Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.5, No.20, 2015

Investigation of the Chacteristics of the Soils behind the Proposed Governors Lodge, Ekwueme Square Awka and the Environmental Hazards Prevalent in the Area

EZEIGWE, PATRICK C.
Department of Architecture, School of Environmental Design and Technology, Federal Polytechnic Oko, Anambra State, Nigeria

Abstract
The study investigated the characteristics of the soils within the Ekwueme square Awka, Anambra State in Nigeria using the experimental method and field observation, with the aim of ascertaining the prevalent environmental problem(s) in the area and suggesting control measures to these hazards. Sample was collected from the site and analyzed at the Nnamdi Azikiwe University Civil Engineering Laboratory. The result showed that the area was made of about 98% sand and only about 2% of silt and clay and the sediments where found to be loose and friable. The prevalent environmental hazards inferred include: soil erosion/gullying and siltation of the nearby Imo-Awka stream; both of which were active in the area as observed. The study recommends that; the Imo-Awka stream should be dredged or made a developed site for sand mining to enhance its suistability and avoid its extinction while good drainage facilities should be constructed to control soil erosion and gullying and their subsequent effects on the environment.

1.0 PREAMBLE

Much of today's geological practices affect the health, safety and welfare of the public, the environment, the economy and the feasibility of engineering works. The roles and expertise of the geologist are many and varied. Geologists are the experts in the discovery of raw materials that underpin and sustain modern life, such as oil and gas, base and precious metal ores and construction materials. Engineering geologists evaluate the natural conditions necessary for the safe construction and operation of roads, railways, high rise buildings, industrial complexes, dams and earthworks generally. Hydrogeologists and environmental geologists are responsible for finding, and advising on the protection of, water supplies, and for locating sites for the safe containment of wastes, be they hazardous or non-hazardous.

Geologists, whatever their specialisations, are frequently asked to provide information that will enable plans and decisions to be made that directly affect the future economic success and safety of a specific project. Commonly geologists work in conjunction with engineers to ensure the safety of structures. Most activities that require geological advice are closely connected directly, or indirectly, to the environment. Mining, quarrying, construction, development of water resources and waste disposal are just a few examples of activities that may significantly change the landscape and the quality and way of life of local inhabitants and in which the geologist has an important role. It is essential in fulfilling this role that the professional work of the geologist is always of the highest technical standard.

As well as the general fields of activity listed above geologists are likely to be experienced in specific fields of activity:

- The exploration for, and utilisation, of natural resources including metalliferous minerals, non-metalliferous minerals, water supply and water management, energy and other natural resources.
- Environmental management, environmental risk assessments, preparation of environmental impact statements and assessment, soil conservation and protection of natural environments.
- Examination of past and present geological processes related to the development of earth history.
- Management and prediction of geological hazards and avoidance of environmental problems in the future.
- Evaluation of human activity directly affecting and necessarily modifying the natural habitat through the construction of buildings, communication links, dams, underground excavations etc. Such activities can have a profound and irreversible effect on the use of indigenous natural resources, on the environment in general and on geology in particular for example dewatering, polluting discharges, underground storage, and land-use.

Some geological factors influence the occurrence of certain environmental hazards, like flooding, erosion, landslide, etc. They include the nature of soils (laterites) and the near surface geologic sequence, existence of geological structures such as fractures and faults, existence of ancient stream channels, and shear zones. The collapse of concealed subsurface geological structures and other zones of weakness controlled by regional fractures and joint systems along with silica leaching, which has led to rock deficiency, are known to contribute to some environmental problems (Onuoha and Onwuka, 2014). The geomorphological factors are

related to topography and surface/subsurface drainage system.

An aspect of this environmental geology which is of great importance in environmental hazards prediction and management is sedimentology. Here the characteristics of a sedimentary rock is being used to predict its behavior. For instance Shale is the commonest type of sedimentary rock, covering a vast area of the earth's surface. It exhibits a wide spectrum of geotechnical behaviour and has often been a cause for concern on environmental and geotechnical issues. Thus shale, most often, is regarded as problem materials. These problems (both environmental and geotechnical) possessed by shales in shaley terrainsof the world are, in most cases, being influenced by mineralogy, especially the predominant clay mineral type(s) (Okagbue, 1989; Obiora and Umeji, 2004)

Several workers have attributed the development of gullies, flooding and other environmental problems in Anambra State to the influence of human activities on natural and geologic processes while others suggested that gullies and floods occurences are linked with concentrated runoff processes and the resilience of the geology of the area. Nwajide and Hogue (1979) attributed the causes of gullies to the combination of physical, biotic and anthropogenic factors. Egboka and Nwankwor (1982) are of the opinion that gullies are caused by hydrogeological, hydrogeochemical and geotechnical properties of the rocks in the affected area. Okagbue (1986), Uma and Onuoha (1986) are in agreement with Nwajide and Hogue on the causes of gullies in South Eastern Nigeria.

