FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 4, August, 2023, pp 317 - 331
DOI: https://doi.org/10.33003/fjs-2023-0704-1940

INTERROGATING THE EFFECTS OF SAND MINING: A CASE STUDY OF AGILA DISTRICT, ADO LOCAL GOVERNMENT AREA, BENUE STATE, NIGERIA

[*1]Mu'awiya, Baba Aminu, [2]Kabiru, Garba Ilelah, [1]Simon, Dalom Christopher, [1]Changde, Andrew Nanfa, [3]Andarawus, Yohanna, [3]Nengak, Musa, [3]Frankie Ojo Balogun, [4]Ahmad Tijjani Dahiru, [+10]Bertha Onyenachi Akagbue, [6]Simon, Tobias, [++11]Oseigbovo, Favour Ofure, [7]Francisco Soki Paca, [8]Pam Dajack Dung, [9]Sadiq Mohammed Salisu, [5]Mansur Sulaiman

[1]Department of Geology, Faculty of Sciences, Federal University Lokoja, Kogi State, Nigeria
[2]Department of Environmental Management Technology, Faculty of Environmental Technology. Abubakar Tafawa Balewa University Bauchi. Bauchi State Nigeria.
[3]Department of Geology, Faculty of Sciences, Federal University Lafia, Nasarawa State, Nigeria.
[4]Department of Geology, School of Science, Zamfara College of Arts and Science, Gusau, Zamfara State, Nigeria.
[5]Department of Physical Planning and Development, Federal University Lokoja, Kogi State, Nigeria.
[6]National Petroleum Corporation of Namibia (Namcor) Namibia.
[7]Department: Coordenador do Curso Extrativa (Geologia de Petroleo, Soyo/Angola) Angola.
[8]Department of Geology, University of Jos, Plateau State, Nigeria.
[9]Abubakar Tafawa Balewa University Bauchi, Bauchi State, Nigeria.
[10]Department of Environmental, Health and Safety, Marshall University Huntington West Virginia USA.
[11]Department of Petroleum Engineering, Federal University of Technology, Owerri. ORCID:

*Corresponding authors' email: Muawiya.babaaminu@fulokoja.edu.ng Phone: +2349099997272
*ORCID: https://orcid.org/0000-0001-5278-153X
[+]ORCID: https://orcid.org/0009-0005-4713-5644
[++]ORCID: https://orcid.org/0009-0005-0130-2435

ABSTRACT

This study is of believe that Illegal acts and discerning sand excavation/mining has become arisk to the ambiances. While theresearchrelied on personal geological observation on the mining sites, qualitative data were used from secondary literature. Using Agila's river and coastal mining sites as a case study, the study revealed that it sparks to diversifications in river channels ways, physical ecosystem and food webs. As well it speeds up the river'scurrent and eventually eroding the river banks. Destroying the soil profile and removing the flora reduces the population of animals and eliminates habitat both the surface and subsurface resources. Sand dunes has played a vital aspect role in stoppage against heavy storms, erosion causes by some agents of transportations like winds, waves or floods. Numerous tiny habitants that are a component of the marine and coastal food chain and whose removal would pose some hazards to some other species rely on them for existence. The water tables in the surrounding areas decline as a result of sand mining, drying out the drinking water wells on the river embankments. Turbidity rises at the mining site as also the aquifers near the shore are affected by saline water intrusion. Sand mined areas loose scenic beauty, it emits radiation reliant on the component minerals, dust pollution, emits vibration/noise and it damages roads and some infrastructures. This researchinspected and reviewed the sand mining impacts on river, dune, marine, hydrological, biological and sociological environments with some case studies of the study area.

Keywords: Sand, Mining, Geological, Environrnental, Hydrology and effects, Aquifer, Turbidity, Radioactive

INTRODUCTION

Sand mining is a geological threat to environmental sustainability, yet, in Nigeria most partsof the country are currently facing the challenges of mining. Such of these mining sites are illegal or/and legal operations. In whatever form, sand mining is the act extracting and mining of sand from the subsurface. Rivers, inland dunes, and dredge from ocean beds are common mining places, as are river bottoms in deltaic settings. According to the research findings from (Juniah R. and Rahmi S. 2019), sand mining has a major impact on the long-term viability of power support and river capacity. This is owing to the fact that mining activities reduce water availability by damaging river bodies, causing sedimentation, and lowering the attributesof river water. Oluwande *et al*., (1983) published a broad assessment on the levels of pollution in certain Nigerian rivers. Based on this submission, sand extraction has a geological and environmental effect when it exceeds the normal disposition.Oluwande *et al.*, (1983) for his part, took into account the following key points regarding the effects of excavating and mining of sand from the subsea bed of the marine biological point: Squids and other benthic breeding animals with eggs attached to bottom objects would be severely harmed; if hazardous material has built up in the silt at the mining site over time, this will result in more contamination. Dredging activities generate physical disruption to the ecosystem, such as noise, which might disrupt nesting/breeding activity. According to research by Ocheli *et al.*, (2021), the geologic context, tectonic and social advancement, geotechnical attributes of soils, mining operations, agriculture, deforestation, and overgrazing activities are all widely acknowledged as major causes of gully erosion in various regions of Nigeria.As society grows and develops, sand becomes more and more important. However, prior research has shown that in-stream sand mining can negatively affect the environment, socioeconomic activities of coastal residents, and water quality. It can also degrade the channel bed and banks and danger the aquatic ecosystem's existence.(Ashraf *et al.*,2011; Ahmad *et al.*, 2012; Shaji *et al*., 2014; Tesi *et al*., 2018). The study revealed that conductivity, sediment, total suspended solids, total solids, salinity, total hardness, biological oxygen demand (BOD), and heavy metals (Cd, Cr, Cu, Pb, Mn, Ni, and Fe) excelled the World Health Organization (WHO) maximum permissible value in surface water around sand mining areas of the Warri River.

It was observed that population explosion, growing economy, unsustainable form of resource consumption is putting pressure on land, water, and other forms of natural resources (Banerjee *et al*., 2021); Sand mining provides revenues through the sale of sand commodities, skill diverseness, and employment possibilities in Nigeria, Kenya, and Ghana (Mutisya 2006; Musa 2009). Many individuals in the global South now work in the sand mining sector, according to studies (Padmalal *et al*., 2008; Akanwa and Ikegbunam 2019; Akanwa 2020; Stebbins 2006; Dagodzi 2010). According to Thomas (2003), the majority of African nations' economy are based on resource exploitation, such as san mining. Approximately 34% of Botswana's GDP was produced from sand mining.

