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ASSESSMENT OF THE EFFECT OF PLASTER SAND EXCAVATION ON PHYSICAL ENVIRONMENT IN MAKURDI TOWN, BENUE STATE, NIGERIA

Benjamin Sunday Agule[*1], Peter Anule[*2], Peverga Daniel Dam[*3], Msughter Gyanggyang Ierve[*4], Achagh Vambe[*5], Aondona Dzer[*6]

[*1,2,3,4,5,6]Department Of Geography, Faculty Of Environmental Science, Benue State University, Makurdi, Benue State, Nigeria.

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ABSTRACT

The study assessed the effects of plaster sand excavation on the physical environment of Makurdi Town, Benue State, Nigeria. The research adopted a multi-stage sampling method. Judgment sampling technique was used to select sites of sand excavation for measurement. Simple random sampling was used to collect data on the effects of sand excavation, and structured interviews for residents 500m close to the excavation sites. A total of 100 respondents were randomly interviewed. The study strongly agrees that sand excavation is the cause of pollution in the study area with a mean of 3.59, the study revealed that sand excavation is helping in building and construction with a mean of 3.75 also, sand excavation is a cause of Soil Erosion in the study area with the mean of 3.13. Sand excavation is the cause of deforestation in the study area with a mean of 3.18, sand excavation rendered some places not habitable in the study area with a mean of 3.27, sand excavation is destroying farmlands in the study area with a mean of 3.36, sand Excavation is destroying ecosystem with the mean of 2.7, sand excavation is causing water scarcity in the study area with the mean of 2.74.sand excavation is causing soil deterioration in the study area with a mean of 3.05. The researcher observed that plaster sand excavation is taking over some farmlands, forest/vegetation and habitable areas. Affecting/causing erosion, pollution and destroying the ecosystem in the study area. The study concludes that the current practices at plaster sand excavation sites are causing significant pollution, deforestation, and land degradation. The study recommended individuals, government and non-governmental organization to implement measures of mitigating soil erosion caused by plaster sand excavation, such as re-vegetation of mined areas, terracing, or erosion control structures, measures to prevent soil deterioration resulting from sand mining, such as soil conservation practices and land rehabilitation efforts. Regulations to mitigate pollution caused by sand excavation, such as promoting cleaner extraction techniques.

Keywords: Plaster Sand Mining; Land Degradation; Pollution; Deforestation; Soil Erosion; Ecosystem Destruction.

I. INTRODUCTION

The world is increasingly becoming urban. Developing nations are striving to become developed and consequently engage in processes such as improved socioeconomic activities, social services, infrastructural development and provision of basic amenities (such as housing, water, electricity and others). Nigeria, with its estimated 16 million housing deficit and infrastructural development, faces a high demand for sand and other construction materials (Atejioye & Odeyemi, 2018). Makurdi Town, experiencing rapid population growth and physical expansion since the 1990s, especially due to the establishment of Benue State University, is a prime example of this increasing demand. This has resulted in an influx of people from different parts of the country. It has therefore become imperative to provide adequate housing and infrastructure for the teeming increasing population (Ikyernum, 2018).

Draggan (2008) reported that sand mining and gravel extraction are a worldwide activity in both developed and developing countries. Globally, many people are increasingly being influenced into sand mining on daily basis (Robert, 2014). This trend of mass movement of people into sand mining has become a major concern for people living in the sand mining fringe communities (Saviour, 2012). However, all the efforts by various governments in curbing this phenomenon have not been very successful; due to the benefits associated with sand mining and other factors (Kusum, 2015). Unfortunately, the extensive use of sand and the increase in mining activities have negative environmental impacts on both the local and global levels (Huang et al. 2018),

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and urgent measures are needed to limit the effects. Leal et al (2021). The environmental consequences vary, in part, depending on where sand is mined and sourced.

Environmental impacts of sand mining are well documented in the form of waste management, impacts on biodiversity and habitat, deforestation of land with the consequent elimination of the vegetation, pollution (water, air, land and even noise pollution), (Abdus-Saleque, 2008).

