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ANALYSIS OF ENVIRONMENTAL SAFETY OF OIL FIELD INFRASTRUCTURE ON THE BASIS OF BIOSPHERE COMPATIBLE CONSTRUCTION TECHNOLOGIES

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ABSTRACT

Annotation: *Pollution of the aquatic environment with heavy metals has become a global problem lately as they have the ability to bioaccumulate in biosystems, they are indestructible and toxic to organisms. Heavy metals can enter water systems from various natural and man-made sources, including industrial or domestic wastewater, the use of pesticides and inorganic fertilizers, storm water, landfill leaching, shipping and port activities, geological weathering of the earth's crust and atmospheric deposition. Metal contamination can have a devastating effect on the ecological balance of the recipient environment and on the diversity of aquatic organisms. Heavy metal pollutants have a direct impact on fish and shellfish. Thus, they are widely used to assess the state of aquatic ecosystems in relation to chemical pollution.*

Subject of research: *The impact of the construction of oil and gas facilities on the objects of the fauna of the Gulf of Guinea.*

Objectives: *Analysis of the environmental safety of the oilfield infrastructure based on biosphere-compatible construction technologies.*

Materials and methods: *statistical data are processed using the method of correlation analysis; informational modeling of the environmental situation in the Niger Delta area is performed.*

Results: *The impact of oil and gas facilities in the Niger Delta is disastrous for the region: degradation of species biological diversity is observed, environmental safety standards are violated and public health is under the threat, heavy metals are deposited and accumulated in the soil of the coastal zone. High levels of THC in the sediment will be maintained as long as oil continues to be used and oil is being spilt into the environment.*

Conclusions: *One of the ways to solve this problem is the use of pipes with higher tensile strength and hardness, which cannot be cut using conventional cutting equipment. Oil companies should also take advantage of the cross-drilling technology to place oil facilities in the field.*

Keywords: Environmental Safety of Oil Field Infrastructure

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1. INTRODUCTION

An important part of the environmental impact assessment of the construction of an oilfield facility is to determine the socio-ecological burden. Currently, such techniques exist [1, 2].

Trace metals, interacting with organic compounds, show toxicity and active sites of enzymes. The influence of anthropogenic impacts is strongly felt in the estuarine and coastal environments adjacent to urban areas. Depending on the concentration, they can have a strong negative effect.

The Niger Delta covers about 50% of the total length of the Nigerian coast; there are 21 main river channels (sleeves) from the Benin River to the Imo River. They include Benin, Escravos, Forcado, Ramos, Dodo, Pennington, Digatoru, Bengatoru, Kulama, Fishtown, Sangan, Nan, Brass, St. Nicholas, St. Barbara, St. Bartholomew Sombrero, New Calabar, Bonney, Andoni and Imo -River. All these branches fall into the Atlantic Ocean. As a rule, the Niger Delta is characterized by a sandy coastline covered with extensive mangrove swamps and barrier islands, separated by tidal channels.

The predominant coastal vegetation of the Bonnie River, due to its tidal influence, is mangroves, the main species of which are red and white mangroves, which constitute more than nineteen percent (19%) of saline marshes. White mangroves are scattered among red ones and they prevail in less wetlands.

The region is characterized by half-day tidal regimes with an amplitude of tides of about 1.2 m and tidal currents reaching higher velocities than overflows. The Niger Delta is rich in flora and fauna and it has such a unique feature as the tidal mud plain. The tidal zone is the breeding ground for most aquatic life forms and it is a nutrient processing zone for a brackish aquatic ecosystem [1-2], which causes a relatively high environmental sensitivity index in most of the Niger Delta [3].

Environmental degradation associated with the exploitation of oil in the Niger Delta is the most debated modern problem in Nigeria. By an ironic quirk, the strategies for dealing with oil spills in the Niger Delta are hardly developed.