The Borge *et al*., (2012) study did not investigate whether a specific environment's sand budget should be monitored prior to the mining of sand.Or It is important to have specific hydrologic and hydraulic information. This is an area that Borge & Freitas's (2012) did not look at and it pertinent to the demand of this paper since it is still a worry for this study to mine without creating unnecessary damage or making a negative impact to the area.

Because sand is essential for river survival, and has a sum of negative consequences on river ecosystems.No wonder, Mensah, (2017) is of the view that sand mining distracts and totally remove thesettlement from the miningareas. He claims, causes diversity in the river's channel structure, physical settlements, and food webs — the river's ecology.However, Mensah's (2017) was not structured to ascertain if it can increment the speed of flood in the river which damagecurrent system that ultimatelywashes away the river flanks. This gap in the literature is necessary to filled because studies NMFS (2018), Bruton(2015); The goal of the research is meant to investigate the geological effect of mining site on the environment especially the sand mining, based on this gap in the literature and this conceptual assumption.With the aim to interrogate if evictionand abolishing of the soil profile destroys settlements, subsurface and reduces the faunal population. particularly using selected area of case studies of mining sites in Ado Local Government Area, Benue State, Nigeria.

MATERIALS AND METHODS

The Research Method and Geographical Location

In order to justify the purpose of this study, both historical and exploratory research design approach was adopted. The essence of the historical approach is to carefully trace past events related to the research problem for the purpose of generating valid inference. While, the exploratory research design approach is to enable us to gain insight about the phenomenon (sand mining) using available documented evidence for onward analysis so as to explanatorily ascertain the justifications and side effects of the illegal mining in the study area. This paper uses both secondary sources of information/data collection and geological survey. Data analysis and presentations were also done using pictorial analysis. All the qualitative data/information generated for both the primary and secondary sources were analytically presented and relevant documents were attached.

Agila is an officially recognized community under the Ado Local Government Area of Benue State, which serves as the study's geographical setting. Ado LGA has a population of 184,389 people, according to the 2006 National Population Census (NPC, 2006). Since the census was conducted in the last nine years, the actual population of Ado LGA must have increased. The Local Government Area is located on the Benue-Ebonyi State boundary in the south-central part of the state. Additionally, it has borders with Otukpo L.G.A to the north, Oju and Okpokwu L.G. A to the east, and Okpokwu and Oju L.G. A to the west. There are two political wards in the Agila district: The Akpoge-Ogbilolo and Apa-Agila wards.

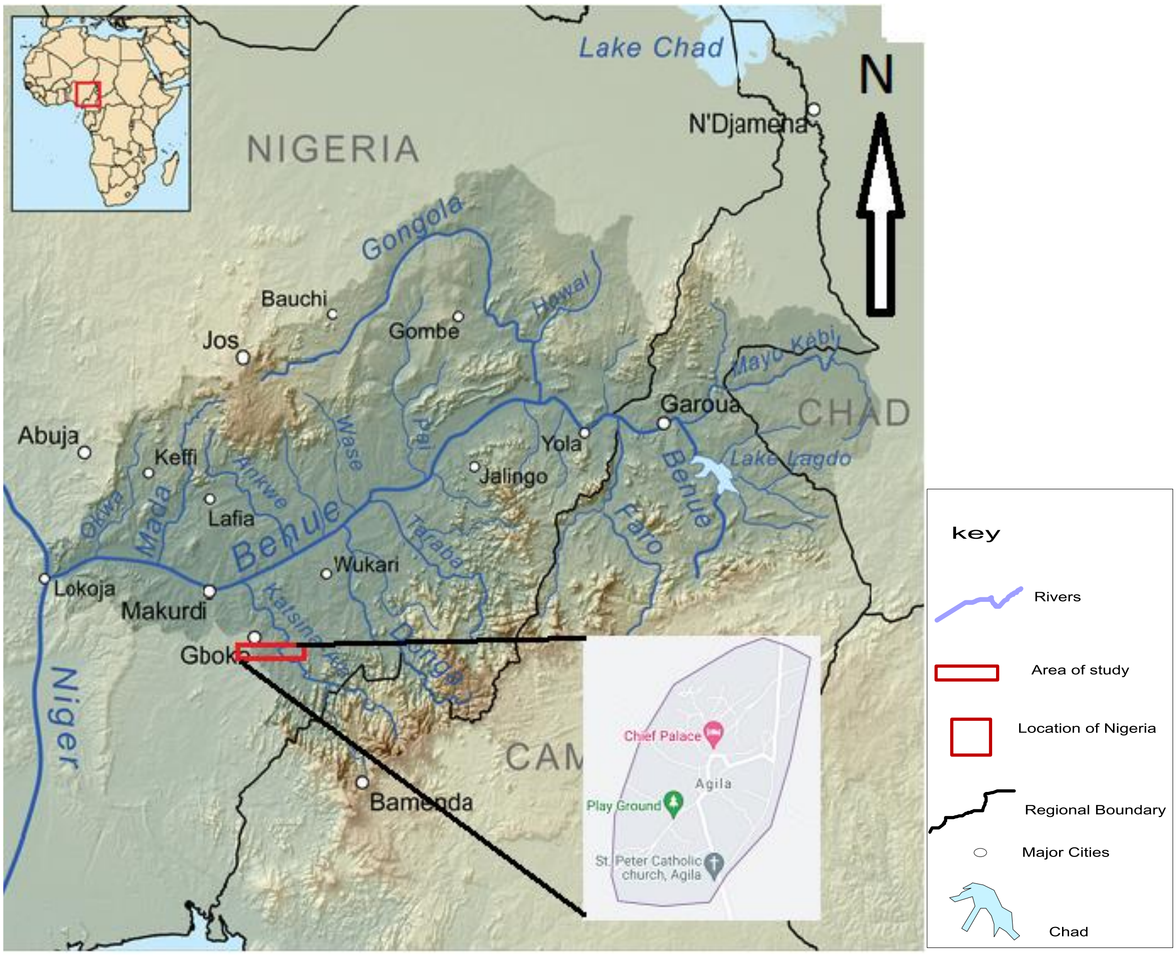

Figure 1: Geographical location: A Map of Nigeria and the areaof study (Modified after Changde et al., 2022a; Mu'awiya et al., 2023; Mu'awiya et al., 2022b).

Agila is a very unique district in Idoma land with twelve clans which are socio-culturally stratified as royal and non-royal respectively. This aged long traditional stratification is what has made Agila more unique district in Idoma land. Agila Akpege- Ogbilolo is the ancestral home of Agila Kingdom, while Apa-Agila is another town in which its size, population, and infrastructural wise has overtaken Akpoge-Ogbilolo. Apart from Akpege- Ogbilolo and Apa-Agila as the two major towns, Agila has villages such as Ikpegba, Ivetse, Avovo, Anganacha, Udo'kwu, Ogbu' kwu.