In Nigeria and many other tropical areas, sand excavation is a major cause of deforestation and forest degeneration, generating a large number of environmental impacts (World Rainforest Movement, 2004). It is noted that large-scale mining activities generally continue to reduce the vegetation of most of the mining communities to levels that are destructive to biological diversity (Akabzaa, 2000). Davis and Tilton (2005) also noticed that local communities tend to bear the negative impacts of mining be it social, economic or environmental. It is therefore important to make efforts to reduce these problems through informed decision-making. However, making informed decision in many areas including monitoring sand excavation activities often involves complicated processes for optimal decision making. Information from various sources is required such as spatial information, which is essential to address activities of sand excavation and their impacts on the environment (Burrough and McDonnell, 2002).

The major problems associated with sand excavation include wrong channelization of the river channel, destruction of the riparian vegetation, degradation of the natural environment, impact on biodiversity, pollution of all kinds, deforestation, erosion along the valley side slopes and disturbance of underground water and coastal sand causing turbidity in the water, which is harmful to organisms. Sand excavation causes removal of physical coastal barriers such as dunes thereby leading to flooding of beachside, buildings (Abdus-Saleque, 2008).

The extraction of plaster sand for construction purposes has led to widespread deforestation, soil erosion, and the creation of deep pits that pose serious environmental and safety risks. These adverse effects are exacerbated by the rapid urbanization and population growth in the region, further emphasizing the urgent need for sustainable sand mining practices and effective environmental management strategies.

The amount of knowledge or foresight of the potential for sand excavation as an important resource and means to physical and socio-economic growth may also be a determinant of the extent of utilization of the sand. In this regard, questions to answer are thus; How do people perceive the plaster sand excavation; is this the best possible way to excavate plaster sand in Makurdi? If not, what other possible methods can be reintroduced into the area to make it a more desirable and economically viable on sand excavation? It is against this background that this study will assess these effects and find possible ways to address the problem of sand excavation in Makurdi town.

II. METHODOLOGY

Study area

Geographically, according to Tyubee (2021) Makurdi Town is located between latitudes 7o 35'- 7o 53'N and longitudes 8o 24'- 8o 42' E in Benue State, North central Nigeria, and covers a land area of 800km2.The town is bounded by Guma local Government Area in the North and North East, Gwer-east in the South, Gwer-west in the west and Nasarawa State in the North West. Makurdi town is a major link between the Northern and Southern part of Nigeria. The river Benue which is the second largest river in the country bisects the town into two parts of North and South banks. Makurdi town plays the double role of being a state headquarters and at the same time, a local government headquarters. Figure 1 is the map of Makurdi town.

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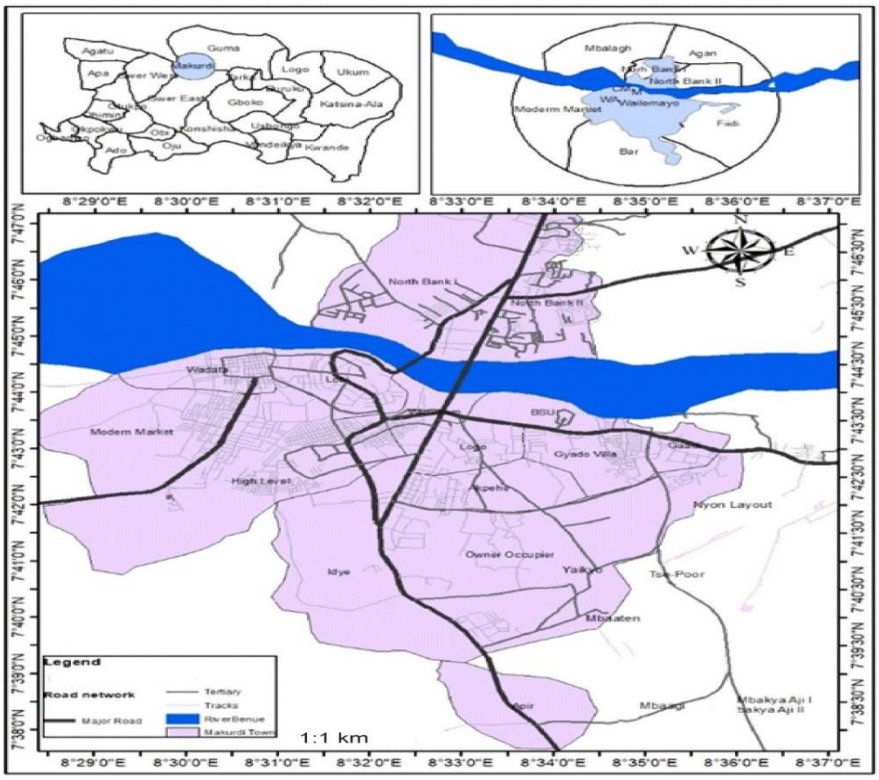

