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Environmental Spatial Impact of East-West Road Construction Project in Rivers State: Implication to Environmental Mitigation and Compliance in Nigeria

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Abstract

Road construction is a very important infrastructure that accelerates socio-economic activities of an area and if completed can improve accessibility and mobility of people, goods and services to an area. However, road construction is associated with serious spatial environmental problems. Therefore, this study assesses environmental spatial impact of East-West road construction project in Rivers State: implication to environmental mitigation and compliance in Nigeria. Focused group discussions were conducted on community stakeholders to examine the social, economic, cultural and aesthetic changes that occurred due to road construction. Key informant interviews were conducted on both construction companies and community stakeholders. Photograph techniques and recording were used for direct observation of changes in the physical environment. Simple ranking and matrix techniques were scored to ascertain levels of impact. The application of matrix methodology for evaluation of transport route

alternatives for scaling of the impacts was employed. The study indicated that impact of road construction on urban settlements was more in the form of damage to houses, road traffic, resettlement, loss of privacy etc. On the other hand, road construction impact on rural communities was more in the form of ecosystems lost, farmland lost, wildlife lost etc. Also, construction companies did not strictly adhere to the environmental policy regulations in Nigeria. The study specially recommends that construction companies should not site classical roads such as East-West road in environmentally sensitive ecosystems and communities of Nigeria.

1. Introduction

Today, the global car population is growing as fast as the human population. The population of vehicles is over 600 million as marked in 1992 and more than one billion by the year 2015. Now, analysts have concluded that the total vehicle number is 1.2 billion already and will increase to 2 billion vehicles in 2035 [1]. As the last millennium was ending, Nigerian government has spent tremendously on roads worth over billions of naira on roads across the country. These road projects take the form of building, expanding and modernizing transport infrastructure across states and communities. Presently, Nigeria is ranked the second country in Africa that has the largest road network with asphalt surface. In the 1990s the total length of roads with proportion of asphalt in the country has exceeded over 300,000 kilometres compared to 120,000 kilometres by 1981 and over 90% of goods and people in Nigeria are conveyed by road [2]. In 2014, the total road network in Nigeria was about 200,000 kilometres and 33,000 kilometres were Federal Highways, 50,000km as State Highways and 117,000km for local government as well as feeder roads. Paved roads were about 60,000 kilometres. These roads are poorly designed, maintained and deteriorated with bad drainage systems resulting to social and environmental as well as health hazards [3].

However, many factors have contributed to short lifespan of road such as climate change which has the capacity to directly affect the life expectancy of road infrastructure in several ways. For instance, high temperature has the effect of cracking roads immediately after construction. The high temperature causes expansion and contraction of road tars by dividing the roads into several parts especially in the tropical countries where there is high temperature experienced throughout the year. Also, high precipitation has the capacity for new roads to develop potholes as a result of increased rainfall. The rain deepens the road and water in the form of flood, washes away road particles to the nearby drainages. Sometimes, sea level rise over-floods the river banks to wash away graveled and unpaved roads adjacent to the coast. The combination of precipitation and radiation actually reduce the lifespan of roads in Nigeria [4].

Road infrastructure has many advantages. It accelerates the rate of growth and development pattern of an area. Road transport is usually the first infrastructure that attracts other basic infrastructures such as water, buildings, electricity, etc. This is crucial because road transport gives access and prepares an area for further development projects. The pattern of growth of a region is dependent upon the available road networks [5]. Road infrastructure can cause rapid regional development, reduce cost of transport fair, reduce local traffic and improve human labour impute at work places. Thus, a well prepared road can reduce occurrence of accidents as safety of road users is enhanced for both pedestrians and vehicle users. Road infrastructure creates employment for the people during and after construction for the stakeholders as they mobilize to the road project [6].

On the other hand, road infrastructure has some negative impacts that should be mitigated and avoided during road construction projects. When a road is under construction or rehabilitation, there are potential negative effects on the environment and communities in the immediate surroundings of the

construction sites. It is observable that water quarries, burrow pits and material storage areas serving the project are contaminated [7] [8]. During a road construction phase, water courses are blocked; natural habitats are destroyed through generated dust, noise and spillage of dangerous materials and garbage generated in the process. Forced migration and resettlement elsewhere from people's ancestral land, damage to fences and resultant escape of livestock, contamination of water, spread of diseases, vehicular traffic, over speeding in busy sections of the road such as schools, churches and trading centres thereby increasing risks of road traffic accidents to communities along the road [9] [10].

The effects of road projects cut across environmental and socio-economic impact assessment studies of places which comprises mitigation, monitoring and institutional actions ought to be undertaken during the detailed design, preparation for implementation such as preparation of tender, construction and operation stages of road project in order to eliminate, reduce or offset the adverse environmental impacts of road construction on the inhabitants of construction sites. The environmental and social management impact has been encouraged as an integral part of road construction project; it aims at enforcing adherence by the contractor to the policy documents during the construction phase. It regulates the actions of the public during the operational phase. The document also measures success or failure of the road construction project for the benefit of the society at large [11] [12].

It is against this background that this research explores the environmental spatial impact assessment of east-west road construction project in Rivers State as an implication to environmental mitigation and compliance in Nigeria. The study was drawn from East-West road construction project carried out by Setraco Nigeria Limited in Rivers State. The study determined the level of environmental changes during road construction project. It analyses East-West road construction hazards and benefits; it discusses nature, impact enhancement and policy measures of road construction.