This work will therefore analyze a specific geologic formation, determine its characteristics and subsequently predict environmental problems that may prevail in the area of study (Awka in Anambra State Nigeria).

2.0 STUDY AREA

2.1 GEOGRAPHICAL LOCATION

Awka is located on latitude 6^0 25N and longitude 7^0E. The city is transversed by the old Enugu road (Zik's Avenue). Awka is bounded with Nibo in the south west, Mgbakwu and Okpuno in the north east and their Umuawulu, Isiagu, Ezinato, in the south east. As one moves from Onitsha to Enugu, the town stretches over a distance of 26 kilometers. (Source: ministry of lands, survey and urban planning, Awka).

Fig. 1: Map of Nigeria Showing Anambra State (Modified from Eni, 2014)

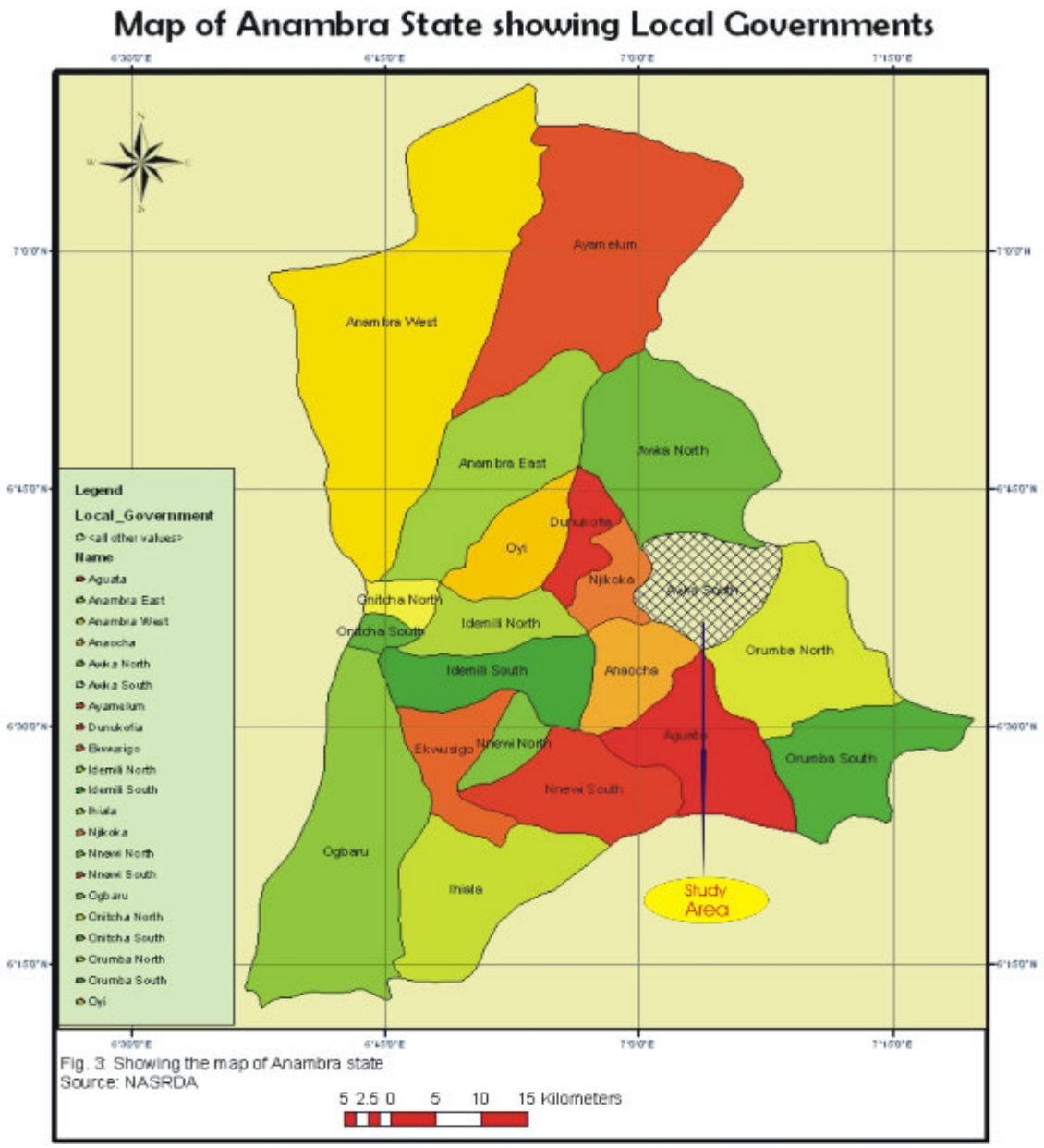


Fig. 2: Map of Anambra State Showing Awka Study Area (Modified from Onuoha *et al*, 2014**)**

2.2 PHYSICAL CHARACTERISTICS

Both the built up and under developed aspect of the town occupy an area of approximately 11 kilometers and a width of 4 kilometers. The size of Awka town makes it suitable to play several roles and serve several functions in the socio-economic and socio-political development of Anambra state especially its administrative function.

2.3 TOPOGRAPHY AND LANDFORMS

Awka is predominantly a low lying region on the western plain of the Mamu River with all parts at 333 meters above sea-level. The region is reversed by some streams like Okpala yam, Obibia etc. The major topographic feature in the region is the cuestas (asymmetric ridges) with east facing escarpment, each trending southwards.

2.4 CLIMATE, RAINFALL, TEMPERATURE AND HUMIDITY

Climate: Awka is part of the rainforest vegetation with two seasonal climatic conditions. They are the rainy season and the dry season which is characterized with the harmattan. The dryness of the climate tends to be discomforting during the hot period of February to May, while the wet period, between June and September is very cold.

Rainfall: Awka is characterized by the annual double maxima of rainfall with a slight drop in either July

