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Ecological Risk Assessment of Heavy Metals concentration of crude oil Polluted mangrove sediments in the Niger Delta, Nigeria

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INTRODUCTION & AIM

Niger Delta being a major crude oil exploration region with no stringent environmental laws in Nigeria, ecological risk assessment of heavy metals in mangrove sediments is critical due to their persistence and toxicity. Crude oil exploration and production improves the socio-economic status of the residents of the host communities and promotes the economic status of the nation, their exploration, exploitation, and trade have also played a role in the current environmental challenges experienced in the world and the Niger Delta today [1]. Crude oil exploration and related activities of crude oil tend to introduce pollutants such as heavy metals into the environment, which disrupts the ecosystem Crude oil spillage, transportation, storage facilities, illegal bunkering, and accidents are the major causes of crude oil pollution [2]]. Crude oil pollution has led to the proliferation of heavy metal concentrations in soil and water systems in the Niger Delta [3]. Heavy metal persistence and toxicity in environmental systems pose a devastating environmental problem today, with specific consequences including soil contamination [3], bioaccumulation and biomagnification [4], and ecosystem degradation [5], leading to profound impacts on human health and ecosystem integrity. Heavy metals pollution of waters and soils is a major environmental issue, and most traditional remediation methods are ineffective [6]. The pollution and ecological risk indices are tools consolidated by geoscientists, chemists, oceanographers, and other professionals involved with environmental issues in assessing the contamination from chemical elements in soils and sediments [7]. The major objective of this research is to analyze the levels of the heavy metals in the sediment, indicating health and ecological risks to humans and aquatic biota, linked to anthropogenic activities. The result recommends efficient governance strategies and strict policy interventions for immediate remediation of these sites. The results suggest further research on histopathological and biochemical effects on humans and benthic organisms.

METHOD

The study was carried out on mangrove sediments of the Buguma community, Asari-Toru Local Government Area in the Niger Delta Nigeria. The people of this are mostly farmers and fishermen and are impacted by crude oil exploration activities. The farm lands and water bodies in the community have been polluted and contaminated by the activities of crude oil exploration over years, activities such as crude oil bunkering, theft, illegal refining, operational failure, and transportation accidents. This study analyses the concentrations of five different heavy metals, which included Cadmium, Lead, Copper, Nickel, Zinc and Arsenic. Samples were collected from three different sites:- Site 1: Located near sediment heap, dump site with oil sheen, litter, particulate contaminants, with an old local illegal crude oil refinery, site 2: an area with maritime discharges, sewage and commercial wastes dumped nearby and site 3: a densely populated settlement lining the tidal-swept mangrove swamp with household pollution. Sediment samples were collected with a hand trowel for at a depth of 0-15cm.

For quality control, the soil auger was thoroughly cleaned after each collection with a 0.1 M hydrochloric acid solution, then neutralised with a sodium bicarbonate solution. The samples were placed in clean labelled Plastic containers at 4°C to slow down biological and chemical changes and transported to the laboratory for further analysis to check for the pollutant's concentrations.

The procedure of [8] was used in the digestion and analysis of heavy metals in collected sediment samples. Soil samples were air-dried, powdered, and passed through a 2 mm filter to remove litter and debris. Prior to analysis, the soil samples were acid digested. The sieved soil sample was weighed (0.5 g) and transferred to a 100 mL beaker containing 10 mL of concentrated nitric acid (HNO3; d = 1.4 g/cm3) and concentrated hydrochloric acid (HCl; d = 1.18 g/cm3) in a 3:1 v/v ratio. The mixture was then placed on a hot plate under a fume cupboard and heated to near-dryness until it turned white. The residue was allowed to cool before being dissolved in 20% nitric acid (5 mL). The mixture was then filtered and diluted to 20 cm3 with distilled water. Heavy metal concentrations were detected using a flame atomic absorption spectrometer (A.A.S.) equipped with appropriate hollow-cathode discharge lamps. Throughout, deuterium background correction was applied. Each heavy metal's working standard solution was prepared by diluting stock solutions (1000 mg/L; Merck KGaA, Darmstadt, Germany).

FUTURE WORK / REFERENCES

Ecological risk of Hydrocarbons and Heavy metals on benthic organisms in sediments of the mangrove ecosystem

RESULTS & DISCUSSION

Results showed that Arsenic and Lead exceeded human permissible limits, while Cadmium, zinc, and Nickel were within limits. The ecological risk assessment indices revealed that the sediments have varying levels of heavy metal concentrations which are discovered to be relatively high. The applied ecological risk indices were: Ecological Risk: Cu (high ecological risk) and Pb (very high ecological risk), Enrichment Factor: Cd, Zn, Pb, Degree of Contamination (very high degree), Contamination Factor: Pb (moderately degree) and Cu (high degree), and Potential Ecological Risk (obviously high). Results indicated increased levels of the heavy metals in all the sediments, indicating health and ecological risks to humans and aquatic biota, linked to anthropogenic activities. The potential ecological risk values for toxic heavy metals were high in this study when compared to those previously reported by [10]. Pb and Cr pollution levels varied from moderate to very high across all locations examined. Other metals, such as Cu, Cd, Zn, and Ni, showed extremely high contamination. According to the findings of this investigation, contamination factor values were higher than those reported for sediments from various Nun River tributaries [11] and sediment samples from Taylor Creek [12]. The Pollution Load Index values were exceptionally high at all sampling stations throughout the research area. The Pollution Load Index values were found to be much greater than those of heavy metals in soil samples obtained from welding workshops at an old market in Kaduna, Nigeria [13].

CONCLUSION

The result recommends efficient governance strategies and strict policy interventions for immediate remediation of these sites. The results suggest further research on histopathological and biochemical effects on humans and benthic organisms whose sources of livelihood are dependent of the sediments.

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