2. Materials and Methods

2.1 Description of Study Area

The East-West road has been in existence since 1960 as a colonial road. Part of this road is located in Rivers State of Niger Delta region of Nigeria and extends over 70,000km^2 and makes up 7.5% of Nigeria's land mass [13]. Although the Niger Delta region holds about 26% of the country's population, yet only 17.6 percent of the country's length of roads is situated in the region. There are twenty three LGAs in Rivers. East-West road construction cuts across seven Local Government Areas in Rivers State which lie within latitude $4^0$30'N and $5^0$45'N, longitude $6^0$30'E and $7^0$30'E (Figures 1 and 2) namely: Obio/Akpor, Emohua, Ahoada East and Ahoada West, Eleme, Tai and Khana. There are communities in the LGAs that are directly impacted by the East-West Road and the resultant health, social, economic and environmental consequences on the communities. Some of the communities are Mbiama and Ahoada (Ahoada East and Ahoada West), Elibrada, Rumuiji, Ndele, Elele-Alimini (Emohua) Rumuokoro, Choba (Obio/Akpor), Nchia (Elema), Sakpanya (Tai), Bori (Khana) and to the extreme Akwa Ibom State. Rivers State has population of over 5,689,087 persons. The projected population of LGAs recorded Ahoada East and West with a population of 215,171 persons, Obio/Akpor 311,272 persons, Emohua 183,347 persons, Tai 117,797 persons, Eleme 190,884 persons and Khana 294,217 persons making a total population of 1,220,971 persons and having 21.5% of the total Rivers State population [15]. The population is as in Figure 3.

Rivers State has boundary with Delta and Bayelsa states in the west, in the east with Imo, Akwa Ibom and partly Abia States. In the extreme northern part, the state has boundary with Imo State. And in the extreme south, Rivers State discharges water into the Atlantic Ocean through the Bight of Bonny. In realization of this fact, the Niger Delta Development Commission (NDDC), in 1998, proposed the construction of 704 km East-West coastal road worth of N211 billion that connects Calabar and Epe in Lagos State. The East-West road impacts on 664 coastal settlements and crosses 60 water bodies as rivers,

streams, estuaries, tributaries and creeks. The East-West road was divided into 4 construction segments handled by four construction firms: Julius Berger Plc later handed over to SETRACO section 1, from Warri to Kiama with 18 briges; SETRACO section 2, from Kiama to Port-Harcourt (Eleme Junction); Reynolds Construction Company (RCC) section 3, Eleme Junction in Port Harcourt to Eket in Akwa Ibom; Gitto Construzuoli Generali (GCG) section 4, Eket-Oron road [14].

In Rivers State the mean maximum monthly temperatures range from 28°C to 33°C and mean minimum monthly temperatures range from 17°C to 24°C. Rivers State has mean annual temperature of 26°C and the hottest months are from February to May. The difference between the dry season and wet season temperatures is only about 2°C. The relative humidity of the study area is high throughout the year and decreases slightly into the dry season. Total annual rainfall decreases from about 4,700mm on the coast to about 1,700 mm in extreme north of the area. [16] [17]. The land surface area of East-West Road in Rivers State can be grouped into three main divisions: the fresh water, the mangrove swamps and the coastal sand ridges zone. East-West Road of Rivers State lies on the recent coastal plain of the eastern Niger Delta. Its surface geology consists of fluvial sediments. Drainage is poor, being low-lying with much surface water in the area. Rainfall is seasonal, variable and heavy.