or August known as dry spell or (August break). The annual total rainfall is above 1,450mm concentrated mainly in eight months of the year with few months of relative drought.

Temperature and Humidity: Awka has … temperature of 27^0c with daily minimum and maximum temperature ranges are about 22^0c and 34^0c respectively. It has a relative humidity of 80% at dawn. (Source: Hydro-meteorological department, Awka).

2.5 VEGETATION

Awka falls within the high forest zone and it comprises of tall trees with thick undergrowth and numerous climbers. The typical trees are deciduous in nature, such trees are palm trees, raffia palm, iroko trees, oil bear trees and gravelina trees. Oil palm trees and raffia palm are the most common and they are not deciduous in nature.

2.6 POPULATION

According to 1991 census data, Awka has a population of 58,225, which was 60,000 approximately. The current population of Awka is estimated to be about 176, 858 people. The entire population comprises of male, female both young and old, all classes of students, workers. (Source: The world Gazetteer). However, the extrapolation of census figures of 1953, 1963, 1978, 1983 and 2006 put the population of Awka town at approximately 90,573 for the year 2007 and 375, 000 persons in 2010.

2.7 GEOLOGY AND SOIL TYPE

Anambra basin has about 6,000 m of sedimentary rocks.The sedimentary rocks comprise ancient Cretaceous deltas, somewhat similar to the Niger Delta, with the Nkporo Shale, the Mamu Formation, the Ajali sandstone and the Nsukka Formation as the main deposits. On the surface the dominant sedimentary rocks are the Imo Shale a sequence of grey shales, occasional clay iron stones and Sandstone beds (Nwajide and Reijers 1996).

The Imo Shale underlies the eastern part of the state, particularly in Ayamelum, Awka, and Orumba Areas. Next in the geological sequence, is the Ameke Formation, which includes Nanka Sands, laid down in the Eocene. Its rock types are sandstone, cal careous shale, and shellylimestone in thin bands. Outcrops of the sandstone occur at various places on the higher cuesta, such as at Abagana and Nsugbe, where they are quarried for construction purposes. Nanka sands out crop mainly at Nanka and Oko in Orumba North LGA.