Figure 1: Makurdi Town.

Source: Geographic Information System (GIS) Laboratory, Benue State University, Makurdi (2024).

Makurdi town by its geographical location falls within the tropical humid and mega thermal wet and dry climate with two distinct seasons, designated 'Aw' Climate of the Koppens classification (1939). Temperature condition of Makurdi town is usually high throughout the year with daily range between 23°C. Three temperature periods are experienced in Makurdi (Tyubee, 2005). These include:

a. The cool dry season, November to January (during the time of low sun).

b. The hot dry season, February to April (just preceding the rains).

c. The hot wet season, May to October (during the rains).

Makurdi is located within the grassland (Guinea Savannah) region of the country, the transition belt between the tropical rain forest and the grassland of the north. Some of the dominant trees includes; Khayasene galensis (mahogany), Daniellia oliveru (soft timber or chiha), Parkabi globosa(Locus bean tree), Amaliaor borea (Gmellia). Some of the dominant grasses include; Pennissetum purpureum (elephant grass), Andropogon gayamus (northern Gamber Grasses) and Penicum maximum (Guinea grass) and Cynodon plectostachyus (Giant Star Grass) among others.

Makurdi is located entirely in the Benue plain. Sandstones of Sedimentary formation generally underlie Makurdi town. These rocks occur throughout the Benue valley as a result of cretaceous sedimentation during the tertiary and quaternary periods (Iorkua et al, 2019). In the North bank and other elevated areas, the influence of parent materials (sandstone) on soil properties is evident in extremely low areas; the influence is negligible due to accumulation of alluvial deposits during seasonal flooding of river Benue.

Makurdi town, according to the National Population Commission (2006) has a total population of 300,377 persons with a population density of about 376 persons per square Kilometre (National Bureau of Statistics, 2017) with an annual growth rate of 3.2 %. Therefore, using the formula given below, we can ascertain the current population in the town.

$P(t)=P_0\times(1+r)^t$

Where:

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P(t) = Population at time t

P0= Initial population (2006 population in this case)

r = Growth rate (as a decimal)

t = Time (in years)

Given:

P0=300,377

r=3.2%=0.032 (converted to decimal)

We can plug these values into the formula and calculate the population for each year from 2006 to 2024.

$P(2024)=300,377\times (1+0.032)^{2024-2006}$

$P(2024)=300,377\times(1.032)^{18}$

$P(2024) =300,377\times (2.2197)$

$P(2024)\approx 666,087$

So, the projected population for 2024 would be approximately 666,087.

The population mostly comprises the Tiv as the dominant ethnic group. Other ethnic groups include Idomas, Igedes, Igalas, Igbos, Etulos, Jukuns, and Hausa. The composition of different ethnic groups in Makurdi town can be attributed chiefly to the function of migration as it is a commercial and administrative centre.