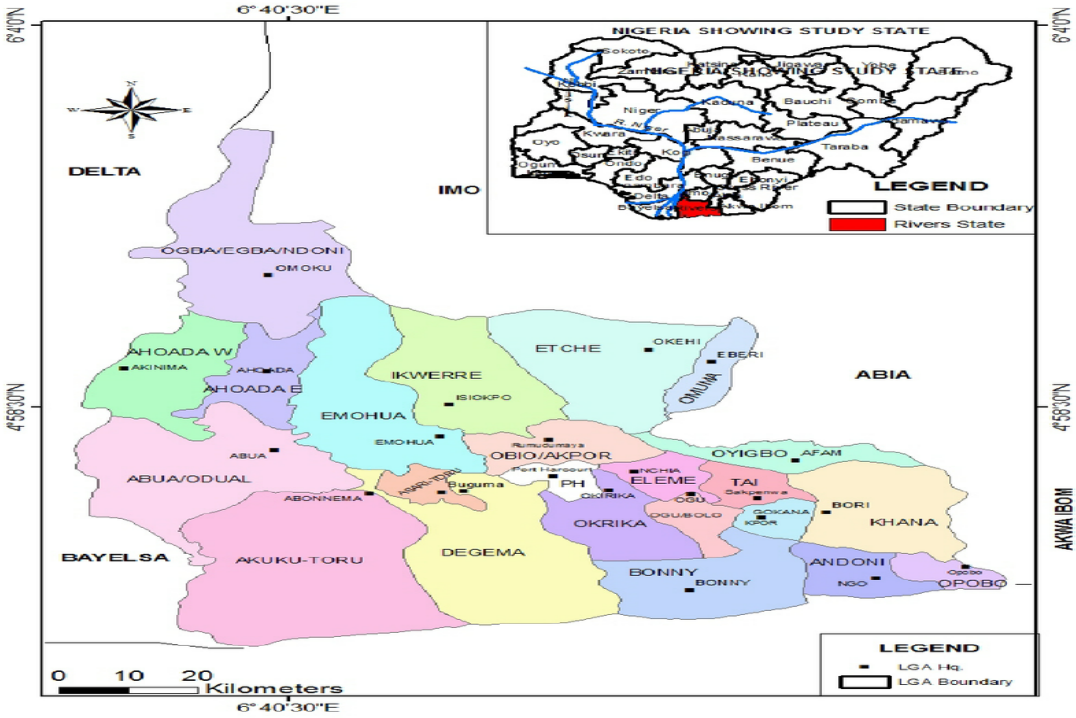


Figure 1: Rivers Sate of Nigeria

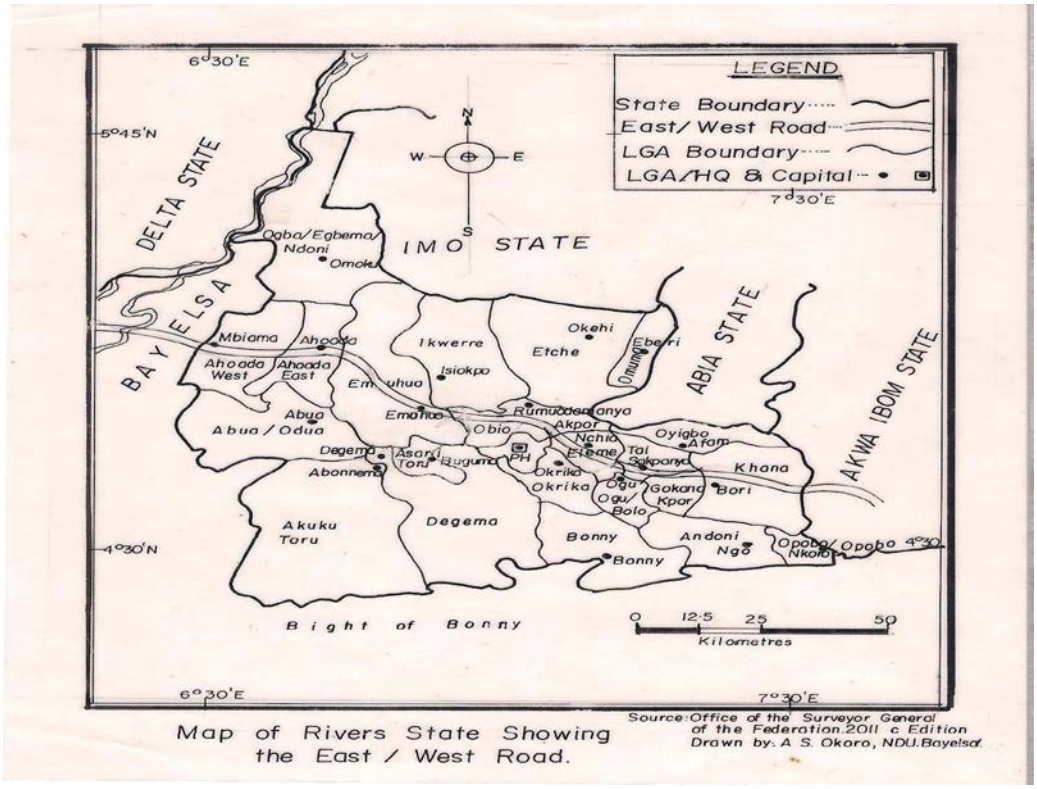


Figure 2: East-West Road of Rivers State

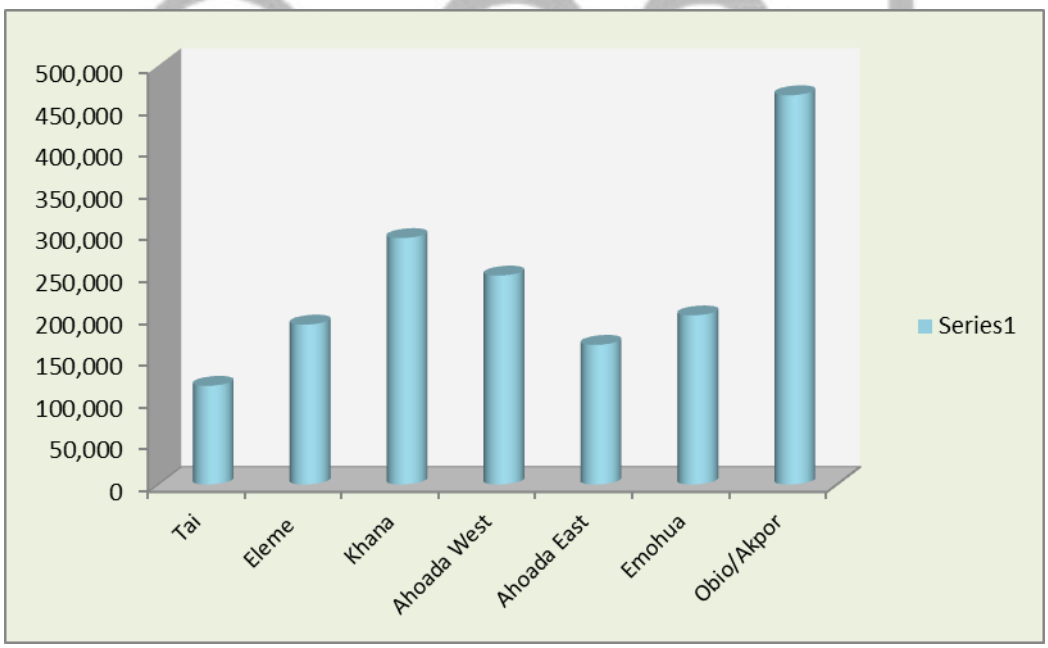


Figure 3: Population of Impacted LGAs

2.2 Methods of Data Collection

Reconnaissance survey of the area was initially conducted. This familiarization field visit helped in providing effective techniques to generate data for the research. This exercise equipped the researcher to understand the dynamics of the study area and prepare for the actual field work. Spatial maps were extracted from Office of the Surveyor General of the Federation of Nigeria to delineate area location of

the East West road and the affected communities. Four field assistants were engaged to carry out the field work on the road with impact assessment template for capturing information. The total area of study was purposively stratified into highly impacted, impacted and low impacted communities based on their proximity and activities with the East-West road construction. The selected LGS were Obio/Akpor, Emohua, Ahoada East and Ahoada West which as at the time of this study Setraco construction work was ongoing along the East-West Road. Seven communities were selected from the sampled LGAs. The studied communities were Ahoada, Elele, Rumuji, Emohua, Elibrada, Choba and Port Harcourt (Rumuokoro) along the East-West road. Direct observations were made along the East-West road about the physical features, vegetation, topography, water channels, land facilities, alteration of the ecosystems, displaced habitats of animal species, etc.