The geological formations that underlies Awka urban are Imo shale and Bende Ameki formation. In the riverine and low lying areas particularly the plain west of Mamu River as far as to the land beyond the permanent Nnamdi Azikiwe University, the underlying impervious clay shales cause water-logging of the soil during rainy season.

2.7.1 Age

It lies conformably on the Maaestrichtian Nsukka Formation, it is essentially thick clayey shale, fine textured, dark grey to bluish grey with occasional admixture of clay ironstone and thin sandstone beds. The Imo Shale range from Paleocene to lower Eocene in age. (Amajor, 1984 and Reyment, 1965).

2.7.2 Lithofacies

Imo shale is dark, very thinly laminated fissile and contains abundant pyrite crystals but poorly fossiliferous. (Amajor, 1984 and Reyment, 1965).

The two main types of soil found in the area are ferruginous soil and hydromorphic soil. Ferruginous soil is rich in free iron and is derived from marine complexes of sandstone, clay and shale.

2.7.3 Environment of Deposition

The Imo Shale was deposited in a shallow marine environment (Nwajide, C.S. 1990).

Below is the geologic map of Southeastern Nigeria, which details the arrangement of the constituent geologic formations outcropping at various areas.

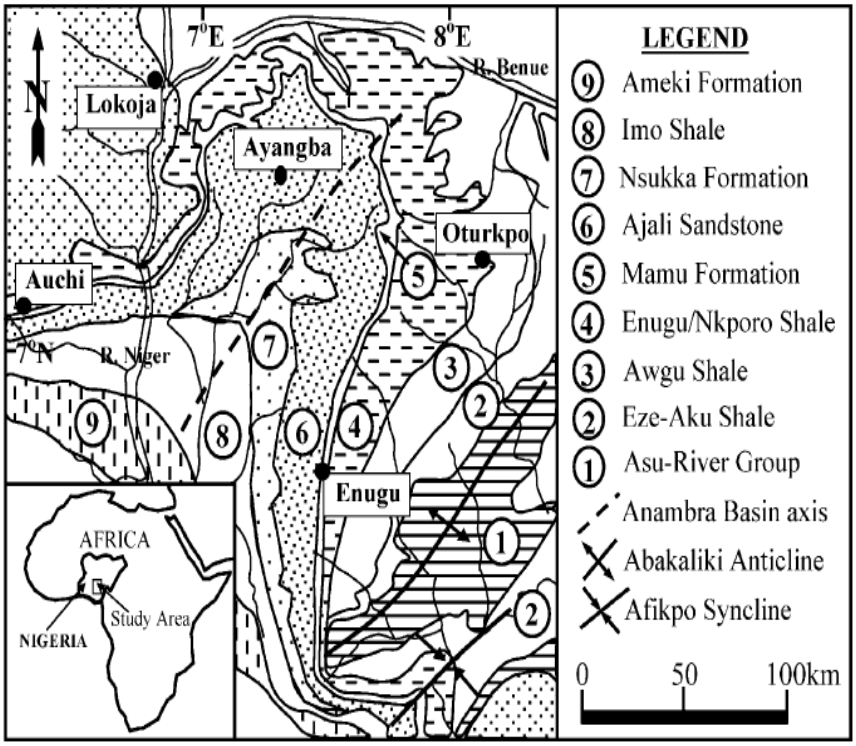


Fig. 3: Geological Map of Anambra Basin showing the different sedimentary units (Inset: showing location of Nigeria and the Anambra Basin). (Source: http://www.springerlink.com/content/a37771860k4n7k96/)

The stratigraphic profile below summarizes the depositional process, environment and age of the various geologic formations in Anambra basin cut across by the road under study.