Makurdi town being the state capital is an urban centre characterised by complex division of labour. The socio-economic activities in the town include; civil service duties, welding, tailoring, carpentry, motor mechanics, building and construction work, fishing (by the jukuns), sand excavation in the river, block industries, furniture making, restaurants, road transport business, filling stations, trading, those selling in the various markets within the town. The socio-economic base of Makurdi comprises several markets. These include Modern Market, which is the biggest market. Other markets include Wurukum, High level, Wadata, North bank and Makurdi international market located along George Akume Road.

Method

A direct field survey was used to enhance the comprehensiveness, accuracy, and relevance of studies on the effect of sand excavation on the physical environment of Makurdi town. Field observation allowed the researcher to directly observe, and identify the environmental effects in real-time and document them. These approaches provide valuable data for decision-making, policy development, and environmental conservation efforts.

Data needs for this research include, data on the location of the sites of sand excavation and data on the effect of sand excavation in the study area. The study utilized data from both primary and secondary sources, Primary data for the study was obtained from interviews, field observations, Data on the effects of sand excavation was also sourced into the field through the use of structured and In- Depth. Interview (IDI). Secondary data for the study included population data from the National Population Commission (NPC), topographical maps of the study area from the Benue State Ministry of Lands and Survey, academic journals, online publications, unpublished dissertations, and publications from agencies.

The study population for the study comprised all sand excavation sites which are sources of plaster sand in Makurdi town, as well as residents of Makurdi. The study took cognizance of major, functional and largest sand excavation sites in Tse Poor, Mbakya Aji, Mbaagi, Mbaaten, NKST Yaikyo, and Nyon Layout areas in Makurdi town, Makurdi, Benue State, Nigeria, and the residents in those settlements within 500m radius of the sites due to their proximity to the excavation sites. In Tse Poor and Mbakya Aji, two pits each were identified. A total of eight (8) pits were identified for the study. Pits were not just counted in their numbers, rather, the major and largest sites were the basis of consideration. An estimated population of 1,000 residents living within a 500-metre radius of the excavation sites in the study area was adopted because the actual population of close residents is not known.

The study adopted a multi-stage sampling method. Sampling procedures were adopted at each stage and where suitable and applicable. Judgment (Purposive) sampling technique was used to select sites of plaster sand excavation for measurement. Eight (8) pits of plaster sand excavation in Makurdi town were selected due to

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their sizes, functionality, and where extensive excavation has occurred. The study administered interview designed for the study to 10% of the estimated study population within a 500-metre radius of the excavation sites, which is consistent with Udofia (2018). Questionnaires were shared equally amongst the sites, however, Tse-Poor Pit 1 and NKST Yaikyo had a slightly higher number of respondents as both pits are the largest in depth and width, while Nyon Layout recorded fewer respondents as the pit is no longer active.

A simple random sampling technique was used to select respondents for the study. This was to ensure that every member of the estimated population of residents within the 500m radius of excavation sites in the study area had an equal chance of being selected. In doing this, all the names of the household heads identified were put in a container thoroughly folded and mixed up. The researcher thereafter, pulled out slips from the container one after the other, until a total of 100 slips, as in Udofia (2018), were pulled out from the container.

Table 1: Number of Interviewees in the Excavation Sites.

S/NO.	EXCAVATION SITES	NO. OF INTERVIEWEES
1	Tse-Poor 1	15
2	Tse-Poor 2	12
3	MbakyaAji pit, 1	12
4	MbakyaAji pit 2	12
5	Mbaagi pit	12
6	Mbaaten	12
7	NKST Yaikyo	15
8	Nyon Layout	10
TOTAL		**100**

A simple random sampling technique was used to select respondents for the in-depth interview of the study. This was to ensure that every member of the estimated population of residents in the study area had an equal chance of being selected.

The method of data collection used in this study involved a combination of structured questionnaires and geospatial analysis. The structured questionnaire was employed as a key method of data collection to systematically gather quantitative and qualitative information from respondents within the sand excavation sites. The structured questionnaires were administered to residents within a 500-metre radius of sand excavation sites to collect information on the effect of sand excavation. The questionnaire consisted of closed and open-ended questions, which allowed for the quantification of responses and facilitated statistical analysis. By using a structured format, the questionnaire ensured consistency in data collection across all respondents, enhancing the reliability and comparability of the data. The information obtained through this method was crucial for understanding the effect of sand excavation on the physical environment in the study area.