Focused group discussions were conducted on community stakeholders to examine the social, economic, cultural and aesthetic changes that occurred due to road construction in the area. Key informant interviews were conducted on both construction companies and community stakeholders to evaluate the level of company compliance to EIA regulation and policies. Photograph technique and recording were used for direct observation of items, facilities, events and changes in the physical environment. Simple ranking and matrix techniques were scored to ascertain levels of positive, negative, direct, indirect, impacted and heavily impacted environment, communities and road users in road construction projects. Some identified impacts were scaled as beneficial or adverse, long term, short term, reversible and irreversible, local, wide, significant, negligible and normal. The application of matrix methodology for evaluation of transport route alternatives for scaling of the impacts of alternatives provides a basis for selection of the preferred impacts as developed by [18]. This procedure results in a more adequate method of data collection, with both potential and its constituent elements being considered.

3 Results and Discussion

Results of the study discussed environmental changes during road construction project. It analyzed East-West road construction hazards and benefits, nature, impact enhancement and policy measures of the road construction.

3.1 East-West Road Construction Hazards and Benefits

According to Table 1, it was observed and scored that the spatial environment of Elibrada, Rumuji, Elele, Ahoada, Emohua had adverse effects on aquatic ecosystems, fisheries, forests, wildlife, species, surface water, soils, air quality, navigation and aesthetic values affected by the road construction project. Forests were opened to alter the ecosystems and wildlife was exposed to being killed by motorists and hunters on regular basis. Scores of the matrix confirmed that surface water quality, groundwater and soils had very wide adverse impacts caused by the road construction project. Land transport, agriculture, socio-economy and aesthetic values were the benefits of the road project. Land transport had very significant impact on the communities as people, goods and services thrive over time. Impact on Agriculture and socio-economy during road construction was very negligible and short term.

Table 1: East-West Road Construction Hazard and Beneficial Impacts

ITEM	NATURE OF IMPACTS									
	ADVERSE						BENEFICIAL			
	ST	LT	R	IR	L	W	ST	LT	SI	N

Aquatic ecosystems		x		x	x					
Fisheries		x		x	x					
Forests		x		x	x					
Terrestrial wildlife		x		x	x					
Rare and endangered species		x		x		x				
Surface water hydrology		x		x		x				
Surface water quality		x		x		x				
Groundwater	*	*	*	*	*	*	*	*	*	*
Soils		x	x		x	x				
Air quality	x				X					
Navigation		x			x					
Land transport								x	x	
Agriculture							x			x
Socio-economy							x			x
Aesthetic		x						x		

KEY

ST	SHORT TERM	**W**	WIDE
LT	LONG TERM	**SI**	SIGNIFICANT
R	REVERSIBLE	**N**	NORMAL
IR	IRREVERSIBLE	*	NEGLIGIBLE
L	LOCAL		

3.2 Nature of Impact and Distribution Levels

Nature of road construction impact on urban communities differed from that of rural communities. The road construction impact on urban areas was more of socio-economic while in the rural areas the impact was more of ecological in nature due to undeveloped plots of land. This is attributed to the fact that cities have small ecological space as a result of urbanization development that deface the ecosystems due to especially housing and road constructions unlike rural communities that have vast ecological space, surrounded by virgin forest, arable lands, etc.

Out of 28 indicators tracked to understand the nature and levels of impact, findings and analysis of observations showed that the East–West road construction project impacted on Rumuji, Elele, Ahoada, Emohua and Elibrada more in the area of ecosystems lost, farmland lost, wildlife lost, economic tree lost, flooding, etc which were adverse, long term and irreversible. Port Harcourt and Choba which were urban areas recorded very high impacts of the road construction in the area of damage to houses, road traffic, population density, local economy, and alternative water supply, loss of privacy, resettlement, education, health and housing services.

Table 2: Impact Scores of Impact Levels in the Communities

No	Item	Port-Har.	Choba	Emohua	Elibrada	Rumuji	Elele	Ahoada
1	Damage to housing	VH	VH	H	L	VH	VH	VH
2	Lose of economic trees	L	L	L	L	H	H	H
3	Lose of privacy	VH	H	L	L	H	H	H
4	Lose of access roads/footpath, etc	L	L	L	L	H	H	H
5	Ecological wild life	L	L	L	H	H	H	H
6	Spread of noxious weed	H	H	H	H	H	H	H
7	Separation of communities	L	L	L	L	L	L	L

8	Forced migration	H	H	H	L	H	H	H
9	Lose of farmland	L	L	L	H	H	H	H
10	Lose of livestock	L	L	L	L	H	H	L
11	Disease outbreak	N	N	N	N	N	N	N
12	Flooding	VH	VH	H	H	H	H	H
13	Auto accident	H	H	H	L	H	H	H
14	Crime rate	VH	H	H	H	H	H	H
15	Road traffic	VH	VH	H	L	L	L	L
16	Air Quality	H	H	H	H	H	H	H
17	Land use change	VH	VH	H	H	H	H	H
18	Water quality	L	L	L	L	L	L	L
19	Population density	VH	H	H	L	L	H	H
20	Tourism	N	N	N	N	N	N	N
21	Employment generation	L	L	L	L	L	L	L
22	Local economy	VH	VH	H	H	H	H	H
23	Alternative water supply	VH	H	H	L	L	H	H
24	Education services	VH	VH	H	L	H	H	H
25	Health services	VH	VH	H	L	H	H	H
26	Housing	VH	VH	H	H	H	H	H
27	Community structure	L	L	L	L	L	L	L
28	Resettlement	VH	VH	H	L	H	H	H
		Port-Har.	**Choba**	**Emohua**	**Elibrada**	**Rumuji**	**Elele**	**Ahoada**

