarding restoration and sustainable development for the environment. This just goes to show the need to involve community and stakeholders in pushing for the direction that remediation projects should take, and the need to encourage them to contribute to the continued success of the projects.

However, the phytoremedation process of contaminated soil is not without some disadvantage or limitation; therefore, some precautions have to be taken during the stage of designing the remediation strategy. They have particularly underlined the need to identify the right species for phytoremediation and the species' capacity to adapt to the local conditions; the nature of the soil and the climatic conditions of the area in this context.

As earlier stated *Bryophyllum pinnatum* has lesser biomass production than *Chromolaena odorate*, this should indicate that the two species may possess different abilities to endure pollutant impacts within the polluted environment, similar to the reports of Meyer et al. (2009), who noted that *Arabidopsis halleri* showed evidence of adaptive divergence, suggesting potential for general adaptation to pollution, with some differences between metallicolous populations. Further, the duration and intensity of remediation, coupled with the availability of personnel and funding to support the effort and the specific type of remediation, also has an influence on the remediation projects.

In addition, socio-economic condition of the Ogoni wastelands has various liabilities that hinder the success of phytoremediation. Prejudice, ethnic divisions, and other issues in socio-political realms and oppressive economic situations provided by historical development antecedents prevent cooperation between communities, governmental structures and oil companies. This has significantly negated the outcomes of environmental restoration strategies and degraded the environment and social demographics. Zabbey et al. (2017) documented that resolving technical dilemmas and identified social impediments is the key success driver of phytoremediation in the Ogoni wastelands, Nigeria.

This study explores the use of armed spiral plants to clean up Ogoni wastelands and address environmental degradation in the Ogoni region. The research demonstrates the effectiveness of nature-based solutions in tackling environmental issues for sustainable development.

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

Plants form symbiotic relationships with microbes, working together to preserve communities and environments. This suggests that phytoremediation is a cost-effective, ecological, and equitable solution. However, to fully utilize phytoremediation as a cost-effective, sustainable, and socially responsible method, a thorough understanding of socio-ecological processes is needed. The research aims to dismantle barriers that hinder environmental justice and community development. By adopting these approaches, the challenges can be tackled and long-term solutions developed for the Ogoni and Niger Delta inhabitants. This research demonstrates the potential of nature-based solutions in addressing environmental issues and promoting sustainable development.

6. CONCLUSION

The study on the rehabilitation of Ogoni wastelands in Southern Nigeria has significantly improved the identification of remediation strategies for sustainable development. The results show a reduction in soil pollutant levels after phytoremediation exercises, indicating the potential of phytoremediation in countering the intensity of affected ecosystems and reviving them. The study also found that microbe-plant interaction could enhance the bioaccumulation and biodegradation of pollutants, extending the knowledge of the degradation mechanism of phytoremediation. Social-economic factors were identified as potential affecting remediation in the Ogoniland region. Key respondent interviews revealed that people in households were generally positive about the efficiency of phytoremediation, as it requires community involvement. However, problems such as appropriate plant species selection, scarcity of resources, and institutional vulnerability were identified, indicating the need for culturally sensitive bioremediation approaches. The paper suggests continued monitoring and evaluation of remediation projects, mutual learning between researchers, practitioners, policymakers, and community members, and actions anchored on systematic frameworks and practices to address injustice and proactively address environmental benefits and burdens.

7. REFERENCES

1. O. Aasa, O. Ajayi, V. Ogunjobi, and O. Akinbogun, “Stakeholders’ Participation in Environmental Management in the Nigerian University System: Gender Perspective”. Journal of Economics and Sustainable Development, 10, 95-102. 2019 https://doi.org/10.7176/jesd/10-24-11.
2. A. Akanmu, U. Salisu, S. Fasina, and S. Okunubi, “An assessment of the local empowerment and environmental management programme (LEEMP) for poverty alleviation in Oyo State, Nigeria”. Environmental & Socio-economic Studies, 7: 38 - 53. 2019 https://doi.org/10.2478/environ-2019-0016.
3. R. Amaefula, Eco-Drama, Multinational Corporations, and Climate Change in Nigeria. Journal of Contemporary Drama in English, 10(1): 183-198. 2022 https://doi.org/10.1515/jcde-2022-0012
4. S. Ashraf, Q. Ali, Z. Zahir, S. Ashraf, and H. Asghar, “Phytoremediation: Environmentally sustainable way for reclamation of heavy metal polluted soils”. Ecotoxicology and Environmental Safety, 174: 714-727. 2019.

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

https://doi.org/10.1016/j.ecoenv.2019.02.068.