The Agila district was made up of these cities and villages.To sum it up, Agila as a district shares common land boundary to north with the Ekwasi, Ngbo villages include Umougda, Akpu, and ukwuagba in the Ohaikwu Local Government Area of Ebonyi State. At the eastern part of the community, Agila has boundary with the Eha, and Eha-Amufu communities of Enugu State. While also Agila borders with Igumale community of the same Local Government Area. Except for the Ngbo, Agila has never had a border conflict with any of her other neighbors. Agila town is a sleepy and seemingly quiet community. It is located about 26 kilometres from *Igumale*, *the administrative* headquarters of Ado Local Government Area, and 85 kilometres from Otukpo.

The community is largely an agrarian one, with vast *arable land for agricultural* purposes. The vegetation is thick with huge trees and wild life for game. The Agila people, like much of the rest of Ado, are primarily farmers. The Agila town is being surrounded by palm trees which invariably become the means of livelihood of most Agilas.

Geological Setting

Benue is a home of different classes of mineral; Industrial mineralsuch as Kaolin/Kaolinitic Clay (Ka), Gypsum (Gy), Baryte (Ba); Barytes are well-known for their role in oil, paint, and paper industries (see fig.3).

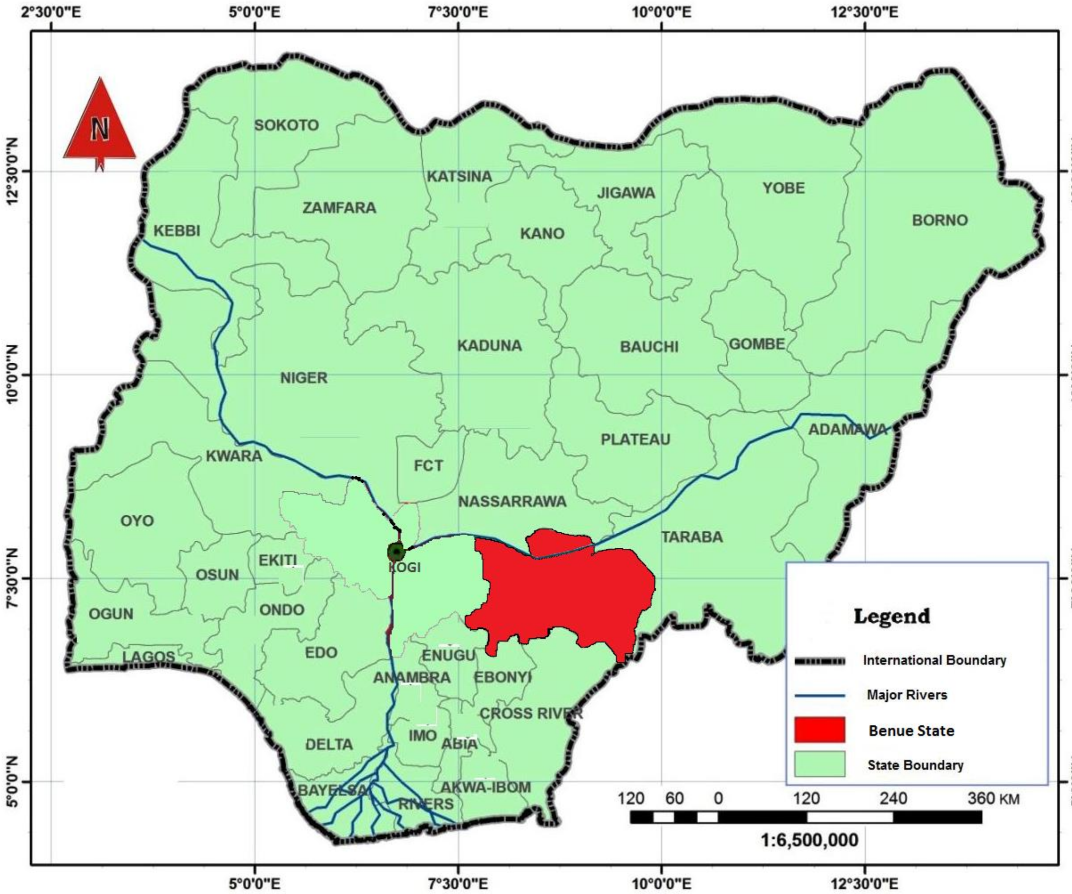

Figure 2: Map of Nigeria showing Benue State (Modified after Changde 2022)