Key

VH V. High **L Low**
H High **N Not Applicable**

3.3 Road Construction Adverse Impact and Enhancement Measures

Enhancement is the net-benefit or new-benefit of the natural heritage interest of a site or area along the road for improved management of new habitats or features. The East-West road construction project had resulted to adverse ecological effects on existing habitats that may be difficult to mitigate, there was loss of an important land in form of burrow-pit site and the road was able to cause roadside erosion and flooding (Plates 1 and 2). The surface water was not properly channeled to discharge into burrow-pits and excavated top soils were not used to reclaim existing burrow-pits during road construction. The losses and the benefits were not weighed as separate issues. Likewise, a competent authority was not in place to weigh the significance of harm to the natural heritage perhaps with enhancement of other environmental conditions.

Plate 1: Road Construction Burrow-pit Induced Erosion Site along Elele Segment of the Road

Plate 2: East-West Road Construction Induced Flooding and Traffic Site at Choba

The distribution and removal of plants and animals, accumulation of contaminants in biological materials and sub-lethal effects of plants and animals brought about changes in population, productivity, composition of plants and animals, communities and habitats as well as alteration of landscape, aesthetic values and their effects on amenity. The survey indicated poor implementation of EIA regulations, unmonitored projects, unmitigated negative impacts, unenhanced positive impacts as well as non-inclusion of affected communities in the social impact assessment program. Impact of road construction projects should be conducted in phases from pre-operational, operational and post-operational phases [19] [20].

3.4 Spatial Effects of the East-West Road Construction

In Figure 4, East-West road passes through Choba, Rumuokoro, Rumudora, Rumukwurushi, Elelenwo, Rumuogba, Eliozu, Rumumasi communities, etc. There are link roads such as NTA, Ikwere, Eliozu, Port-Harcourt/Aba Epresss, Eneka in Obio/Akpor which the East-West road passes to Eleme LGA. These settlements and link roads are influenced by the East-West Road construction project.

The connectivity of East-West road to major Port Harcourt internal roads such as Ikwere Road, PH-Aba Express road, PH-Igwurita road at Rumuokoro round-about junction has significant control of the city traffic. East-West road supplies Port Harcourt a great deal of vehicular volume, therefore affects the inflow and outflow of goods and passengers into the city.