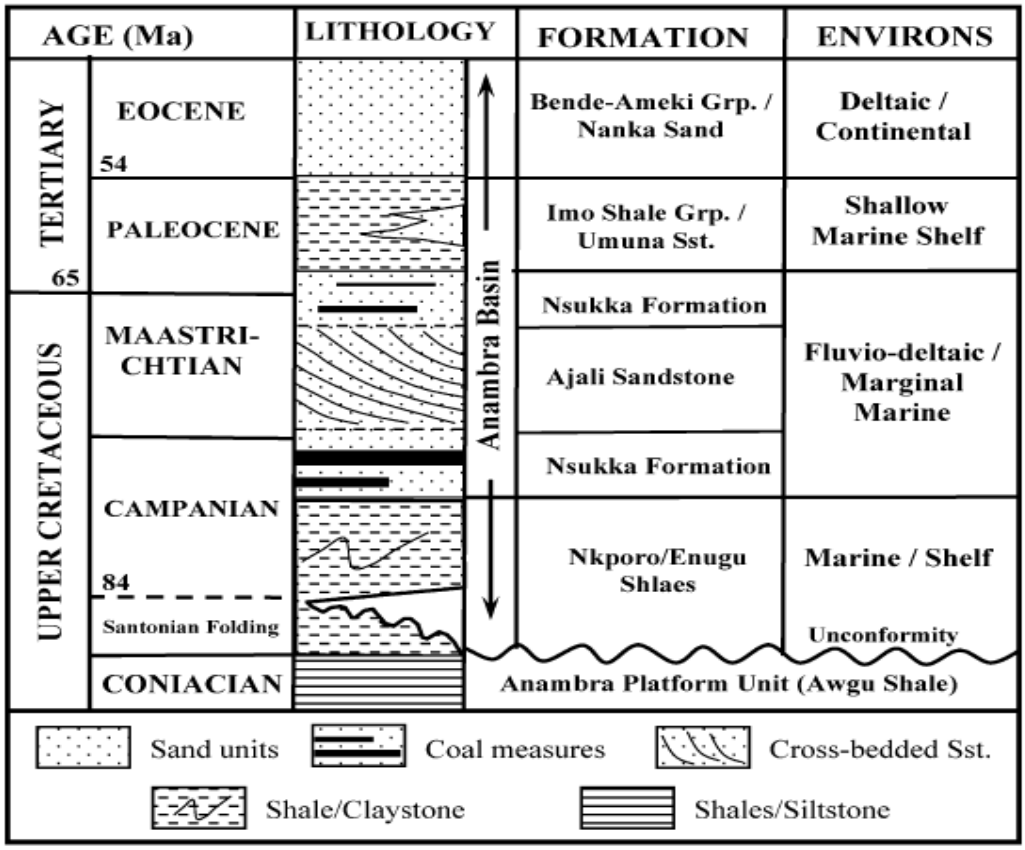


Fig. 4: Stratigraphic profiles and depositional environment of the sedimentary units within the Anambra Basin Nigeria. (Source:http://www.springerlink.com/content/a37771860k4n7k96/).

2.8 URBANIZATION

Awka has suffered severe and uncontrolled interface due to high population. Most of the high forest regions have been cleared to provide residential, commercial, administrative buildings, schools, banks and hospitals. The urbanization of Awka witnessed a great expansion since 27th of August, 1991 when Awka was made the capital city of the new Anambra state. This attracted a lot of investors, businessmen, who wanted to invest on state capital. Many civil servants returned to their indigenous homes and helped increased the urbanization of Awka. The Nnamdi Azikiwe University with their high rate of students enrollment led to the great explosion of the population in the study area.

3.0 LABORATORY ANALYSIS RESULT AND DISCUSSION

3.1 DESCRIPTION OF THE SAMPLE COLLECTION PROCESS:

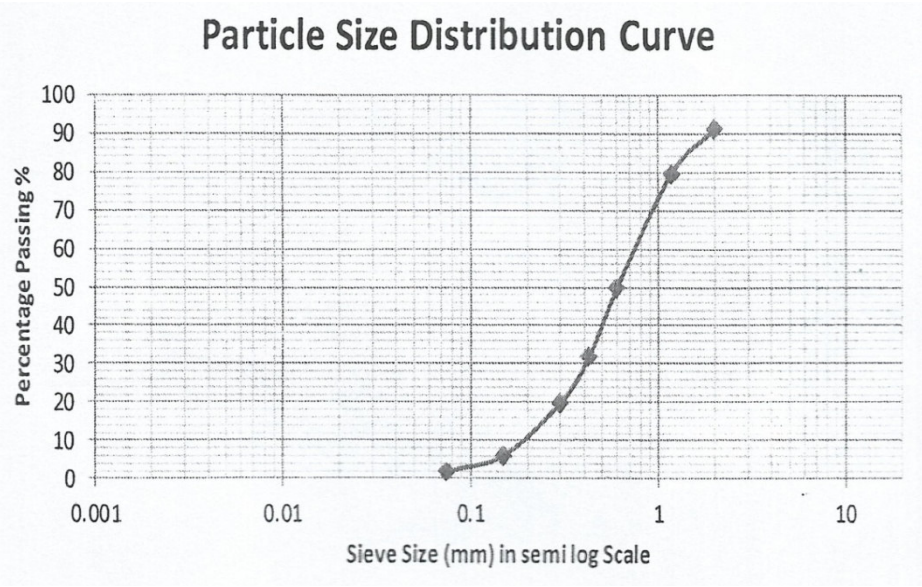
The following are the description of the sample collection processes:
Location: Behind Ekwueme square Awka.
Sample characteristics: Medium-Fine grained, light coloured and moderately indurated soil.
Rock type: Sand
Quantity of sample collected: about 1000 grams (1kg.)
Equipments used in sample collection: Trowel, geologic hammer, chisel and cellophane bags.
Depth of collection: about 3meters from the top of the gully channel.

