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Economic Applications of Geological Signatures to the Development of Eia in Katsina Suburb, Nigeria

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Abstract

Ordinarily, for over a couple of decades EIA's are only done for surface areas/conditions with regard to Nigerian context, without consideration for the geological structures or conditions of the earth's surface. These have serious implications for the survival of the building structures, underground water supply and the environment as a whole. This paper examines the economic applications of geological signatures to the development of EIA within Katsina metropolis. Data for the study were collected through field work that involves physical on-sight assessment of building structures, use of sub-surface therameter for finding sub-surface, infiltration and underground water depletion conditions. The results indicated that the frequency of instability of building structures is on the increase, lowering of the ground water table and contamination are also identified within the study area. This paper therefore recommends the involvement of geologists in the conduct of EIA's for optimum land use.

Keywords: *EIA, Geological signatures, Economic applications, Katsina State-Nigeria*

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Background to the Study

Environmental Impact Assessment (EIA) is currently, commonly done with an observation of surface features. The EIA is a process designed for predicting consequences of major investment and development projects and identifying appropriate measures for minimizing adverse effects on people, their properties and livelihoods, other nearby developments and a wide range of elements within the Ecosystem. However, sub-surface features are almost the most important geologic features to be considered for predicting negative consequences prior to project execution. Katsina State falls within the Basement Complex which is regarded as stable relative to tectonism. Whilst other geological signatures are not considered such as development of heavy structures which require mapping of the surface and the sub-surface. This can eventually provide information of an underground water condition, rock succession, rock mechanics, and hydrological behaviour of soils and the degree of weathering of underlying rock strata (Adekoya, 1995).

It is a common observation that many built areas reveal cracks along walls, which directly answer different stress. In addition, some buildings sink to the bottom of the foundation level. The later infers weathered or clay bearing rock materials. Another step in accessing a particular land prior to excavation is to conduct a structural mapping which could provide detailed information about the extent of fractures and possible building of an axial angle of each limit. In all, geologic and hydrogeological EIA determinations must be possible, which includes the following:

1. Literature Survey of the area.
2. Determination of surface and sub-surface features.
3. Geological formation of a regional context.
4. Unique geologic features.
5. Identifying areas prone to subsidence or geological instability.

Study Area

Katsina metropolis (city) is situated between Latitudes 11° 18'N and 13° 22' N, (see Figure 1) and Longitudes 6° 52'E and 9° 20'E. It was built on a spur of land between Ginzo and Tilla streams which flows in a north-easterly direction, and is at a narrow neck of water shed between the Gada and Tagwai River Basin (Figure 2.1)Katsina is an ancient old City that was formerly a City State surrounded by City wall of 21 kilometres in diameter/length Katsina is a Local Government Headquarter and the capital city of Katsina State. It is one of the 36 States that comprises the Federal Republic of Nigeria. The city is moderately populated with about 700,000 persons/settlers been recent estimates mainly as a result of natural increase and migration from other cities that were affected by insecurity in northern Nigeria. The climate is Tropical Continental type, classified according to Koppen's Climate Classification as AW, with long dry season and short wet season.

Vegetation type is Sudan Savannah with short scattered trees and grasses. Most of the vegetation is affected by human activities such as deforestation for fuel wood and clearance of vegetation for residential purpose (NiMet, 2010).

The geology of the area governs the nature of river flowage. The project area lies within the Nigerian Basement Complex which is divided into crystalline basement of migmatite and geniuses. The crystalline basement initially behaved as one tectonic unit, but later experienced two periods of syntectonic metamorphisms with deformations in two successive phases called the Intense Alpine types deformations. The deformations took place during the Pan African Orogeny (Kankara, 2014)which were accompanied by metamorphism, granitization and feldspatization. The first tectonics resulted in extensive migmatization of the basement but was further differentiated during the second tectonics to produce homogenous gneiss and intrusive granites (Wright, 1970)

The migmatites and gneiss represent the oldest rocks in the basement complex (Kogbe and Obialo, 1976).There are at least two generations of migmatitic gneiss of widely different ages within the study area. The migmatitic gneiss underly mica schist, dipping south-east at between 270 and 430 with most outcrops observed in stream channels (see plate 2.1). The mica schists are generally fissile dark-grey to greenish grey in colour and weather to a silvery to a light grey colour with red iron- oxide stains on its fissile surfaces.