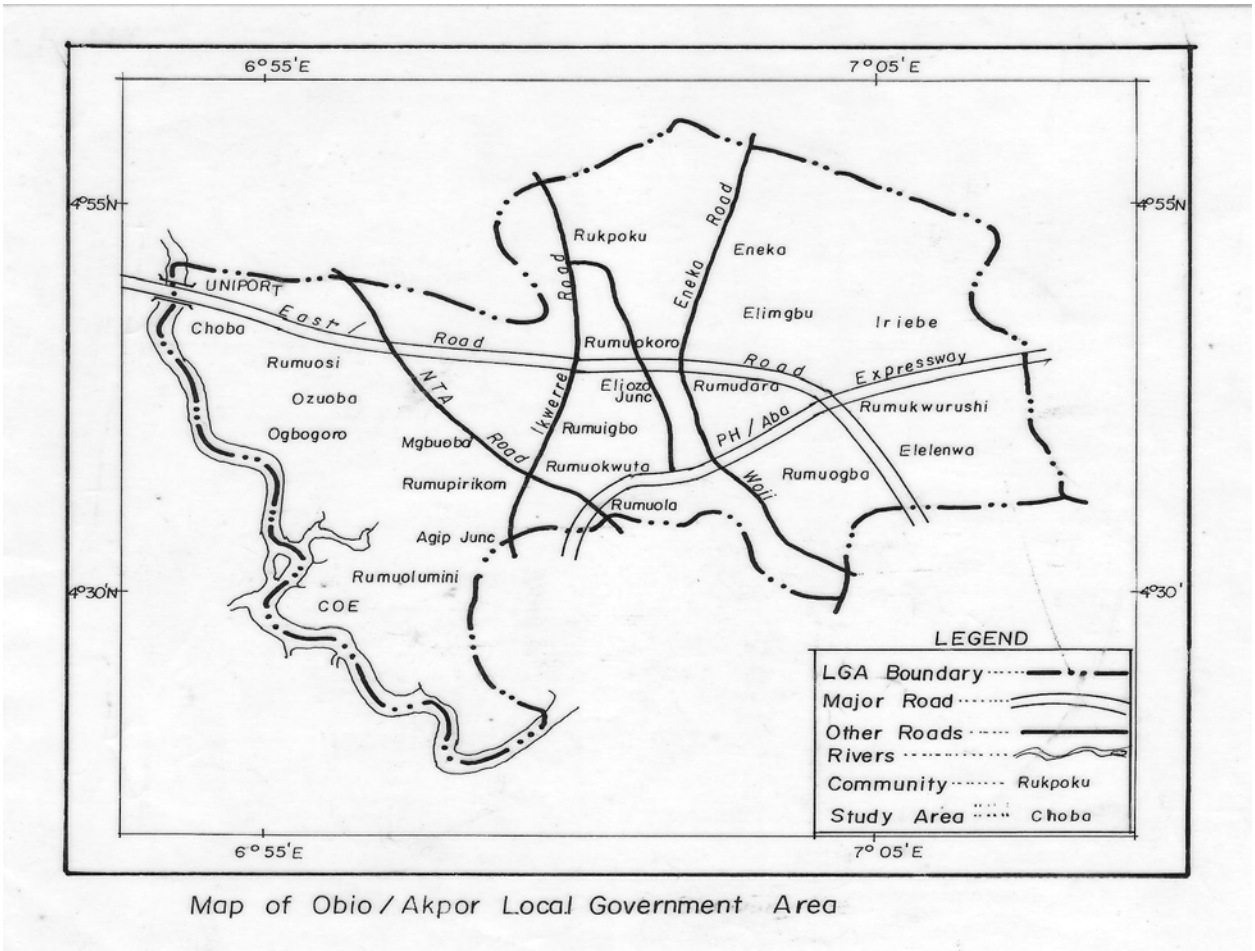
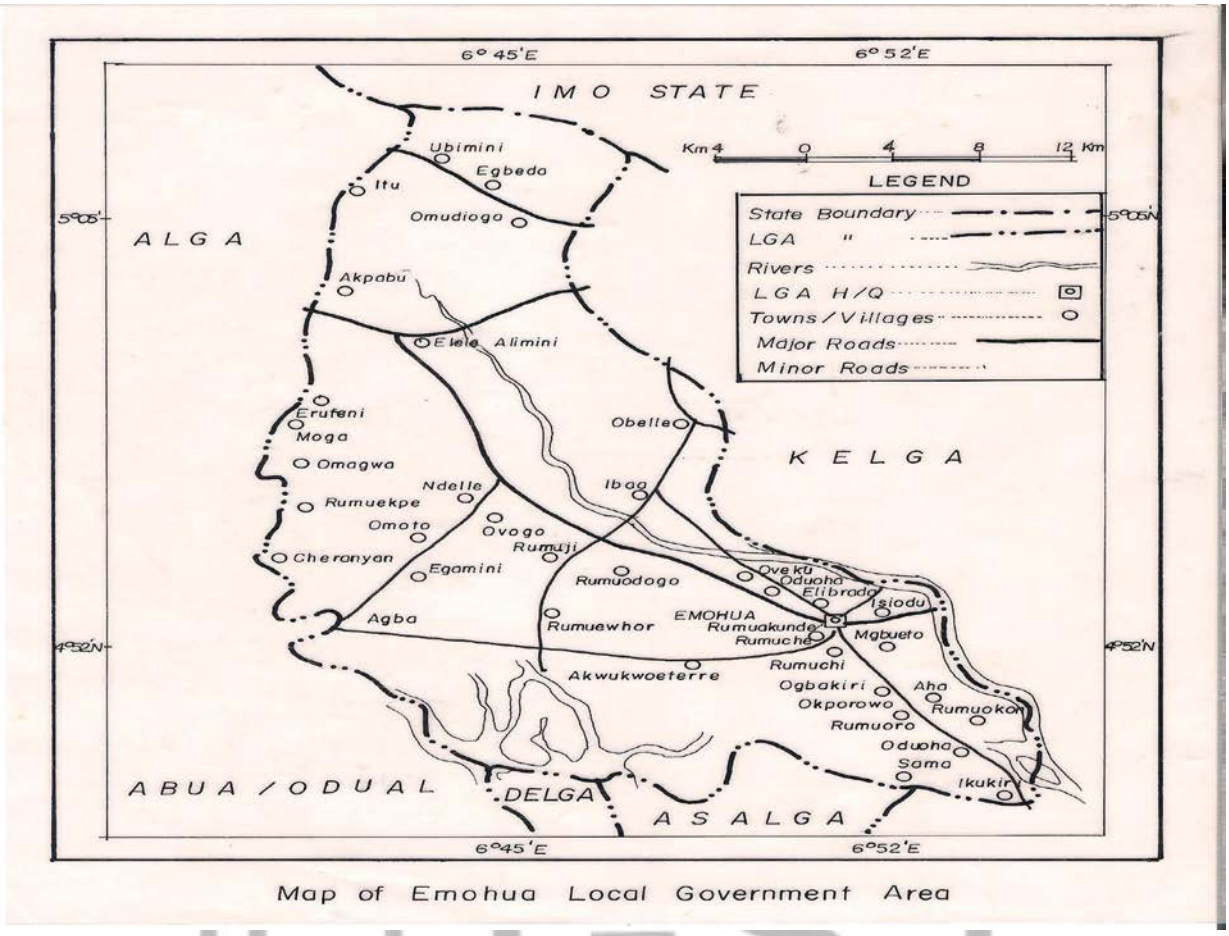


Figure 4: Settlements Impacted by East-West Road in Obio/Akpor LGA

In Emohua LGA, East-West road supports socio-economic activities such as trading, housing etc along the settlement route of Elele-alimini, Rumuji, Ndele, Ovogo, Emohua, Rumuokunde, Isiodu, Rumuche, etc. Emohua town is the LGA administrative headquarters where other surrounding communities are linked. Emohua is central town along the East-West route which link roads to interior communities of the LGA, such as Agba-Ndele, Ekwukwoeterre-Rumuenwor-Rumuodogo-Obelle road; Ikukiri-Mgbuero, Ibaa, Oveku roads, etc. East-West Road cuts across the Choba River in Emohua LGA which serves the purpose of fishing and sand quarrying as well as navigation for the local people. The network of link roads to East-West road is an indication of its importance in the LGA as in Figure 5.

It is observed that settlements at the centre is nucleated and spread linearly to the periphery along road transport routes. Most farmlands have been converted to built-up areas. Ideally, most commercial landuses are located along intersection of roads and along transport routes.



Map of Emohua Local Government Area

Figure 5: East-West Road and Impacted Communities in Emohua LGA

Ahoada East LGA has few settlements along the East-West route. These are Ula-ikata, Ihuike, Ahoada (Figure 6). There exist some settlements linked with roads that extend to the East-West road such as Abua-Ahoada Road, Ahoada-Omoku Road, Ekpene-Odieke Road and Ihubuluku-Ulakpata road respectively. East-West road cut across the Orashi River in Ahoada East LGA. The long stretched Orashi River encourages fishing and quarrying economic activities patronized by road users of East-West road.