3.2 DATA ANALYSIS AND REPRESENTATION:

Weight of sample used - 100 grams
Shaker type - automatic
Balance type (weighing balance) - Electronic Weighing Balance
Sieving time - 5 minutes
Method of sample desegregation - Manual Use of pistle and mortar
Sieve sizes use - 2mm and below

TABLE 1: TABLE OF RESULTS AND OUTCOME /PASSING

SIEVE SIZES	MASS RETAINED	% MASS RETAINED	CUMULATIVE % MASS PASSING	CUMULATIVE % MASS RETAINED
2	18.0825	9.04125	90.95875	9.04125
1.18	22.8125	11.40625	79.5525	20.4475
0.6	59.6425	29.82125	49.73125	50.26875
0.425	36.6725	18.05125	31.68	68.32
0.3	23.6725	11.83625	19.84375	80.15625
0.15	27.3325	13.66625	6.1775	93.8225
0.075	8.7225	4.36125	1.81625	98.18375
Tray	**3.6325**	**1.81625**	**0**	**100**



Graph of the Laboratory Analysis Result.

Note:

- All the calculations were made after every experimental loss has been taken care of.
- Mass retained was measured directly from the sieve by measuring the mass of the sieve and the sample retained together, then subtracting the weight of the sieve to get the mass retained.
- % mass retained = mass Retained/Total mass X 100/1
- The other unknowns were calculated by cumulative addition and subtraction from the % mass Retained.

3.3 INFERENCES FROM THE ANALYSIS RESULT

The following can be inferred from the analysis result:

1. That the sample is sand comprising of above about 98% of sand and only about 2% of silt and clay.
2. The study area due to the sandy nature its geology cannot be recommended as a waste disposal centre, as it can easily allow pollutants to percolate the underground also its close to the Imo Awka stream and can pollute it.
3. The very fine sand deposits of the river are good for plastering works.
5. The sample contains almost all particle sizes although in very small quantities thus can be said to be graded.
6. The environment of deposition is likely to be a marine environment.

3.4 ECONOMIC POTENTIALS/ACTIVITIES AROUNDTHE STUDY AREA

1. **Farming:** The inhabitants of the area engages themselves in farming mostly subsistent, to produce food for themselves and their family. This is due to the highly fertile plains of good soil surrounding some parts of the area. There are many streams around the study area (Awka), like the Imo Awka stream very close to the point of sample collection, thus late planters cultivate around the area during the dry season using the stream as a source of irrigation water supply, especially for vegetables.
2. **Sand Mining:** Due to the high rate of erosion washing down the particles to the nearby Imo Awka Stream, the stream has a lot of sand deposited in it, which in turn is been extracted and used as raw material for building and other construction processes.
3. **Lumbering and forestry activities**: The vegetation of the environment is one that makes for lumbering providing wood for construction, building and even wood fuel or firewood, all these being source of revenue generation to the inhabitants of the area.
4. **Hunting**: The vegetation cover creates a nice habitat for wild animals, thus game for hunters.