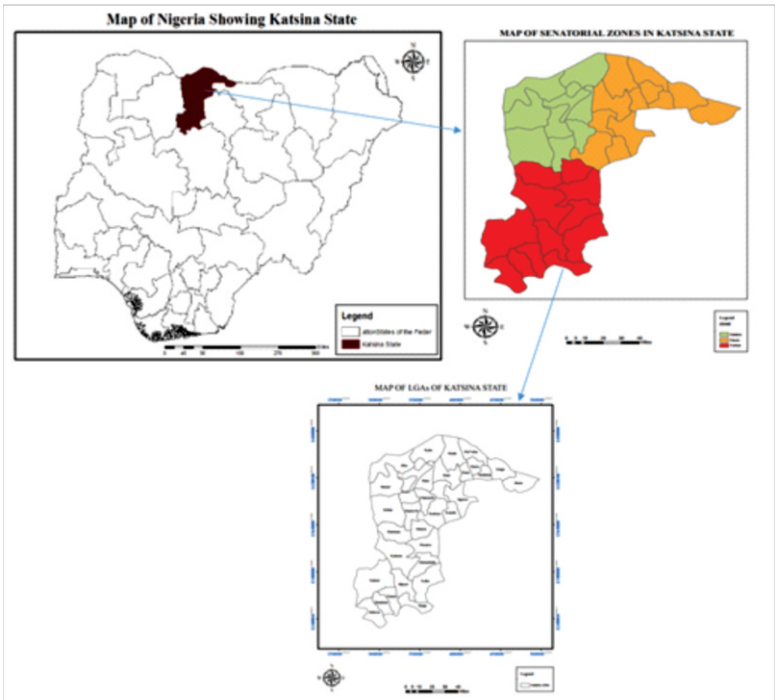

Fig. 1: Map of Katsina State showing the study area

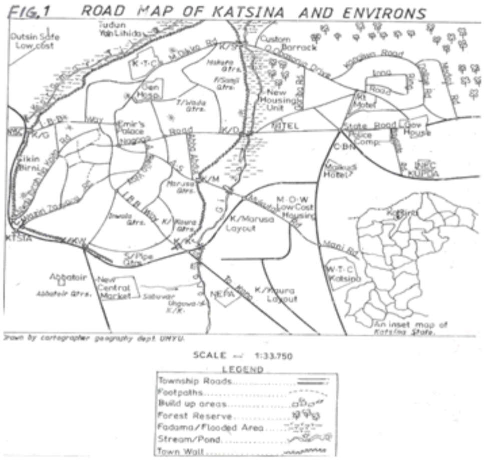

Figure 2: Road map of Katsina and Environ
Source: Field work, 2016

Plate 3: A gutter at Kofar Kaura, Katsina City.
Source: Field work, 2016

Regional Geology of Katsina Suburb and Other Surroundings

Migmatite occurs in the lower slopes to the northeast of hills south of Daura and are pale grey in colour, with abundant mesopherthitic feldspar grains and brown biotite. It occurs in subordinate amount when compared with the medium grained variety. The top of the hill consist of the medium grained 1otite granite which is the dominant rock type. The porphyritic micro granite occurs near the contact with the basement, SW of Rogogo. Again, a variety of microgranite occurs as a small dyke lie body of light brown (reddened) micro granite in the same locality.

Sedimentary Formations*:* The northern part of Katsina state forms the southern fringes of the Gundumi and Chad formations (Kankara, 2014). Details of the major parts of these formations which lie outside the study area can be obtained as the main sedimentary rocks in the Gundumi formations are cretaceous sandstones and conglomerates, while Pliocene to Pleistocene sands and clays formed the argillaceous Chad Formation of lacustrine origin. The Chad formation is uncomformably overlying the basement, with sediments still accumulating in the lake. The sandstone unconformably overlies the basement, and two varieties of the sandstones were based on mineralogy, texture and general appearance (Kankara, 2014; Danbatta, 1999).