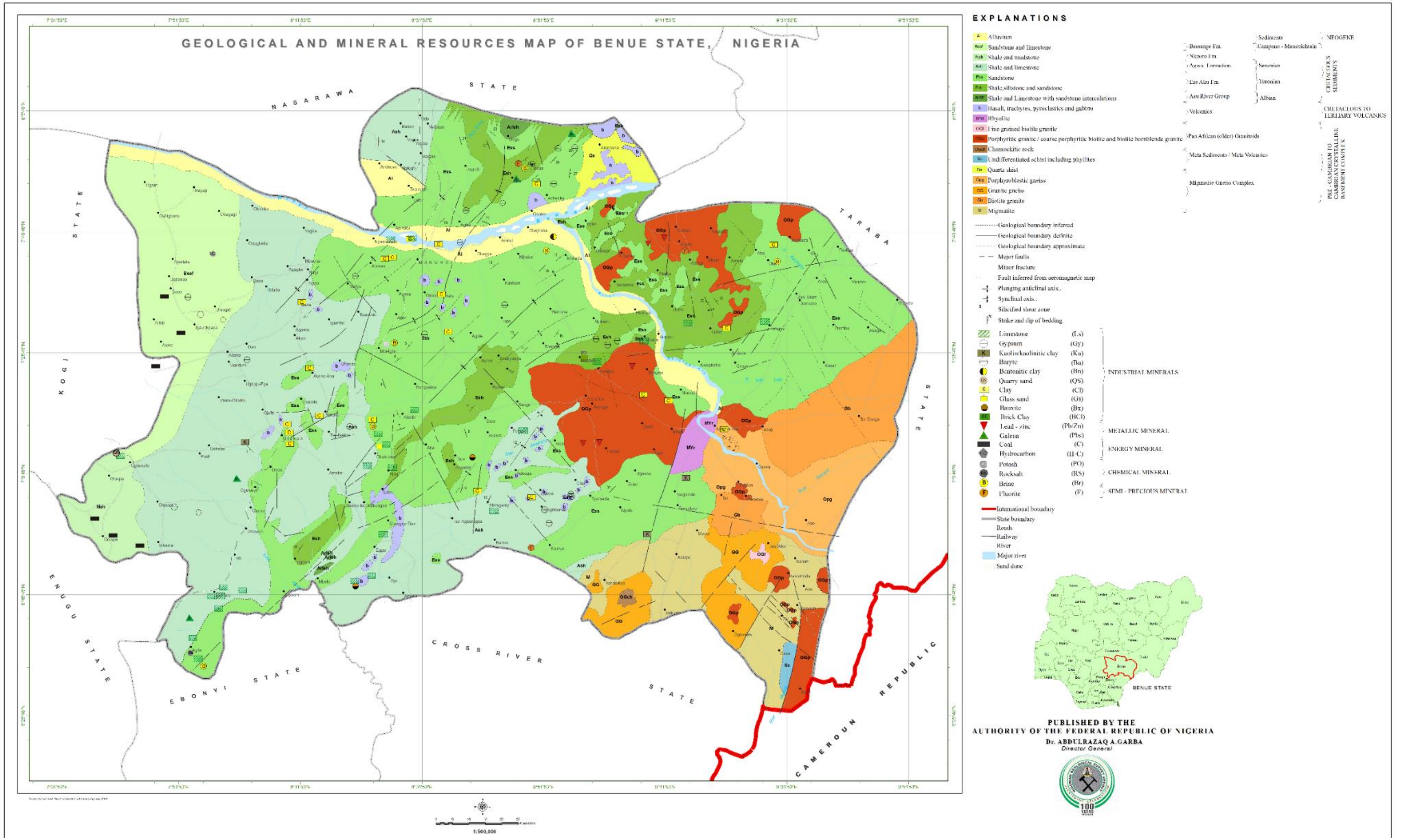

Figure 3: Geological and Minerals Resources Map of Benue State, Nigeria

Benue is a blessed State in Nigeria with minerals resources, these mineral resources are so far reported by Geological Survey of Nigeria Agency are as follows:

(Baryte): Also known as barite, is a mineral composed of BaSO4. It can create a solid solution series alongside celestite (SrSO4). It has a specific gravity ranging from 4.3 to 4.6 and a hardness rating of 3.0 to 3.5. This mineral exhibits an orthorhombic crystal structure and can appear colorless or white, though it is often found with shades of yellow, brown, blue, green, and red. Baryte leaves a white streak and has a vitreous luster. Its crystals are typically tabular or prismatic but can also be fibrous, lamellar, and frequently granular.

Baryte possesses perfect cleavage along {001} and is additionally found with cleavage along {210} and {010}. It is commonly found as a vein filling mineral and serves as gangue material accompanying ores of lead, copper, zinc, silver, iron, and nickel. Baryte is often associated with calcite, quartz, fluorite, dolomite, and siderite. It is also known to occur at lower temperatures, replacing limestone, and acting as a cement in sandstone formations. Notably, it does not dissolve in acid.

Beryl is categorized as an accessory mineral with a chemical composition of $Be_3Al_2Si_6O_{18}$ It possesses a specific gravity in the range of 2.6 to 2.8 and a hardness level of 7.5 to 8.0. Its crystal structure is hexagonal, and it typically appears green, although it can also exhibit shades of blue, yellow, or pink. Beryl is translucent to transparent and has a vitreous luster. Its crystals often take the form of hexagonal prisms with striations, but it can also be found in massive formations. The mineral has perfect cleavage along the basal {001} plane. Beryl is commonly found in cavities within granites, pegmatites, mica schists, gneisses, and is often associated with rutile. It serves as an ore mineral for beryllium, and noteworthy varieties include emeralds (transparent green), aquamarine (bluish-green), and morganite (pink) (Michael A. 2008).

Clay, on the other hand, is a type of fine-grained natural soil material that contains clay minerals. When clay is wet, it acquires plasticity due to a molecular film of water surrounding the clay particles. However, upon drying or firing, it becomes hard, brittle, and loses its plasticity. Most pure clay minerals appear white or light-colored, but natural clays often exhibit various colors due to impurities. These impurities can result in colors such as reddish or brownish, primarily due to the presence of small amounts of iron oxide (Maroto et al., 2018).

Coal: is a carbon-rich mineral deposit that originates from the preserved remnants of ancient plant life. Initially, these plant materials are laid down as peat, but as they undergo burial and experience elevated temperatures at greater depths, a series of physical and chemical transformations occur. This process, known as "coalification," leads to the formation of different coal types or ranks, referred to as the "coal series." This series includes peat, bituminous coals, lignite, and anthracite. With each ascending rank within this series, there is a decrease in the proportion of volatile substances and moisture, accompanied by an increase in the proportion of carbon content.

If coal is predominantly derived from fragments of trees or shrubs, it is categorized as "woody" or "humic" coal. Conversely, if the primary constituents of coal are pollen grains and finely divided plant debris, the term "sapropelic coal" is applied (Michael A. 2008).

Gypsum: is a type of evaporate mineral that is typically found in layered sedimentary deposits, often in the company of other minerals like halite, anhydrite, sulfur, calcite, and dolomite. Gypsum, chemically represented as ($C_aSO_4.2H_2O$), closely resembles anhydrite (C_aSO_4)., with the key distinction being that gypsum contains two water molecules while anhydrite lacks water altogether. Gypsum stands out as the most prevalent sulfate mineral.

In terms of its appearance, gypsum can range from colorless to white, and it may occasionally exhibit hues of yellow, tan, blue, pink, brown, reddish brown, or gray due to the presence of impurities. It has a Mohs hardness rating of 2 and a specific gravity falling within the range of 2.31 to 2.33. Some of its notable characteristics include transparent and bladed crystals, as well as fine-grained textures with slight coloration.

Gypsum is widely extracted from natural sources and serves multiple purposes. It is employed as a fertilizer and forms the primary component in various applications such as plaster, blackboard/sidewalk chalk, and drywall. Its uses extend to the manufacturing of wallboard, cement, plaster of Paris, and soil conditioning. Additionally, gypsum acts as a retarding agent in Portland cement. There are gypsum varieties known as "satin spar" and "alabaster," which find use in decorative and ornamental applications; however, their relatively low hardness limits their durability.

Limestone: is a sedimentary rock primarily composed of calcium carbonate (CaCO3), typically in the forms of calcite or aragonite. It may also contain varying amounts of magnesium carbonate (dolomite), along with other minor constituents such as clay, iron carbonate, feldspar, pyrite, and quartz.

The majority of limestones exhibit a granular texture, with constituent grains ranging in size from minuscule particles measuring 0.001 mm (0.00004 inch) to visible particles. In many instances, these grains consist of microscopic fragments originating from the shells of fossilized marine organisms.