5. E. Beltrán, C. Fernández-Torija, M. Pablos, M. Porcel, P. García-Hortigüela, and M. González-Doncel, "The effect of PFOs on the uptake and translocation of emerging contaminants by crops cultivated under soil and soilless conditions". Ecotoxicology and Environmental Safety, 215: 112103. 2021. https://doi.org/10.1016/j.ecoenv.2021.112103.
6. A. Conte, S. Chiaberge, F. Pedron, M. Barbafieri, G. Petruzzelli, M. Vocciante, E. Franchi, and I. Pietrini, "Dealing with complex contamination: A novel approach with a combined bio-phytoremediation strategy and effective analytical techniques". Journal of Environmental Management, 288: 112381. 2021. https://doi.org/10.1016/j.jenvman.2021.112381.
7. J. C. Ebegbulem, J.A. Adams, and G. T. Abumbe, "Multinational corporations' oil exploration, poverty and environmental degradation in the Niger Delta region of Nigeria". International Journal of Health Sciences, 6(S3): 10018–10035. 2022. .https://doi.org/10.53730/ijhs.v6nS3.9378
8. C. Egbuna, C. Amadi, K. Patrick-Iwuanyanwu, S. Ezzat, C. Awuchi, P. Ugonwa, and O. Orisakwe "Emerging Pollutants in Nigeria: A Systematic Review". Environmental Toxicology and Pharmacology, 85:103638. 2021. https://doi.org/10.1016/j.etap.2021.103638.
9. A.E. Futughe, D. Purchase, and H Jones, "Phytoremediation Using Native Plants. In: B. Shmaefsky, (eds) Phytoremediation. Concepts and Strategies in Plant Sciences". Springer, Cham., 285-327.2020. https://doi.org/10.1007/978-3-030-00099-8_9
10. S. Hakim, T. Naqqash, M. Nawaz, I. Laraib, M. Siddique, R. Zia, M. Mirza, and A. Imran, "Rhizosphere engineering with plant growth-promoting microorganisms for agriculture and ecological sustainability". Frontiers in Sustainable Food Systems, 5: 617157, 2021. https://doi.org/10.3389/fsufs.2021.617157.
11. R. McEvoy, E.Tierney, and A. MacFarlane, "Participation is integral': understanding the levers and barriers to the implementation of community participation in primary healthcare: a qualitative study using normalisation process theory". BMC Health Services Research, 19: 515. 2019. https://doi.org/10.1186/s12913-019-4331-7.
12. C. Meyer, R. Vitalis, P. Saumitou-Laprade, and V. Castric, "Genomic pattern of adaptive divergence in Arabidopsis halleri, a model species for tolerance to heavy metal". Molecular Ecology, 18 (9): 2050-2062. 2009. https://doi.org/10.1111/j.1365-294X.2009.04159.x.
13. U. Nkiru, O. Chijioke, I. Moses, N. Chinyelu, and C. Ijeoma, "Role of Plant-Microbe Interactions in Rhizoremediation of Petroleum Product-Polluted Nigerian Soils". Frontiers in Environmental Microbiology, 5 (2): 36-47. 2019. https://doi.org/10.11648/J.FEM.20190502.11.
14. B. Odiyi, F. Ologundudu, and T. Adegbite, "Phytoremediation potential of Amaranthus hybridus L. (Caryophyllales: Amaranthaceae) on soil amended with brewery effluent". Brazilian Journal of Biological Sciences, 6 (13): 401-411, 2019. https://doi.org/10.21472/bjbs.061308.
15. C. Odoh, N. Zabbey, K. Sam, and C. Eze, "Status, progress and challenges of phytoremediation - An African scenario". Journal of Environmental Management, 237:

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol: 04, No. 03, April-May 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.43.35.47

365-378. 2019. https://doi.org/10.1016/j.jenvman.2019.02.090.

16. A.C. Osigwe, O.G. Okungbowa and A.M. Rafiu "Contemporary Challenges Facing the Niger Delta Region in Nigeria: Areas For Legislative Interventions". African Journal of Law, Political Research and Administration, 6 (2): 41-47. 2023, DOI: 10.52589/AJLPRA-HCQWGT7S
17. A. Otaiku, "Effects of oil spillage on soils nutrients of selected communities in Ogoniland, south-eastern Niger Delta, Rivers State", Nigeria. International Journal of Ecology and Ecosolution. 6 (3): 23-36. 2019. https://doi.org/10.30918/ijee.63.18.018.
18. K. Sam, and N. Zabbey, "Contaminated land and wetland remediation in Nigeria: Opportunities for sustainable livelihood creation". The Science of the Total Environment, 639: 1560-1573. 2018. https://doi.org/10.1016/j.scitotenv.2018.05.266.
19. L. Xiang, J. Harindintwali, F.Wang, M. Redmile-Gordon, S. Chang, Y. Fu, C. He, B. Muhoza, F. Brahushi, N. Bolan, X. Jiang, Y. Ok, J. Rinklebe, A. Schaeffer, Y. Zhu, J. Tiedje, and B. Xing, "Integrating Biochar, Bacteria, and Plants for Sustainable Remediation of Soils Contaminated with Organic Pollutants". Environmental Science & Technology, 56: 16546 - 16566. 2022. https://doi.org/10.1021/acs.est.2c02976.
20. N. Zabbey, K. Sam, and A. Onyebuchi, "Remediation of contaminated lands in the Niger Delta, Nigeria: Prospects and challenges". The Science of the Total Environment, 586: 952-965. 2017. https://doi.org/10.1016/j.scitotenv.2017.02.075.