They include ferruginous sandstone which is coarse grained and feldspathic sandstone which is fine to medium. The ferruginous variety is generally dark brown and rusty, consisting of poorly sorted quartz (40% of the rock), intensely weathered feldspars (30% of the rock), iron oxides (15% of the rock) and some rare mica flakes (2% of the rock). The fine to medium variety is a well sorted whitish grey rock, consisting of sub-angular to sub-rounded pebbles and boulders of quartz, feldspars, muscovite and iron oxide. Cementing materials includes fine-grained quartz, chlorite, green biotite, epidote and carbonates. The feldspatic sandstone is less ferruous and form the basal sandstone layer in. the state with the feldspars intensely altered into friable clays. Stratification in the sandstone is rarely observed. However, agar feldsphatic sandstone containing pegmatitic materials in its matrix was observed. This occurs 100 m thick sequence of feldsphatic sandstone beds (arkoses) interbedded with the ferruginous sandstones (McCurry, 1976).

Superficial Deposits*:* These include laterites and alluvium deposits formed as a result of weathering of different lithologies in Katsina state. Indurated laterite occur as low- lying hills and ridges which forms a hard cover and are very common occurrences in and around the state. River deposits in the state include pale-colored sands occurring in the better developed drainage channels and alluvium in poorly developed drainages. The alluvium contain varying amount of sands, silt and clay. Almost half of this area is covered by red sandy soils which support the thick thorn vegetation. Most of the laterite and alluvium are exploited, for economic purposes like construction of roads, buildings and bridges. In the southeastern portion of Katsina state, there is a silica deposit in and around some swampy areas.

The silica sand deposit occurs in two 2-3 m and about 6 m thicknesses, both west and Kano road or east of Daura. The top part, which forms the thiner horizon is reddish brown and contains silt and clay. In the bottom and thicker horizon, the sands are white in colour. This could be due to the leaching away of the brownish colouring films of iron oxides during transportation or the top sand horizon may have been stained (Danbatta, 1999). In the first locality the kaolin is exposed as a N-S trending body with an average width 0 m and a length of 200m, while the second deposit is exposed in pits and quarries which cover a very wide area of about 15,000 m^2. The thickness of this kaolin deposit is not known, but it is estimated to be about 20m from hand dug wells located at the border of Katsina state. The kaolin deposits in the area probably were formed as a result of kaolinization over pegmatites.