The purpose of this research is to study the case of an oil spill in the Bonnie River and to offer the strategies to reduce the impact of the oil spill on the river ecology. To determine the level of THC exposure along the Bonnie River, between Bonnie and Port Harcourt 12 sampling stations were established on the area of 56 kilometers. The total concentrations of hydrocarbons, nickel and vanadium were determined for sediment samples, collected at the sample stations. In order to determine the THC these samples were homogenized and as a standard the certain sample weight was taken. The THC values obtained for all samples, as a rule, exceed the nutrient level of 50 mg / kg. The values obtained for nickel and vanadium show that hydrocarbons are derived from petroleum sources. THC values obtained for mesogalin (brackish) zones are usually higher (172.5 - 2342.5 mg / kg) than those obtained for polyhaline (sea) zones (125.8 mg / kg to 325.3 mg / kg) and oligalin (freshwater) zones (124.5 mg / kg (B. 2) at 1265.2 mg / kg).

Table 1 A number of trace metals in seafood, water, and soil of the Bonnie and New Calabar rivers in the Niger Delta, Nigeria (2011-2015)

Seafood (mg/kg)				Water (mg/l)		Soil (mg/kg)	
year	Metals	Range	Mean ±SD	Range	mean SD	Range	mean
2011	Pb	0.24-0.30	0.27±0.01	0.21-0.28	0.23±0.02	0.20-0.92	0.46±0.27
	Cr	1.17-2.62	2.08±0.3	1.11-2.12	1.746±0.38	0.80-2.90	1.74±0.84
	Co	0.20-0.28	0.25±0.02	0.22-0.42	0.3±0.08	0.36-0.70	0.52±0.12
	Cu	0.46-4.89	3.1±0.9	0.36-0.46	0.42±0.04	0.36-1.30	0.72±0.34
	Ni	0.06-0.26	0.13±0.03	0.18-0.33	0.21±0.08	0.16-0.68	0.44±0.17
	V	NA	NA	NA	NA	NA	NA
2012	Pb	0.25-0.27	0.26±0.01	0.21-0.25	0.24±0.02	0.15-0.75	0.40±0.25
	Cr	1.18-2.56	2.08±0.7	0.08-2.34	1.39±0.08	0,77-3.96	1.67±1.1
	Co	0.24-0.28	0.26±0.02	0.15-0.34	0.24±0.07	0.32-0.70	0.52±0.23
	Cu	0.48-4.14	2.88±1.86	0.32-0.37	0.35±0.03	0.34-1.31	0.72±0.34
	Ni	0.08-0.24	0.13±0.8	0.06-0.34	0.2±0.09	0.35-0.82	0.44±0.17
	V	NA	NA	NA	NA	NA	NA

2. MICROELEMENTS IN SOIL

Concentrations of all metals measured in precipitation, with the exception of Co and Na, were slightly higher in 2012 than in 2011. However, only OK recorded significant differences in its concentration over two years (figures). Calcium was ranged from 3.1–10.5 mg / kg in 2011 and 7.5–10.9 mg / kg in 2012, with average values of 6.1 ± 1.1 and 9.7 ± 0.6 mg / l in 2011 and 2012, respectively. The magnesium concentration was ranged from 50.6-53.3 mg / kg in 2011 and 52.2-53.4 mg / kg in 2012, with average values of 52.3 ± 0.4 and 53.0 ± 0.1 mg / kg in 2011 and 2012, respectively. Potassium was ranged from 18.7-28.3 mg / kg in 2011 and 18.3-38.1 mg / kg in 2012 with average values of 24.2 ± 1.5 and 28.1 ± 3.3 mg / kg in 2011 and 2012, respectively. Zinc was ranged from 1.5–3.3 V in 2011 and 0.2–6.0 in 2012 with average values of 2.7 ± 0.9 and 2.8 ± 0.7 mg / kg in 2011 and respectively. Lead concentration was ranged from 0.2-0.6 mg / kg in 2011 and 0.20.9 mg / kg in 2012, with average values of 0.6 ± 0.1 and 0.3 ± 0.06 mg / kg in 2011 and 2012 respectively. Cadmium was ranged from a lower detection limit to 0.1 mg / kg in 2011 and 0.01–0.2 mg / kg in 2012, with mean values are of 0.06 ± 0.02 and 0.1 ± 0.03 mg / kg in 2011 and 2012 respectively.