4.0 ENVIRONMENTAL HAZARDS PREDOMINANT IN THE AREA

The major environmental problem of the area are;

1. **Erosion:** The highly erodible soil of this area makes erosion predominant in the area especially in the vicinity of the sample collection where an active gully channel has developed and is gradually engulfing the whole area.
2. **Siltation:** the erosion process makes for the transportation of very huge amount of sediments and the subsequent deposition of these sediments into the nearby Imo Awka stream. This stream therefore highly silted. The continuous occurrence of the process with time will lead to the disappearance of the stream except if some precautionary measures are taken.
3. **Flooding:** The almost impervious geology of the major parts of the area in accordance with the table land topography and inefficient water/surface runoff channelization, makes flooding a yearly affair in the area. Especially during seasons of heavy down pour. During this time, the Awka town is under serious menace of rain water flood, farmlands are destroyed, hunting and fishing retards especially in the nearby mamu river where the brownish color depens due to the presence of mud. Sometime it claims the lives of some brave ones who wouldn't mind to continue their business and properties are being destroyed. Although there were no special machinery set aside to monitor or measure the extent of damage, but information gotten during my personal chatting with some of the inhabitants of the area shows that their finances, properties and total economy is most times affected due to this flooding issue. Not only do people stop their work but also people who invested in agriculture loose most of their crops as they are eaten up by flood before harvest.

It should be noted that the main causes of flooding in this area includes:

- *Heavy rainfall ,*
- *Shale geological make up/Rock type,*
- *inefficient drainage system/channels and bad roads.*

4. **Surface Water Contamination:** The waters of the streams river channels most times during the rainy season becomes so muddy and unswimable that fishes die massively. This coloration of the water makes it bad to be used domestically by the inhabitants of the areas close to these sources of water supply.

5. **Chemical Contaminations:** this takes place when fisherman uses chemicals to fish, thus contaminating the whole water. Also refuse dumping directly on the river and in channels where water can carry them, to the streams/river channels contaminates them. Due to time some of the specific chemicals could not be ascertained but responses during my personal interview with them shows that they use chemical methods to fish sometimes.
6. **Water logging:** due to the nature of the soil type predominant in this area, water logging is allowed. This affects the survival of the crop plants in the negative direction. Some farm lands are been rendered unsafe for nursery planting and others have their see beds engulfed and seedlings destroyed due to this type of phenomenon. Farmers and hunters in this area suffer worm bites more because of this problem although the growth of these worms provides the fisherman with materials to set their traps, but some are every deadly e.g. the guinea worm. Water logged areas are breeding points for mosquitoes thus enhancing the spread of malaria. This kind of scenario is evident in areas after Nnamdi Azikiwe University around Amansea where the Mamu river passed through.

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

From the findings of this work, it is glaring that the geology of the study area affects the type of environmental problems seen in the area. Although the area is underlain by Imo Shale formation which is more of clay and occasionally sand, the almost 98% sand can be justified as the topmost part of Imo Shale is sand and the presence of some recent sediments cannot be ruled out completely. It is therefore concluded that the prevalent problem which is erosion is a product of the loose sand geology as was reported in the result of the analysis.

5.2 RECOMMENDATION

Base on the result of the analysis, geology of the area and the inferential environmental problems/hazards that are prevalent in the area, the following were recommended:
1. The Imo Awka stream should be dredged or made a developed site for sand mining to enhance its suistability and avoid its extinction.
2. Good drainage facilities should be constructed to control soil erosion and reduce flooding and its effects on the environment.
3. The village fishermen should avoid the use of toxic chemicals in fishery so as to eliminate surface water contamination through fishing activities.
4. Farmers to endeavour to leave the surrounding flood plain, around the Mamu river especially during the rainy season in order not to risk the destruction of their crop plants during flooding.
5. Provision of a refuse dump site to avoid indiscriminate of refuse which may either block the channels of flow (thereby causing flooding) or contaminating the surface water.

REFERENCES

Adegoke, O.S., Arua, I. Oyegoke, O., 1986. *Two new nautiloids from the Imo shale, (Paleocene) and Ameki formation (middle Eocene), Anambra State*, Nigeria Journal of mining and geology vol.1, No.17, pp 85-89.

Amajor, L.C., (1984): "Sedimentary Facies Analysis of the Ajali Sandstone" (Upper Cretaceous), Southern Benue Trough. *Journal of Min. Geol*, 28, PP.7- 17.

Egboka, B.C.E. and G.I. Nwankwor (1986), the hydrogeological and geotechnical parameters as causative agents in the generation of erosion in rain forest belt of Nigeria. Journal of African Earth Sciences, 3, pp 417-425.