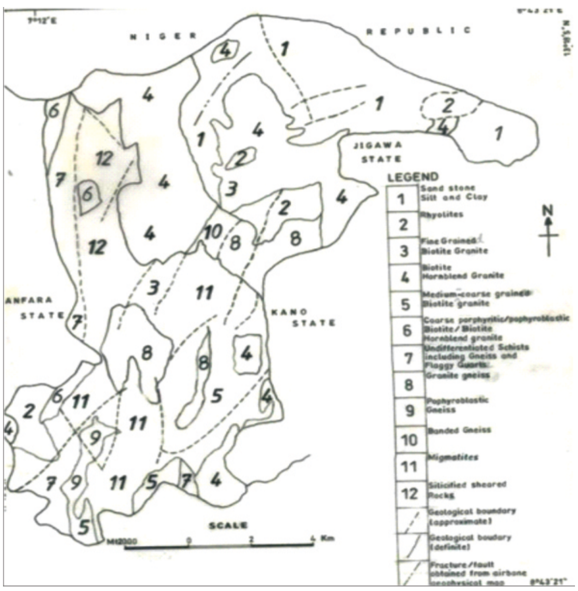

Figure 4: Geological map of Katsina State

Supracrustal Rocks and Older Supracrustal Relics*:* Schist and Phyllites which now make up the supracrustal belts represent an assortment of and mainly volcanic igneous lithologies, the proportions of which differ considerably çom belt to belt and in particular from region to region. Among the metasediments, mica-schists and phyllites generally predominate. These are rocks of pelitic composition, signifying their originally argillaceous nature as muds, silts and shales. Also common are psammitic composition, quartzites and quartzo-feldspathic rocks, originally quartz-sandstones, arkoses and greywackes (see figure 3.1). These are arenaceousrocks, also sometimes called arenites conglomerate facies may be hally abundant. In some belts, the peliticschists and phyllites are rich in manganese oxides, and some of the quartzites are banded with magnetite or haematite BIF or itabinite Calcareous lithologies are generally less common among the metavolcanics, greenstones, amphibolites and chlorite-rich schist are the predominant rock types, representing basaltic ashes and pyroclastics and minor intrusives, and are often called metabasic rocks or simply me1asites. Amphibolites of andesitic rather than basaltic composition are plentiful in some belts, and some amounts of acid volcanics (dacites and rhyolites) are quite widespread (Grant, 1970).

The relative proportions these two main groups of rocks differ considerably from region to region in the Archaean age province, metasediments and metavolcanics bulk about equally; in the Proterozoic terrane, metasediments are somewhat more abunndant than metavolcanics, whereas in the Pan African age ice, they overwhelmingly dominate the supracrustals, with metavolcanics being greatly subordinate. Metamorphic grades of the supracrustal belts are mainly in the greenschist to lower amphibolitesfacies, locally reaching higher grades in the amphibolite and even granulite facies. It is sometimes possible to show that metamorphic grades in the supra crustals increase towards boundaries with large syn-tectonic granite bodies (see figure 3.1). In some places, the metamorphic grade is low enough for original igneous arid sedimentary features to be preserved, including pillow structures in\lavas and graded bedding and cross stratification in sediments.

Geological Structures That Necessitate EIA in Katsina Suburb

Structurally, the rocks of the supracrustalbelts appear to be relatively simple, when compared with those of the basement, even though in some belts several phases of deformation can be recognized. The structures appear simple mainly because the folding is almost everywhere tight to isoclinal on all scales, with a steep axial plane foliation (Kankara, 2014; Danbatta, 1999). The strike of the foliation is predominantly between N-S and NE-SW along the trend of the belts themselves, which are the predominant indicators of the regional structural grain. The quartzite in particular form long narrow strike ridges, but other lithologies can also have some linear topographic expression. The supracrustal rocks represent sediments and volcanics that were deposited prior to the last reactivation of the adjacent or underlying basement, and were themselves deformed and metamorphosed during that last event. Layers and lenses of amphibolites, quartzite, marble, mica-schist and other rocks that occur among the basement gneiss and migmatites are believed mainly to represent remnants of older, supracrustal sequences. Some are probably small outlying slices and inclusions of the main supracrustal sequences, which have been separated from the larger belts tectonically or by erosion or both.

Basement rocks of a particular age province may include volumetrically small amounts of quartzites, marbles, amphibolites, and so on. Many of these may represent remnants of older supracrustal sequences dismembered and engulfed in the basement during successive reactivations. It also shows how older supracrustal relics can be progressively eroded from the antiformal regions between the belts of down folded younger supracrustal/sequences. Another possible reason for the progressive obliteration of these older relic/lies in the composition of the rocks themselves. Most of the sediments were derived by e1ósion of granitic gneiss-migmatite basement terranes in the first place, and in many cases their mineralogy was dominated by assemblages of quartz, mica and detrital feldspars (Pulles et al, 2005). Some of the volcanic rocks were of intermediate to acid composition (andesite to rhyolite). A high proportion of supracrustal sequences thus had an overall composition not very different from that of granite. Such rocks would have been susceptible to the partial melting and granitisation processes that accompanied each reactivation, and could they become part of the gniess-migmatite basement, which therefore probably comprises both paragneisses and orthoisses. On the other hand, clay-rich sediments, quartzosandstones and limestone are less prominent to transformations in this way, and the same applies to basic volcanic rocks (McCurry, 1976; Ajakaiye, 1985). It may be no/coincidence that the rock types most commonly encountered among the demonstrably of supracrustal relics in basement terranes are peliticmetasediments rich in alumina silicate minerals, quartzite, marbles and amphibolites.