CO concentrations was ranged from 0.4–0.7 mg / kg in 2011 and 0.3–0.4 mg / kg in 2012, with average values 0.5 ± 0.05 mg / kg and 0.5 ± 0 , 06 mg / kg in 2011 and 2012, respectively. Chromium was ranged from 0.8–1.8 mg / kg in 2011 and 1.0–2.9 mg / kg in 2012, averages were of 1.1 ± 0.2 mg / kg and 2.0 ± 0 , 3 mg / kg in 2011 and 2012, respectively. The concentrations of CU and Fe in 2011 and 2012 were between 1.4–1.9 and 0.4–2.2 mg / kg, 0.4–0.6 and 38.0–38.7 mg / kg, respectively, with mean values between 0.9 ± 0.3 and 0 , 5 ± 0.09 mg / kg,

25.6 ± 7.4 and 29.9 ± 5.9 mg / kg were for CU and Fe in 2011 and 2012, respectively, while NI and Na was ranged from 0.2-0.7 and 0.2-0.8 mg / kg, 4.1 - 23.3 and 5.1-18.7 mg / kg, respectively, average values of 0.4 ± 0.09 and 0.5 ± 0.08 mg / kg, 13.8 ± 3.2 and 12.8 ± 1.8 mg / kg were for Ni and Na in 2011 and 2012 respectively.

The micro metallic content obtained in the dry season for Ca, Zn, Pb, Cd, Co, Cr, Cu, Fe, Ni and Na was slightly higher than during the wet season in relation to station 3. This can be explained by the adsorption of sediment particles as a result of a decrease in the volume of water, usually associated with an increase in the evaporation rate during the dry season. On the other hand, higher values recorded during the dry season can also be explained by low freshwater influx and evaporation, resulting in a concentration of material in the river or as a result of the slow flow of water in the dry season, allowing particles to settle. Subsequently, this can probably be due to dilution with rainwater, which affects the concentration and mobility of heavy metals. However, as reported, the mobility of heavy metals depends not only on the total concentration in the soil and sediment, but also on the properties of the soil or sediment; metal properties and environmental factors. Unsustainable high values of Ca, Mg, K, Cd, Co, Zn, Fe in the rainy season at stations 1 and 2 may be due to the influence of rainwater runoff and the factor of anthropogenic impact. Sediments are sinks of many pollutants, including heavy metals. Unsustainable high values of Ca, Mg, K, Cd, Co, Zn, Fe in the rainy season at stations 1 and 2 may be due to the influence of rainwater runoff and the factor of anthropogenic impact. Sediments are sinks of many pollutants, including heavy metals. Bauer reported that precipitation is the main storage of metals; in some cases, the content of more than 99% of the total amount of metal is represented in quantities several times higher than the natural background in polluting sediments in large industrial and urban areas. Consequently, sediments contaminated with heavy metals pose a threat to the health of aquatic organisms.

3. RESULTS

In polygonal zones (electrical conductivity 2000 to 25000 / cm3) in the estuary of the Bonnie River, the THC concentration is ranged between 125.8 mg / kg to 325.3 mg / kg with an average value of 202.3 ± 93.93 mg / kg, with a total of 0.46. While the nickel concentration varies from 0.24 - 0.46 mg / kg with an average value of 0.37 ± 0.13 mg / kg and as a result it is of 0.36, and the value of vanadium is ranged from 0.09 mg / kg (B. 3) to 0.22 mg / kg (BN2) on average it is 0.16 ± 0.03 mg / kg, CV 19.76%. In mesogalin zones (electrical conductivity 4600 - 9600 / cm3) THC range of values from 172.5 - 2342.5 mg / kg with an average value of 1022.45 ± 929.39 mg / kg and a total is of 0.9%. Values for nickel are ranged from 0.25 to 0.85 mg / kg with an average value of 0.475 ± 1.99 mg / kg and a total of 0.56, while V is ranged from 0.12 to 0.32 mg / kg with an average value of 0.22 ± 0.10 mg / kg and the final from 0.46.

In mesogaline zones THC concentrations are ranged from 124.5 mg / kg (BN 2) to 1265.2 mg / kg with an average value of 647.83 ± 503.51 mg / kg and a total of 0.46. In oligaline zones (i.e. from 750 to 2300 ^ s / cm). In this zone, the Ni concentration varies from 0.12 to 0.4 mg / kg with an average value of 0.24 ± 0.12 mg / kg and a total of 0.48. The value for vanadium is ranged from 0.016 mg / kg to 0.04 mg / kg with an average value of 0.03 ± 0.07 mg / kg, CV 24.7%.