The change in landuse, spread of settlement and built-up areas along transport routes is as a result of improved road transport for easy accessibility into undeveloped plots. The economic activities taking place in the communities are brought about by improved mobility of people and goods initiated by road transport facility.

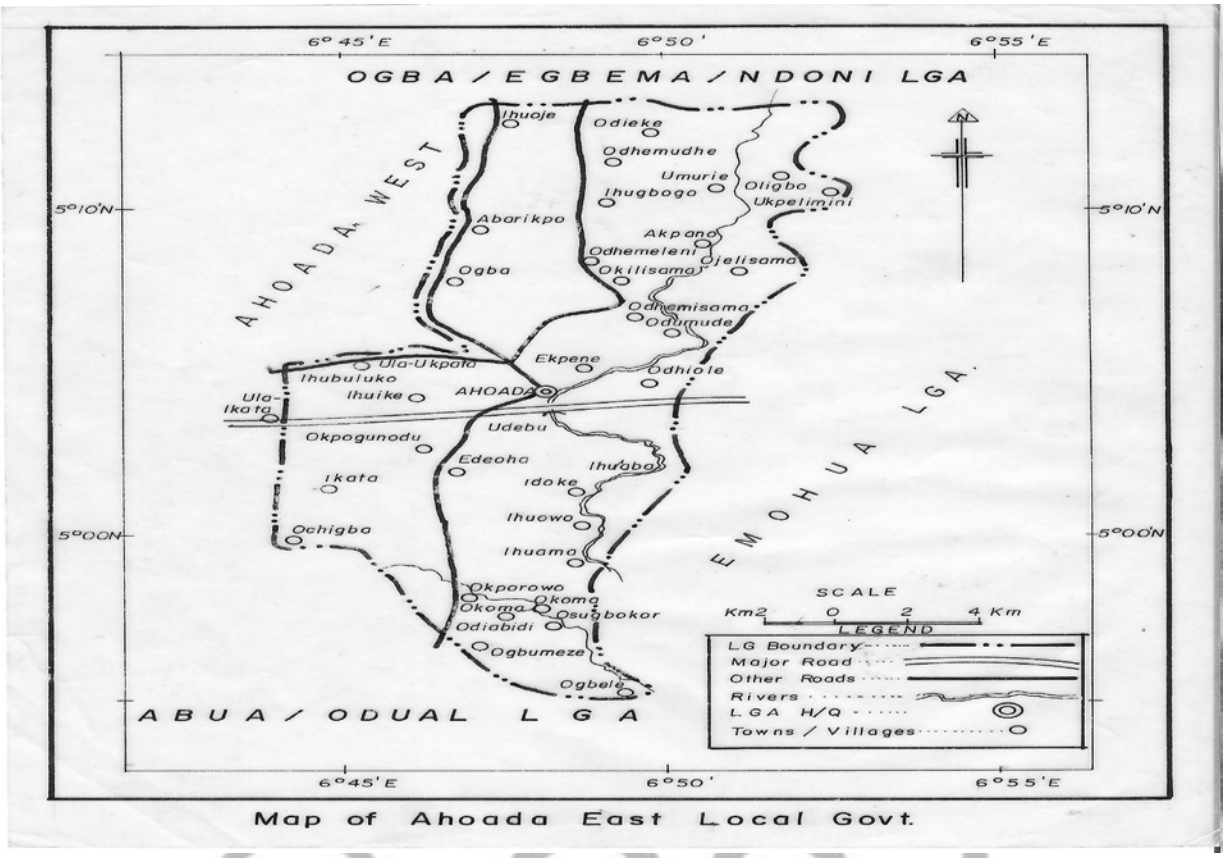
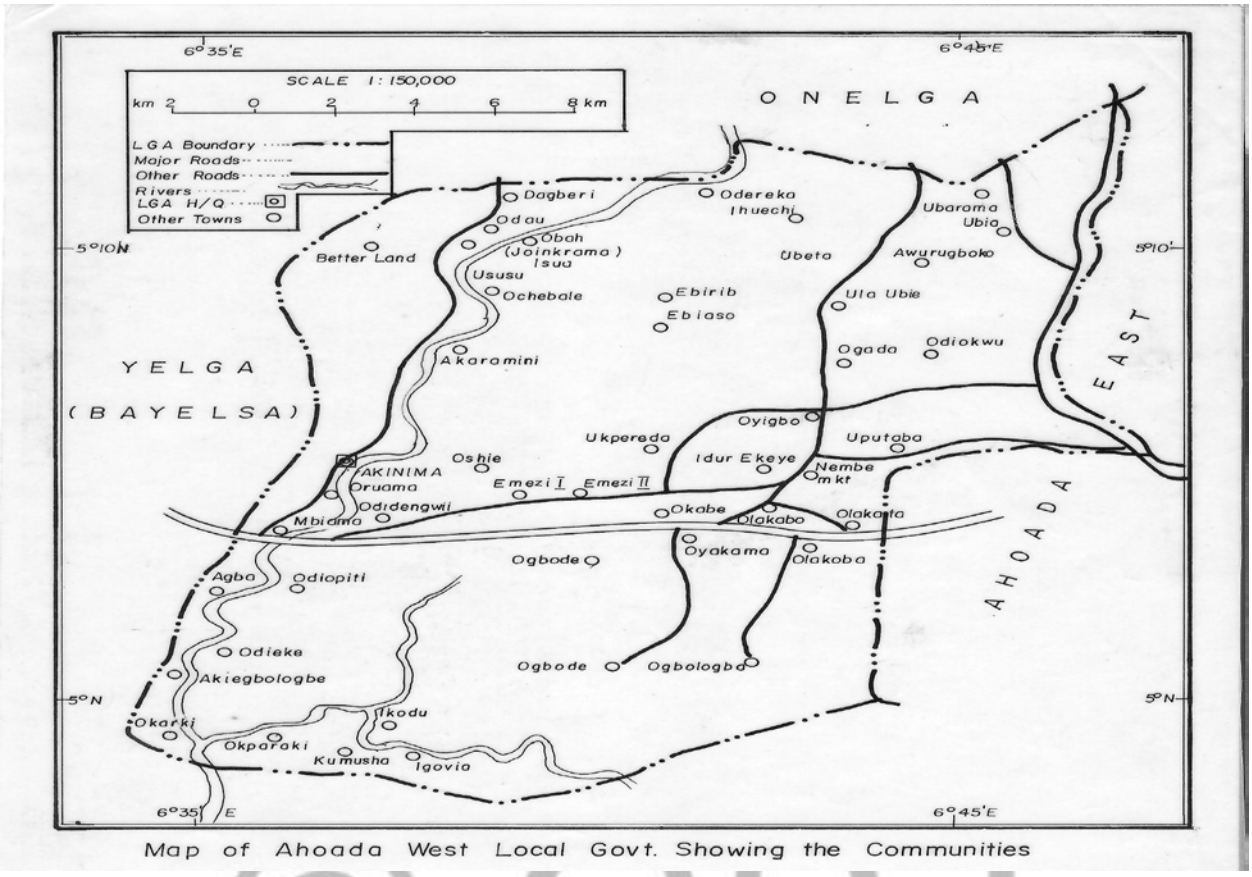