Limestone originates from two main sources: (1) biogenic precipitation in seawater, primarily driven by lime-secreting organisms and foraminifera; and (2) the mechanical transportation and deposition of preexisting limestones, resulting in clastic deposits. Various limestone varieties include travertine, tufa, caliche, chalk, sparite, and micrites.

Limestone holds a significant place in the field of earth science due to its abundant fossil content, which has greatly contributed to our understanding of Earth's history and development. Moreover, limestone has substantial commercial importance. Limestone enriched with phosphate, as a result of chemical processes in ocean waters, serves as a crucial raw material source for the fertilizer industry. When heated to temperatures ranging from 900 to 1,000 °C (1,650 to 1,800 °F), limestone undergoes a chemical transformation, releasing carbon dioxide and yielding lime. Lime has essential applications in glass manufacturing and agriculture. Additionally, specific types of limestone are used as building stones, commonly employed in flooring, interior and exterior facings, and monuments.

In certain regions like Mbatyav and Igumale, substantial limestone deposits exist in industrial quantities. However, currently, only the limestone deposits in Mbanyion in Gboko are being exploited by Dangote Cement Company. Interestingly, this represents the sole mineral deposit being actively utilized within the entire state, indicating an underdeveloped resource utilization in the area.

***Uranium*:**is a chemical element with the symbol U and atomic number 92. It is a silvery-grey metal in the actinide series of the periodic table. A uranium atom has 92 protons and 92 electrons, of which 6 are valence electrons. Uranium is weakly radioactive because all isotopes of uranium are unstable; the half-lives of its naturally occurring isotopes range between 159,200 years and 4.5 billion years. The most common isotopes in natural uranium are uranium^{-238} (which has 146 neutrons and accounts for over 99% of uranium on Earth) and uranium^{-235} (which has 143 neutrons). Uranium has the highest atomic weight of the primordially occurring elements. Its density is about 70% higher than that of lead, and slightly lower than that of gold or tungsten. It occurs naturally in low concentrations of a few parts per million in soil, rock and water, and is commercially extracted from uranium-bearing minerals such as uraninite.

Uranium is a chemical element represented by the symbol U and holds the atomic number 92. This silvery-grey metal belongs to the actinide series within the periodic table. A uranium atom consists of 92 protons and 92 electrons, with 6 of these electrons classified as valence electrons. Uranium is characterized as weakly radioactive due to the inherent instability of all its isotopes. The naturally occurring isotopes of uranium possess varying half-lives, spanning from 159,200 years to 4.5 billion years.

In the composition of natural uranium, the two most prevalent isotopes are uranium^{-238}, with 146 neutrons, accounting for more than 99% of the uranium found on Earth, and uranium-235, which has 143 neutrons. Notably, uranium boasts the highest atomic weight among the elements originating from primordial sources. Its density is approximately 70% greater than that of lead and slightly lower than that of gold or tungsten. Uranium is naturally present in low concentrations, typically measured in parts per million, within soil, rock, and water. It is commercially extracted from uranium-bearing minerals, such as uraninite.

Sulfur: is a naturally occurring non-metallic element with the chemical symbol S. It possesses a specific gravity of 2.0 and a hardness rating of 2.0. Sulfur is typically yellow in color and can be found in massive forms or as tabular crystals when it crystallizes. It is produced through fumarole volcanic activity and is also generated by hot springs. Additionally, sulfur is commercially recovered from sedimentary deposits that are associated with gypsum and salt domes. In modern times, a significant portion of sulfur is obtained as a by-product of the oil-refining process, as it commonly contaminates natural oil.

Phosphate rock refers to a deposit or rock predominantly composed of inorganic phosphate compounds, often containing calcium phosphate. Examples of minerals associated with phosphate rock include apatite, autunite, monazite, pyromorphite, torbernite, turquoise, vivianite, and wavellite. These minerals are characterized by their high phosphate content and are significant sources of phosphorous for various industrial and agricultural applications.

Table 1: Summary Table of Mineral Resources in Benue State (Nigeria Geological Survey) Copyright reserved: Nigerian Geological Survey Agency. 2019.

S/n	Mineral	Location	Local Govt. Area
1		Ukaa	Gboko
		Acheche	Makurdi
		nyibam	Ado
	Baryte	Ik[a	
		Agba	Oju
		Okpoga	Okpoga
			Gboko
2	**Bauxite**	Tsuv/Anambe	Gwer east
		Mbeki/Oju	Oju
3	**Bentonitic clay**	Gbjimba/Icheadu	Guma
4	**Brick Clay**		
5	**Brine**	Uke	Ukum
		Mbakor/Icheadu	Gboko
		Ube/ukaa	Guma
		Agila	Ado
		Moi-Igbo	Ado
6	**Clay**	Nada	Gwer west
		Kuman	Makurdi
		Makurdi	Makurdi
		Otobi	Otukpo
		Aonko Ana	
		Otukpo	Otukpo
		Taraku	Gwer east
		shingami	Unshogo
		Gboko	Gboko
		Katsina Ala	Katsina Ala
		Ugba	Logo
		Afia	Ukum
7	**Coal**	Ajoke	Apa
		Orukpa	Ogbadibo
		Ichama	Okpokwu
		Bopo	Apa
8	**Fluorite**	Amimi	Logo
		Ube/ukaa	Guma

		Bamio	Konshisha
		Kpinya	Konshisha
9	**Galena**	Ube	Guma
		Akoma/Gogo	
		Oguweyi/Otobi	Obi/Otukpo
		Agila	
10	**Glass Sand**	Okugwa	
11	**Hydrocarbon**	Ojantale/Odugbeho	Agatu/Apa
12	**Gypsym**	Bopo	Apa
		umogidi	Apa
		Igaogpaya	Apa
		Adoka/ogodumi	Oturk
		ogpoba	
		Tsetyo	
13	**Kaolin,Kaolinitic Clay**	ochebo	
		Tsegbinde	
		Adigpo	
14	**Lead Zinc**	Tyoban/Amimi	
		Lessel	
15	**Limestone**	Agila	Ado
		Foyum	
		Iguamale	Ado
		Okukukwu	Gwer East/Konshisha
		Aina	Gwer East
		Aliade	Gboko/Gwer East
		Nyasando	Makurdi
		Ajoroku	Makurdi
		ShangevTiev	Konshisha
		Oju	Konshisha
		yandev	Gboko
		Mbati	Buruku
		uyoo	
		Tongov	Logo
16	**Phosphate**		
17	**Potash**	Moi Igbo	Gwer East
18	**Salt**		
19	**Sulphur**		
20	**Quarry Sand**	ugbokolo	Okpokwu

Selected *Case Studies* of mining sites in Agila District in Ado L.G.A. Benue State

This study made a case for discussing the effects of sand mining on the contextusing selected c*ase studies* of mining sites in Agila district. Agila has two major mining areas naming. Agbada River, Agbada coastal area, Agbada layout, and Okpakpor River. Through the Agbada mining location in Agila district is a huge altitudes vulnerability take place where tea gardens are ample. The ability of ground water to be recharged during the rainy season and discharged to surface water during the dry season, the vegetation is cleared away and replaced with tea plants. Due to the lack of groundwater storage and increased surface flow on wet days, minor streams will effectively dry up. The Agbada River mining operations in the Agila area are shown in fig.4 below.