Precise spatial mapping of sand excavation sites within the study area was facilitated through the use of Global Positioning System (GPS) coordinates.

III. RESULTS AND DISCUSSION

The results and discussion may be combined into a common section or obtainable separately. They may also be broken into subsets with short, revealing captions. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. This section should be typed in character size 10pt Times New Roman.

Spatial Distribution of Plaster Sand Excavation Sites in Makurdi Town

In Makurdi town, there are no permanent sites for plaster sand excavation. The expansion of the town is the determinant of these sites of sand excavation as the soil is predominantly hydromorphic soil. The first and early sites of plaster sand excavation in Makurdi town have been developed or turned into houses and roads. Nevertheless, plaster sand excavation sites still exist in Makurdi town and six (6) are active while two (2) are

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inactive but the pits exist with physical effects on the Makurdi environment. The distribution of the current sites of plaster sand excavation (2) is clustered as determined by the Nearest Neighbor Analysis decision of Rn = 0.71 and found in the southern part of Makurdi Town due to the presence of hydromorphic soil which is good for plastering and other building construction works. These places also represent the underdeveloped segment of the Town.

Table 2: Plaster Sand Excavation Sites in Makurdi Town.

S/No	Names/Description	Latitude	Longitude	Status
1	Tse Poor Pit 1	7.6762520	8.5822480	Active
2	Tse Poor Pit 2	7.677160	8.5825530	Active
3	MbakyaAji Pit 1	7.6389920	8.5982070	Active
4	MbakyaAji Pit 2	7.638220	8.5963330	Inactive
5	Mbaagi pit	7.6373120	8.5808180	Active
6	Mbaaten pit	7.6631390	8.5708740	Active
7	Opposite NKST Yaikyo	7.677490	8.5666020	Active
8	Nyon Layout pit	7.6968260	8.5902430	Inactive

Source: Author's Fieldwork, 2023.

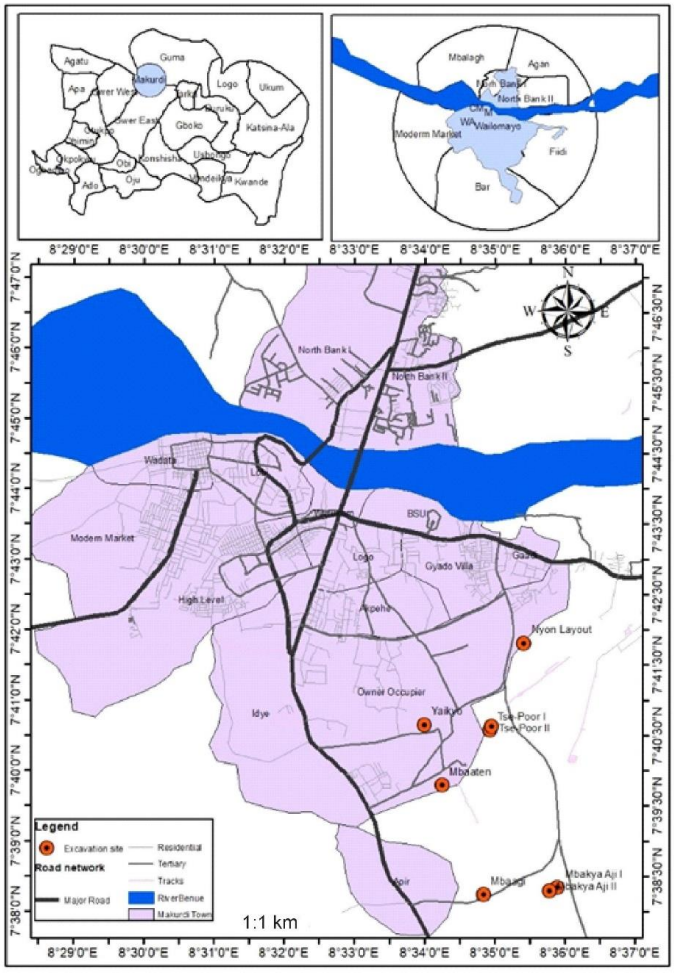

Figure 2: Location of sand excavation sites in Makurdi Town

Source: Geographic Information System (GIS) Laboratory, Benue State University, Makurdi (2024).