Figure 6: Settlements Impacted by East-West Road in Ahoada East LGA

However, Figure 7 shows the settlement distribution and road linkages to the East-West road in Ahoada West LGA. Although few settlements are directly traversed by the East-West road in the LGA. These are Mbiama, Odidegwu, Okobe, Ulakaba, and Olokanta. Some roads linking the settlements, discharge goods and people in the LGA through Nembe-Mbiama Road, Ubarama-Olokobo Road, Mbiama-Dagberi Road, Ogboda-Oyakan Road, Ogbalogba-Olakaba Road, etc. East-West Road cut across Mbiama River in the LGA. The outward development of areas along transport routes such as the Mbiama River and East-West road shows that the development of an area takes place along transport routes.



Map of Ahoada West Local Govt. Showing the Communities

Figure 7: Settlements Impacted by East-West Road in Ahoada West LGA

3.5 Policy Implications and Recommendations

The ultimate goal of road construction is to protect the spatial environment and people. Spatial impact should be conducted first before project design and implementation. Monitoring and compliance of project should cover the pre-construction, construction and post-construction phases. Rural communities with greatest forest lost such as Elibrada, Emohua and Rumuiji were prone to serious ecological and soil degradation as a result of the road construction. In such situation bulldozers should be used in the forested areas with less than 1:3 ground slopes, while excavators should be preferred when the slope is greater 1:3. Operator of bulldozer should be well trained to improve the efficiency of construction activity, regarding economic and environmental aspects.

Field observations and visits indicated that used materials and facilities were abandoned in some segments of the road after road construction especially those facilities close to Choba community due to the Choba bridge construction. Degraded sites during road construction have to be restored to their previous conditions. Structures setup for the duration of the work, such as drainage ditches, concrete slabs for storing hazardous material or refuse pits have to be demolished after use. Machinery and used parts (batteries, tyres, spark plugs, filter, etc) should be removed. Samples of burrow-pits were scattered at Elele, Ahoada, Rumuiji, Choba and Port Harcourt along the East-West road where construction company quarried laterites used for surface filling of the road should be rehabilitated with considerations being given to their specific requirements in terms of rainfall and hydrographs. In areas of heavy rainfall, natural run-off channels should be re-established. And large-scale replanting of appropriate species should be organized with existing flora and fauna being protected. From field observations, during top soil excavation, trees were massively fallen and abandoned without being used by community people and

site based camps were situated in environmentally sensitive areas such as forest reserves. It is pertinent that trees may not be fallen unless appropriately necessary and if it is impossible to avoid deforestation operations, tree trunks be cut off to local populations. Site-team base camps should not be set-up in protected environments such as reserves or parks.

From field visits and data generated, two recurring problems linked to road construction are degradation and pollution. To limit these, the directives require servicing, toxic-material storage and site machinery washing areas should be concrete. There should be systematic sprinkling of roads, work areas and crushing sites to reduce the amount of airborne dust. To limit erosion risks, embankments, trenches and outfalls should be strengthened. Repair, maintenance or construction of road communication routes are also an opportunity to improve the way of life of the people living in the immediate neighborhood – access routes to dwelling and water supply points are improved, parking and trading areas are created.

To follow the process of spatial impact of road construction for community participation and involvement in the road construction project, unskilled labor is recruited predominantly locally, from among the population affected by the road project. Moreover, implementing a number of measures during all three stages of road construction process (planning, construction and maintenance) can reduce the environmental impact of road building. In general careful route selection, avoidance of unnecessary earthmoving and construction of an effective drainage systems yield the best results. Road-bank revegetation and regular maintenance are also crucial to good environmental performance.

4. Conclusion

Impact of road construction has been identified as constituting a lot of changes to the spatial environment, livelihood of community people and economy of road users. Therefore, quick actions are really needed to implement the recommendations of this study and minimize the problems associated with these changes without further delay especially on the East-West road construction of Rivers State in Nigeria. A full scale Environmental Impact Assessment (EIA) would save the spatial environment of man from adverse effects of construction projects for sustainable development.

Authors hereby declare that there is no conflict of interests therefor this manuscript be published.

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