Figure 4: Sand mining at Agbada river in Agila district

This mining activity poses a threat to residences situated near the river. This is primarily due to the consistent sand excavation and mining operations carried out in the study area, resulting in a significant drop in the main riverbed's elevation. Consequently, the water flowing through this river is frequently obstructed, leading to blockages for prolonged periods. The layered sand, about 15 to 20 feet thick, that once formed the riverbed of Agbada river has completely disappeared, extending beyond its original width.

Mining in Coastal Environment in Agila District

The coastal mining areas in Agila consist of Agbada Layout and Okpakor village. The process of beach formation begins with the erosion of continental materials. These formations comprise pieces of gravel and cobble, which are transported to the sea by glacial rivers. The devastation caused by storm surges and tsunamis can be lessened with the aid of dunes. The man-made however has a significant influence on the coastal sand dunes (Jayadev, 2013). Thus, below are impacts of sand excavation and mining in Agila district. Beaches and dunes face challenges when the sand contains minerals within a depth of 30 meters from the surface or is located at a distance of less than 3 kilometers from the shoreline (fig.4). Sand dunes are integral to the beach ecosystem, acting as sand reservoirs that replenish the beach especially during tropical storms and hurricanes. Their destruction exposes coastal areas to the risk of flooding. These sand dunes serve a critical function as protective barriers, shielding against forces such as intense storms, wave-driven erosion, and floods.

The ruin of scenic coastlines leads to a decline in tourism. These beaches provide a habitat for various plants and small creatures that are integral to both the marine and coastal food chains. The disappearance of these organisms poses a danger to other species as well. The erosion of beaches is driven by factors like sand mining and excavation, adversely impacting habitats and the means of people's livelihoods.

Figure 5: Coast mining site at Okpakpor Village, Agila.

The substantial expanse of coastal sand along the Agila shoreline is regularly renewed by river floods and ongoing cliff erosion. The ecosystem along the coastline suffered significant damage as a result of sand mining. This activity has led to the flooding of low-lying regions during the monsoon season, causing them to be predominantly submerged in seawater. The predominant crop on most of these regions is rice. Most of this extensive and connected marshland lies approximately 1.5 meters beneath sea level, and numerous water bodies are present, typically with brackish water.After a narrow coastal barrier that shields the region from seawater is extracted, the land could be inundated by seawater intrusion, leading to the contamination of both the land and groundwater with salt. An unfavorable sequence of events is anticipated to follow.

People experienced health hazards from titanium mining because of sand mining close to the Agila shore Mangroves, coral reefs, stable antelopes, marlins, and tiger sharks all lost their habitants. Sand mining has had a tremendous impact on land in Agbada.The Government classifies the environmental violations as those that affect air, water, flora and animals, and land. The government is worried about both the local community's rehabilitation and noise pollution (The Voice, 1, vol. 4,2021).This is due to the fact that sand dunes are harmed when vegetation is cleared for sand excavation and mining near Agbada beaches. The sediment starvation was seen along the damaged portions of Okpakor Beach.In the past, the white-pink sand dunes along the beach were so tall that travelers and the tourists had to climb in order to see the vast ocean. However, sand dunes are now absent, and the thickness has significantly decreased; the once expansive beach has dwindled to a minuscule strip that continues to shrink gradually each day (fig.6).

Figure 6: Sand dune before the escavation

Illegal extraction of sand had a profound impact on the northeastern part of the island, spanning from Savannah Bay to the tip of Windward Point. Sand dunes that once towered above the beach, safeguarding the inland coastline and vegetation, have been reduced to a mere three-foot embankment, subject to erosion by wave action and ongoing sand mining activities. The ground composed of sand has been eroded by large vehicles and heavy equipment, resulting in a cliff that is now exposed and precarious (refer to fig.7a, b and c). The beach has disappeared due to extensive sand mining, and a protective barrier is being implemented to prevent further erosion of the coastal land. While the breakwater might reduce erosion, it also hinders the replenishment of the beach as waves are unable to deposit sand. The coastal construction sector in Agila primarily depends on coastal sand and pebbles for building houses, bridges, and roads. Sand mining has caused the ecosystem along the shore to deteriorate at an alarming rate (see fig. 8a and b).

Figure: 7a, b and c Sand mining during the escavation

Figure 8a and b:Environmental degradation of sand mining.

Sand extraction poses a significant threat to the rich biodiversity found alongside our year-round rivers and temporary watercourses in their ecological context. It can obliterate riverine plants, cause weathering and erosion, contaminate the sources of water, and decrease animal diversity. The beach and dune systems within coastal regions also experience negative impacts on their ecosystems. Sand is pumped into the biota during offshore sand mining, which harms coastal ecosystems. As demonstrated by this study, are some effects of sand mining on the ecological ecosystem. Offshore sand extraction releases sand into the biota, harming coastal ecosystems. Consequently, numerous tree and shrub species that relied on the groundwater retained within the river sand at various depths within arid riverbeds would disappear.

(i) Their chances of surviving and attracting new recruits may be harmed by the removal of sand from the riverbed.
(ii) Truck-generated dust which can prevent plants from completing their photosynthesis.
(iii) Consequently, numerous tree and shrub species that relied on the groundwater retained within the river sand at various depths within arid riverbeds would disappear.
(iv) Due to the detrimental effects of sand mining on soil structure and riverbanks, it often results in isolated clusters of trees. Consequently, the ensuing runoff can lead to erosion of both the riverbanks and these tree islands.
(v) Fish migration obstructions at low flows might be caused by mined regions that exhibit a reduction in the depth of the surface flow.
(vi) Heavy machinery operation on the channel bed can directly disrupt fish and macroinvertebrate breeding habitat, raise turbidity, and generate suspended material downstream. Overburden and stockpiles left in the flood plain can change the hydraulics of the channel during heavy floods. The operation of heavy machinery on the bed of the channel can directly disturb the habitats where fish and macroinvertebrates breed, increase water cloudiness, and produce suspended particles that flow downstream. Piles of excess materials and stored

resources in the floodplain can alter the flow dynamics of the channel, especially during intense flood events.

