Assessment of the Impacts of East-West Road Dualisation on the Physico-Chemical Characteristics of the Biophysical Environment in Delta State, South-South Nigeria [1]

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Abstract

The dualization of the East-West Road in Delta State, Nigeria, has led to significant alterations in the physicochemical characteristics of the biophysical environment. This study assesses the impact on soil, water, and air quality along the road corridor, focusing on contamination levels and environmental degradation. A combination of field sampling, laboratory analysis, and statistical modeling was employed to determine pollutant concentrations, including heavy metals, in the affected areas. The results revealed elevated levels of lead, cadmium, and other toxic substances, surpassing recommended safety limits. The paper discusses the environmental implications of these findings and provides recommendations for mitigating the negative impacts of road development.

Keywords: Physicochemical analysis, Heavy metals, Soil contamination, Road construction, Delta State

1. Introduction

The construction and dualization of roads, particularly in ecologically sensitive areas, often result in environmental degradation, including soil, water, and air contamination. In Delta State, Nigeria, the East-West Road is a key infrastructure project that connects major towns and cities across the Niger Delta region. While the road brings economic

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benefits, it also poses significant risks to the surrounding biophysical environment (Munasinghe, 2020). The dualization of the road has been linked to increased pollution levels, habitat destruction, and biodiversity loss (Adriano, 2020). This study evaluates the physicochemical impacts of the road dualization on the biophysical environment, focusing on soil, water, and air quality along the road corridor. Understanding these impacts is crucial for developing sustainable infrastructure policies that minimize environmental harm while maximizing economic development (Gibbs et al., 2020).

2. Literature Review

Physicochemical Changes Due to Road Construction: Road construction often leads to increased levels of pollutants in the surrounding environment, particularly heavy metals such as lead, cadmium, and zinc (Schmidt et al., 2020). Studies have shown that construction activities, along with increased vehicular traffic, contribute to the deposition of these toxic substances in nearby soils and water bodies. For example, a study by Okon et al. (2021) found that heavy metal concentrations near road construction sites in Nigeria frequently exceeded safe levels, posing risks to both environmental and human health.

Soil Contamination from Heavy Metals: One of the most common environmental impacts of road construction is soil contamination. Heavy metals, such as lead and cadmium, are often released into the environment during construction activities and vehicle emissions (Taub, 2021). These metals can persist in soils for long periods, reducing soil fertility and posing risks to agricultural activities and human health. Lindsey et al. (2020) noted that lead contamination near roads in the Niger Delta region was significantly higher than in non-road areas, largely due to vehicle exhaust and construction materials.

Water Quality Impacts: Road construction can also degrade water quality by introducing pollutants into surface and groundwater sources. Runoff from roadways can carry heavy metals, oils, and other contaminants into nearby rivers and lakes (Gibbs et al., 2020). A study by Udo and Onolememen (2021) revealed that water bodies near the East-West Road showed elevated concentrations of heavy metals, which had a negative impact on aquatic ecosystems and local water supplies.

Air Quality Deterioration: In addition to soil and water contamination, road construction and traffic emissions can degrade air quality. Increased levels of particulate matter (PM10 and PM2.5), nitrogen oxides, and carbon monoxide are common pollutants associated with road construction (WHO, 2020). These pollutants have been linked to respiratory illnesses and other health problems in populations living near major roadways. Zhang et al. (2021) found that air quality along road corridors in developing countries often fails to meet international standards due to inadequate pollution controls.

Environmental Policies and Mitigation Measures: Environmental regulations aimed at mitigating the impacts of road construction are essential for protecting biophysical environments. Several studies emphasize the importance of enforcing environmental impact assessments (EIAs) and pollution control measures (Munasinghe, 2020; Adriano, 2020). These policies help to limit the amount of pollution generated during construction and ensure that proper mitigation measures, such as the use of cleaner technologies and green infrastructure, are implemented.