Oil spill in tributaries and branches in the Niger Delta, as a rule, depends on the hydrodynamics of the stream / river; they include the height of the tide, the speed and direction of the flow of water and the shape of the stream / river at the oil spill point. As the oil is being spilt, it is transferred by the incoming tidal water to the tidal zone. On its way, the oil envelops the respiratory roots of mangrove plants, forcing the plants to starve without much needed oxygen. Also direct exposure to toxic components of crude oil is direct scorching of the affected roots. Plants die within 6–10 weeks, starting at the coastline and ending at the over-tidal zone, a phenomenon is called extinction (IPS, 1989).

It is usually noted that the degree of dieaway is proportional to the spread of the tide and the width of the tidal zone at various points. As the oily water recedes at the turn of the tide, the tidal zone is smeared with twisted oil, covering the surfaces of tidal mud layers and vital substrates of tidal communities. At the same time, almost all sedentary life forms in this area die, and some mobile ones barely escape [4,5].

The THC values obtained for all samples, as a rule, exceeded the nutrient level of 50 mg / kg (guidelines and standards FME 2002). The values obtained for nickel and vanadium show that hydrocarbons are derived from petroleum sources. The THC values obtained for the mesogaline zone, as a rule, are higher (172.5 - 2342.5 mg / kg) than those obtained for the polyhaline and oligaline zones. Alakiri and Orubiry oil fields located in the area of mesogaline stations are most likely to be responsible for various oil spills resulting from the activities of these facilities over a long period. High levels of THC in the sediment will be maintained as long as the oil continues to be exploited and oil is being into the environment.

4. MIGITATING MEASURES

The following mitigation measures are offered to reduce the environmental impact of oil spills.

- Valid reasons put forward by communities due to oil spills as a result of equipment failure and aging pipelines, and the counter argument of oil companies that oil spills result from sabotage by community youth are outdated and should be replaced by initiative efforts from oil companies. One of the ways to solve this problem is to use pipes with higher tensile strength and hardness, which cannot be cut with ordinary cutting equipment. Detailed studies on such pipes and the possibility of their use for new pipelines and the replacement of obsolete pipes are needed.
- Most companies have established procedures for responding to oil spills, which are either not practiced in the event of an oil spill, or are not effective enough to contain the spread of spilled oil.

Often time, location hydrodynamics and technical costs used at the time of the spill can limit the extent of coverage of the spill and thus reduce the magnitude of the impact of the spill. This led to the formation of the organization of the “Pure Nigeria” oil companies, which were operating in Nigeria. The task of the organization is to mobilize resources that will be aimed at containing oil spills by member companies. In previous years, the organization was effective, but over the years it has lost its relevance, as the rhetoric and discussion of the causes of oil spills between companies and communities began to replace the real struggle against oil spills and work to mitigate the effects of these spills. The Nigerian National Petroleum Corporation should revive “Pure Nigeria” with clearer goals and rules.

- Oil companies can take advantage of cross-boring technology to place oil facilities in the fields where they can be better controlled to prevent deliberate damage from angry young people.

- Political will is required from various levels of government to create jobs and divert the attention of young people in the Niger Delta from vandalism at oil facilities.

5. CONCLUSIONS

The obtained data on the speed of the pollution process showed that the minimum and maximum environmental impacts had been observed for several years. As it is well known, low sedimentation rates mean a very calm environmental situation, while the relatively rapid sedimentation rate is due to adverse weather conditions accompanied by flooding. The sedimentation rate obtained during observations at stations 1 and 2 was actually higher than for station 3, indicating post-sediment mixing or sediment processing caused by distortions. In addition, historical data on total hydrocarbons level indicate massive oil spills during this period. High levels of THC in the sediment will keep as long as oil is spilt into the environment as a result of oil extraction activities. The offered mitigating measures are to use of pipes with higher tensile strength and hardness that cannot be cut by common tools. It is also offered the National Oil Corporation to resume and coordinate the activities of the "Pure Nigeria" oil spill response team for more effectively monitoring of the environmental situation in the region.

Oil companies should also take advantage of the cross-drilling technology to place oil facilities in places where they can be better controlled to prevent intentional damage from angry young people.

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