(vii) Drawing from the aforementioned study, the biodiversity of St. Kitts and Nevis, including its river turtle population, faces a significant threat due to the increase in unauthorized sand and excavation mining. In Agila Rivers, the structure of the benthic community has been severely disrupted, and restoring it to its previous composition and community arrangement might require more than 2 years. Sand plays a crucial role as both an effective aquifer and a buffer for the riverbed's hydrological environment. The depletion of sand can have a detrimental impact on the diverse range of life that it supports, and this outcome is also influenced by excavation and sand mining activities.

(i) Water table reduction

Sand mining causes the water tables in the study area and its surrounding areas to decline, and these depleted levels are replenished by underground sand aquifers.Sand mining and excavation it is not only puts bridges endanger but it also river beds into gigantic and dip open pits, which causes the groundwater table to fall and dries out the drinking water wells on the river embankments.

(ii)Water Quality

Excavation and mining sites experience heightened turbidity due to sediment accumulation resulting from stockpiling, the collection of silt and organic particles, oil spills, or leaks from excavation equipment, as well as the movement of vehicles such as trucks and cars.

(iii)Salinization

Excavation and mining sites experience heightened turbidity due to sediment accumulation resulting from stockpiling, the collection of silt and organic particles, oil spills, or leaks from excavation equipment, as well as the movement of vehicles such as trucks and cars.Metals may be hazardous to both people and animals, even in very little quantities.If care is not taken,acid mine drainage might seep into groundwater or wash into nearby streams and rivers. In such streams, it is doubtful that any plants, animals, or fish would survive. Sands from the Okpakor River have been excessively exploited in the Okpakor area. Thus, the area is mostly dry, and the residents depend on tanker water. Farmers now need to have water pumped in over great distances because wells have dried up.Sand can only be dug up to a depth of one meter according the regulations, however you can dig down as far as seven meters. A region formerly renowned for its abundant rice crop now struggles with a water shortage in the Okpakor River basin as a result of severely declining water levels. The levels of groundwater have substantially decreased in the villages and the nearby cities.an unimpeded river Sand and excavation mining caused Agila to lack water. In the center of the river, plants and acacia groves have sprouted since the sand layer was removed. The third-longest river in Agbada, the Agila River, has experienced a similar fate as well.

Illegal and excessive sand mining within the riverbed of the Agbada catchment area in Agila has led to the depletion of groundwater levels and a degradation of the local ecology in the surrounding villages.Agila, a freely running river, was dry due to sand and excavation mining. In the center of the river, plants and acacia groves have sprouted since the sand layer was removed. The third-longest river in Agbada, the Agila River, has experienced a similar fate.

Sand and excavation mining activities have resulted in the drainage and deterioration of numerous perched lakes and wetlands. After mining, there is a lack of effort on the part of miners to restore the original geomorphology of these areas during the rehabilitation process. Instead, they reintroduce a uniform landform with extremely diverse hydrological properties.Several perched lakes and wetlands have been drained and damaged as a result of sand mining. In their post-mining rehabilitation, the miners make no attempt to duplicate the original geomorphology. Instead, they reintroduce a uniform landform with extremely diverse hydrological properties.On these consequences, more detail is provided. Coastal regions are renowned for the beautiful splendor of their beaches and backwaters. Undoubtedly, one of the key sectors for economic growth is beach and backwater tourism. A few harbors and commercial hubs may be found along the coast. The beauty won't be visible soon.

(i) Coastal Erosion

Wherever sand mining is practiced, residents in coastal areas are always in danger and subject to the wrath of nature. Property destruction from coastal erosion contributes to societal unrest. Beach sand extraction exposes coastal regions to erosion's wrath.

Radiation

The radioactive mineral residue, especially monazite and zircon, are harmful to the nearby flora. It is imperative to follow established guidelines for safe handling, storage, and disposal of radioactive materials (Bertha & Mu'awiya 2023).

(ii) **Cancer**

In some regions where silica sand is mined, the fracking process may cause cancer.

(iii) Dust Pollution

The substantial quantities of dust released into the air during processes such as sand excavation, sand mining, and their associated logistics contribute to respiratory issues.

(iv)Noise and vibration

Due to the fact that mines often work around-the-clock and with a broad range of sound levels, noise is a problem in mining sites. The sounds contaminate the surroundings and keep people away from sleeping. In a highways and other constructions: Heavy vehicle movement can lead to traffic dangers as well as damage to roads and bridges.

CONCLUSION

This research paper has established that illegal sand mining has geological, sociological and environmental effects. Based on this study, the mining sites in Agila are situated in an area that is predominantly inhabited by a community of fishermen. Currently, the practice of sand mining poses a significant threat to both the study area and its surrounding environment.

RECOMMENDATION

The study highlights the growing concern regarding illegal activities and unregulated sand excavation, which pose significant risks to the environment. By combining personal geological observations from mining sites with qualitative data from secondary sources, the research focused on the case of Agila's river and coastal mining sites. The findings of this study shed light on the multifaceted impacts of such activities on various ecosystems.

The study's key findings indicate that sand mining contributes to changes in river channels, affecting the physical ecosystem and disrupting food webs. The increased river current accelerates erosion along riverbanks, while the removal of soil profiles and vegetation diminishes animal populations and eliminates essential habitats. Furthermore, the study emphasizes the vital role of sand dunes in mitigating storms and erosion caused by factors such as winds, waves, and floods. The removal of sand affects these dunes, jeopardizing their protective function.

Importantly, the research highlights the intricate web of marine and coastal life that relies on sand dunes for survival, potentially disrupting the entire food chain. The study also uncovers the adverse hydrological impacts of sand mining, including declining water tables and saline water intrusion, which affect both drinking water sources and aquifers. In addition, the study identifies negative socio-economic effects, including loss of scenic beauty, radiation emissions from mineral components, dust pollution, noise, and infrastructure damage.

The research provides a comprehensive analysis of sand mining's wide-ranging effects on river, dune, marine, hydrological, biological, and sociological environments. Through case studies in the Agila area of Benue State, Nigeria, the study underscores the urgency of addressing these issues and implementing sustainable practices to mitigate the ecological and societal consequences of unregulated sand excavation.

REFERENCES

Agyingi C.M. (1993). Palynological evidence for a late cretaceous age for Patti formation, eastern Bida basin, Nigeria. J. Afr. Earth Sci., 17, pp. 513-523.