Egboka, B.C.E. and Okpoko, E.I. (1988). *the Hydrology of Awka and Njikoka Local Government Areas of Anambra State, Nigeria*. A case of study of a Developing Economy Journal of the Nigerian Association of Hydrogeologists, Vol. 1, No 1, pp 45-55.

Kogbe,C.A (1989); *The cretaceous and Paleocene Sediments of Southern Nigeria, in Geology of Nigeria,* ed. Kogbe C.A., Rock view publishers, Jos.

Nwajide, C.S and H. Hoque (1979), gullying processes in south eastern Nigeria. The Nigerian Fields, 44, pp 64-74.

Nwajide, C.S. (1990). Cretaceous Sedimentation and Paleogeography of the Central Benue Though. In: Ofoegbu, C.O; (Ed.), The Benue. Tough structure and Evolution International Monograph Series, Braunschweig, pp. 19-38.

Nwajide, C.S. (1990). *Cretaceous Sedimentation and Paleogeography of the Central Benue Though*. In: Ofoegbu, C.O; (Ed.), The Benue. Tough structure and Evolution International Monograph Series, Braunschweig, pp. 19-38.

Nwajide, C.S. and Reijers, T.J.A. (1996). Geology of the Southern Anambra Basin. In: Reijers, T.J.A. (Ed), selected chapters on Geology, SPDC, Warri, pp. 133-148.

Nwajide, C.S. and Reijers, T.J.A. (1996). *Geology of the Southern Anambra Basin.* In: Reijers, T.J.A. (Ed), selected chapters on Geology, SPDC, Warri, pp. 133-148.

Obi, C.G. (2000). Depositional Model for the Campanian-Maastrichtian Succession, Anambra Basin, Southeastern Nigeria. Ph.D Thesis, University of Nigeria, Nsukka, Nigeria.

Obi, C.G. (2000). *Depositional Model for the Campanian-Maestrichtian Succession, Anambra Basin, Southeastern Nigeria.* Ph.D Thesis, University of Nigeria, Nsukka, Nigeria.

Obiora SC, Umeji AC (2004). Petrographic evidence for regional burial metamorphism of the sedimentary rocks in the lower Benue Rift. Journal of African Earth Science, 38(3): 269-277.

Okagbue CO (1986). The physical and mechanical properties of laterite gravels from southeastern Nigeria relative to their engineering performance. J. Afr. Earth Sci., 5(6): 659-664.

Okagbue CO (1989). Geotechnical and environmental problems of theNiger Delta. Bull. Assoc. Eng. Geol., 27: 119-126.

Onuoha, D. C. (2004): "Geology of Iva-Valley and its Environs". Unpublished B.Sc. Project Work, Department of Geological Sciences Faculty of Natural Sciences, Nnamdi Azikiwe University, Awka.

Onuoha, D. C. and Onwuka, S. U. (2014): "The Place of Soil Geotechnical Characteristics in Road Failure, a Study of the Onitsha-Enugu Expressway, Southeastern Nigeria" *Journal of Civil and Environmental Research.* IISTE, USA. Vol. 6, No. 1, pp 55-67. (http://www.iiste.org/Journals/index.php/CER/article/view/10313/10516)

Onuoha, D. C., Onwuka, S. U. and Obienusi, E. A. (2014). Evaluating the Causes of the Road Failure of Onitsha-Enugu Expressway, Southeastern Nigeria. *Journal of Civil and Environmental Research.* Vol.6, No.8. Pp. 118 - 129. *(http://www.iiste.org/Journals/index.php/CER/article/view/14703/15059)*

Reyment, R.A. (1964): *Review of Nigerian cretaceous Cenozoic Stratigraphy.* Journal mineral Geology Vol. 2, no. 2, p.61-80.

Reyment, R.A. (1965):.*Aspect of the Geology of Nigeria*. Ibadan Univ. Press, p133.

Short, K.C. and Slauble, A.J. (1967); *Outline of geology of theNiger Delta* Bulletin A.A. P.G. Vol 54, No. 5, p. 761-779.

Simpson, A. (1955): *The Nigerian coalfield, the Geology of parts of Onitsha, Owerri and Beue Provinces.* Geological survey of Nigeria Bulletin No. 24, p.85.