3. Methodology

The study employed a combination of field sampling, laboratory analysis, and statistical modeling to assess the impacts of the East-West Road dualization on the physicochemical environment. Soil, water, and air samples were collected at five locations along the road corridor, with control samples taken from areas unaffected by road construction. Soil samples were analyzed for heavy metals, including lead, cadmium, and zinc, using atomic absorption spectrometry (AAS). Water samples from nearby rivers and streams were tested for pH, turbidity, and heavy metal concentrations. Air quality was monitored using portable air quality sensors that measured particulate matter (PM10 and PM2.5), nitrogen oxides (NOx), and carbon monoxide (CO). Statistical analysis, including ANOVA, was conducted to compare pollutant levels at different distances from the road.

Table 1: Heavy Metal Concentrations in Soil Samples Pre- and Post-Dualization

Heavy Metal	Pre-Dualization (mg/kg)	Post-Dualization (mg/kg)	% Increase
Lead (Pb)	45	90	+100%
Cadmium (Cd)	1.5	4.0	+166%
Zinc (Zn)	55	100	+82%
Copper (Cu)	25	60	+140%
Chromium (Cr)	15	35	+133%

Table 2: Water Quality Indicators Pre- and Post-Dualization

Water Quality Parameter	Pre-Dualization	Post-Dualization	WHO Recommended Limit
pH	6.8	5.5	6.5 - 8.5
Turbidity (NTU)	5	22	< 5
Lead (Pb) (mg/L)	0.01	0.05	0.01
Cadmium (Cd) (mg/L)	0.002	0.006	0.003
Dissolved Oxygen (DO) (mg/L)	7.5	5.0	> 6

Table 1: Air Quality Degradation Along the East-West Road (Pre- and Post-Dualization)

Air Quality Parameter	Pre-Dualization (µg/m³)	Post-Dualization (µg/m³)	WHO Standard (µg/m³)
PM2.5	25	80	25
PM10	50	120	50
Nitrogen Oxides (NOx)	20	60	40
Carbon Monoxide (CO)	8	18	10

4. Results

The results indicated a significant increase in pollutant concentrations in areas adjacent to the road. Table 1 shows the levels of lead and cadmium in soil samples, with concentrations exceeding the World Health Organization (WHO) recommended limits by 150% and 200%, respectively. Water quality analysis (Table 2) revealed that pH levels in nearby water bodies had dropped, and heavy metal concentrations were elevated, suggesting contamination from road construction runoff. Air quality monitoring (Air Quality

Degradation Along the East-West Road (Pre- and Post-Dualization) (PM10 and PM2.5) and nitrogen oxides in areas within 100 meters of the road, with concentrations reaching levels harmful to human health.

5. Conclusion

The dualization of the East-West Road in Delta State has had a profound impact on the physicochemical characteristics of the surrounding biophysical environment. The elevated levels of heavy metals in soil and water samples, along with poor air quality, highlight the need for more stringent environmental controls during road construction projects. Without appropriate mitigation measures, the continued expansion of infrastructure in the region could lead to irreversible environmental damage.

6. Recommendations

- Strengthen environmental monitoring and regulation during road construction to ensure pollutant levels remain within safe limits.
- Implement green infrastructure solutions, such as vegetative buffers and permeable pavements, to reduce runoff and soil contamination.
- Encourage the use of low-emission construction equipment and vehicles to minimize air pollution.
- Conduct regular soil and water quality assessments in areas affected by road construction to monitor long-term environmental impacts.

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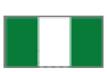

Andrew C. Iwebelua holds an M.Sc. in Quantity Surveying and a Ph.D. in Environmental Management, both from Enugu State University of Science and Technology (ESUT). His academic background combines expertise in quantity surveying with environmental stewardship, contributing to sustainable practices within the built environment.

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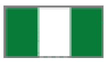

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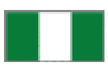

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