Ahmad, I. K., Salih, N. M., Khadi, T. R., &Nzar, Y. H. (2012). Determination of water quality index for Qalyasan stream in Sulcaimn City, Iraq. *International Journal of Plant, Animal and Environmental Science* 2(4), 31-50.

Akanwa, A. O., Ikegbunam F. I. (2019) Natural resource exploitation in Nigeria: consequences of human actions and Best practices for environmental sustainability- a review. *Int J Multidisciplinary Res Stud* 2(3):1–14

Akanwa, A. O. (2020) Effect of sand mining on planetary health: A case study of Ulashi, river, Okija, Anambra state, Nigeria. J Ecol Nat Resource 4(2):000198

Ashraf, M. A., Maah, M. J., Yusoff, I., Wajid, A. & Mahmood, K. (2011). Sand mining effects, causes and concerns: A case study from Bestari Jaya, Selangor, Peninsular Malaysia. Scientific Research and Essays 6(6), 1216-1231.

Banerjee, A., Meena R. S, Jhariya, M. K., Yadav, D. K., Raj, A. (2021) Agroecological Footprints Management for Sustainable Food System. ISBN 978-981-15-9495-3. Springer,

Bertha, O. A & Mu'awiya, B A. (2023) Effect of Na-22, Cl-36, 3-H, and P-32 Exposure on Laboratory Clinical Researchers. *Communication in Physical Sciences*, 2023, 9(4): pp 438-446

Benkhelil J (1989). The origin and evolution of the Cretaceous Benue Trough, Nigeria. *J Afr Earth Sci* 8:251–282

Borges, P., Andrade C. and M. C. Freitas (2012) Dune, Bluff and Beach Erosion due to Exhaustive Sand Mining – the Case of Santa Barbara Beach, São Miguel (Azores, Portugal), Journal of Coastal Research, SI 36 pp.89-95 (ICS 2002 Proceedings), Northern Ireland.

Bruton, M.N. (2015) *The effects of suspensoids on fish. Hydrobiologia*, V. 125, pp. 221-24214, pp.349–367.

Changde, A. N, Mu'awiya B.A, Simon D.C, Ernest O. A, Kizito O.M, Godwin O.A &Okiyi, I.M., (2022). Electric Resistivity for Evaluating Groundwater Potential Alongthe Drainage Zones in The Part of Jos North, Plateau State, Nigeria. *European Journal of Environment and Earth Sciences* Vol 3 | Issue 6 | November 2022.

Dagodzi, D. (2010.) Environmental impacts of sand mining. Lantern Publications, Accra, Ghana Ecological Footprint (2017) Overview: Footprint network. Global footprint network. https:/www. footprintnetwork.org/. Accessed 16 Apr 2017

Mensah John Victor, (2017) Causes and Effect of Coastal Sand Mining in Ghana, Singapore Journal of Tropical Geography, V. 18, pp. 69–88.

Juniah R, Susety D, and Rahmi H. (2019) Technical Review of Land Usage of Former Limestone Mine for Rubber Plantation in PT Semen BaturajaTbk for Sustainable Mining Environment.

Juniah R., Rahmi S (2017). The Influence of Sand Mining towards the Sustainability of Power Support and Capacity of Lambidaro River. AIP Conference Proceedings 1903, 040015 (2017); http://aip.scitation.org/toc/apc/1903/1 American Institute of Physics Research Gate.

Maroto-Moreno, José, M.; Alonso-Azcárate, Jacinto (2018). "What is clay? A new definition of "clay" based on plasticity and its impact on the most widespread soil classification systems". *Applied Clay Science.* 161: 57–63. doi:10.1016/j.clay.2018.04.011.

Michael Allaby (2008) Dictionary of Earth Sciences. Oxford University Press 1990, 1999, 2003, 2008 Published in the United States by Oxford University Press Inc., New York ISBN 978–0–19–921194–4 1 3 5 7 9 10 8 6 4 2.

Mu'awiya, B., Simon, D. C., Changde A.N., Ahmad T. D., Andarawus, Y., Nengak, M., Simon, Tobias. (2022a). Petrography and Heavy Mineral Studies of Lokoja Formation along Mount Patti North Central Nigeria: Implication for provenance Studies. *European Journal of Environment and Earth Sciences.* 3(2)36-51

Musa, J. A. (2009). Assessment of sociological and ecological impacts of sand and gravel mining. A case study of east Gonja, district, Ghana and Gunner sholt (Iceland). Ghana. *J Geosci Geomat* 2(2):42–49.

Mutisya, D. N. (2006) Sand harvesting and its environmental and socio-economic effects in arid and semi-arid, Kenya. Soil and Water Conservation, Kenyatta University. Kenya. pp. 82–90.

National Population Commission (2006). 2006 Population Census. Abuja: NPC.

NMFS. (2018) *National Marine Fisheries Service (NMFS) National Gravel Extraction Policy*. Abuja: NMFS Press,

Ocheli A., Ogbe O B., &. Aigbadon G. O. 2021. Geology and geotechnical investigations of part of the Anambra Basin, Southeastern Nigeria: implication for gully erosion hazards. *Environmental system research* https://doi.org/10.1186/s40068-021-00228-2.

Oluwande P. A., Sridhar M. K C., Bammeke A. O., Okubadejo A .O. (1983) Pollution levels in some Nigerian Rivers. Water Research 17: 957-963.

Padmalal, D., Maya K., Sreebha, S., Sreeja R. (2008) Environmental Effects of River Sand Mining: A Case from the River Catchments of Vemb Vnadlake, SouthWest Coast of India. *Environ Geol* 54 (4):879–889.

Jayadev S.K., & Sekhar, L.K (2013) "Karimanal (Mineral Beach-Sand) Mining in the Alappuzha Coast of Kerala – A People's Perspective" in Martin J. Bunch, V. Madha Suresh and T. Vasantha Kumaran, eds., *Proceedings of the Third International Conference on Environment and H*ealth.

Shaji, J., and Anilkuar, R., (2014). Socio-environmental impact of river sand mining; an example from Neymar River, Kerala, India. *Journal of Humanities and Social Science* 19(1), 11 -17.

Stebbins, M. (2006). Can gravel mining and water supply wells co-exist? University of Maine. United Nations Conference on Environment and Development Report, Orono, ME

Tesi, J.A., Tesi, G.O. and Enete, C.I. (2018). Assessment of the socio-economic impacts of river sand mining along the Warri River, Delta State. *FUW Trends in Science and Technology Journal* 3(1), 56 – 59.

Thomas, N. (2003) Artisanal and small scale mining: challenges and opportunities. Russel Press, Nottinghan, UK.