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Effects of Sand Mining on the Surrounding Environment

In order to ascertain the environmental effects of sand excavation in the sand excavation sites, further enquiry was made using a questionnaire. The result of the interview conducted to complement the field measurement done is analysed in this section. The result is presented in Table 4.

Table 3: Effects of Sand Mining on the Surrounding Environment

Effects	Rating				$\overline{X}$	Decision
	4	3	2	1		
Sand excavation is a cause of soil erosion in the study area.	27	61	10	2	3.13	Agree
Sand excavation is the cause of deforestation in the study area.	32	61	1	6	3.18	Agree
Sand excavation rendered some places not habitable in the study area.	62	22	2	9	3.27	Agree
Sand excavation is causing soil deterioration in the study area	27	61	2	10	3.05	Agree
Sand excavation is the cause of pollution in the study area.	71	24	0	3	3.59	Strongly agree
Sand excavation is destroying farmlands in the study area.	50	43	0	7	3.36	Agree
Sand excavation is destroying ecosystem.	23	54	2	12	2.7	Agree
Sand excavation is causing water scarcity in the study area.	30	35	14	21	2.74	Agree

Source: Researcher's fieldwork 2023

Note: TWV=Time Weighted; X=Mean

Table 3 presents data on the effects of sand mining on the surrounding environment. The data reveals that respondents strongly agree that sand excavation is the cause of pollution in the study area with a mean of 3.59 and this agrees with the submission of Kuttipuran (2006), who reported that there is a loss of agricultural lands due to continuous movement of heavy vehicles and burning causing pollution, the study agrees that sand excavation is helping in the building and construction with the mean of 3.75 and this aligned with the findings of Pereira (2012) who asserts that sand is important in construction and manufacturing industries. Respondents also agree that sand excavation is a cause of soil erosion in the study area with a mean of 3.13. This finding corroborates the position of Lupande (2012) who identified soil erosion as one of the effects of sand mining. Sand excavation is the cause of deforestation in the study area nwith a mean of 3.18, sand excavation rendered some places not habitable in the study area with a mean of 3.27, sand excavation is destroying farmlands in the study area with a mean of 3.36, sand Excavation is destroying ecosystem with the mean of 2.7, sand excavation is causing water scarcity in the study area with the mean of 2.74. This result corroborates those of Bagcchi (2010) and Lawal (2012) who identified water contamination as a major effect of sand mining on the environment. The respondents also agree that sand excavation is causing soil deterioration in the study area with a mean of 3.05. The plates show the effects of sand excavation on the environment.

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Figure 3: Evidence of sand excavation causing deforestation at Tse Poor

Figure 4: Evidence of sand excavation causing deforestation at Yaikyo

Figure 5: Evidence of sand excavation on building at Tse Poor.

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Figure 6: Sand excavation causing erosion at Yaikyo.

Figure 7: Excavators Loading Plaster Sand at Tse Poor Pit 2.

Figure 8: Tipper taking sand after loading at Mbaaten Pit.

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IV. CONCLUSION

Based on the findings of the study, the study concludes that the current practices at plaster sand excavation sites are causing significant pollution, deforestation, and land degradation, making the affected areas unsuitable for habitation. Without intervention to regulate excessive removal and enforce refilling measures, the safety of Makurdi Town residents could be compromised. Despite the adverse environmental effects, sand mining remains a source of revenue for those involved in the business.

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