Also, the provenance of these occurrences will contribute to the understanding of knowledge of paleo-environment of the study area.

Hydro geological Investigations
These must include the following:

1. Monitoring of Boreholes and VES (Vertical Electrical Sounding) (D'ltri and D'ltri, 1977).
2. Determination of various underground water aquifers/aquitards/aquiludes.
3. Logging of Earth's profile or boreholesto determine the soils potentials to pollution.
1. Determination of underground water quality(Banister et al, 2002) and its physical, chemical and biological behaviour relative to the types of Land use development.

Pre-EIA and EIA Operations
Beyond adherence to philosophy, it is a pragmatic response to the lesson of experience from otherwise laudable projects which have turned into disasters because their potential negative impacts on the environment were not properly explored, and pre-emptive measures devised and applied (Caravanos et al, 2011; Umar, 2015). The EIA operations in the study area should comprise the following:

1. Mineral mapping
2. Geochemical mapping
3. Toxicological studies
4. Futuristic continuation of toxicity disintegration. These have radioactive elements with radioactive properties such as Pb, Cd, Th, etc (Dynkner and Wester, 1983). They have the capacity to give adverse effects to humans and livestock in general if consumed (Garba, 1988; Adelekan and Abegunle, 2011).

Artisanal Mining and EIA in Katsina
Any mining company ought to conduct a medical examination relative to immune systems, physiological habit and response to environmental changes of the field labourers/miners it engages. These medical examinations should be based on the geological, mineralogical, geochemical and toxicological reports after every mine activity. This was never done before. If done, this will surely protect the health conditions of the miners (Hilson, 2006; Aigbedion and Iyayi, 2007).

The Syn-mining EIA monitoring shall use equipments that could be used. The proposal could be based on the primary data gathered. The equipments to be used shall include Scintillation Counter and GeagerMuller Counter which detect radiations.

Problems of EIA Conductance

Most of EIA conductivity relies on secondary data only without going to the field to investigate on the actual happenings as a primary data. EIA team or Staff walks into public and Institutional Libraries to gather an already existing information about a geology of a given area and came out with suggestions on what is supposed to be done to the area before any mining can be assumed. They do that without putting any concern on the current changes on the geological background and the erosional /denudational /weathering changes that might have occurred of recent. Environmental hazard is a long time dependant occurrence that generates data.

Discussion

The moment a signal get triggered it inches and enlarge, cumulating or compounding to evolve into a large environmental hazard. If EIA is properly done the Zamfara State Lead Poison of March 2010 wouldn't have occurred (Nura, 2015) Besides, the Department of Resources Development that is a stake holder in the mining operations does not compel those companies engaged in the mining to be involved in the true services of toxicologists to carry out their investigation after the geological and geochemical reports were submitted.

Meanwhile, for the purpose of executing its statutory mandatory of EIA activity, it is suggested that the Katsina State Environmental Protection Board or Agency should prepare a manual of safeguarding the whole environment and distribute it to all property owners and State Ministries, so also other firms. Penalties or fines can then be imposed for contravention.

Conclusion

It must be borne into mind that EIA prior to project commencement is different from Environmental Monitoring. Monitoring is a continuous activity during and after. It makes more sense for the EIA as a proactive measure, to be arrested by denying the grant of activity permit at the development control, until when deemed fit. There is thus the need for further interpretation of the Environmental Laws to determine an actual Agency to shoulder a responsibility.

Recommendations

1. Many of the mining companies or firms with which the miners are attached to do not have proper safety policy. Geological and geochemical surveys need to be carried out at the eve of exploration and exploitation so as to analyze the samples in the Laboratories in order to identify the toxicity of each atomic and iron constituent.
2. The Department of Resources Development should make it compulsory for all intending explorationists and miners to adopt such strategies before any mining activity should be commenced.
3. Medical examinations should be conducted before an artisanal miners go to field so as to detect the history of a disease associated to each miner.
4. Safety policy adaptation should be imposed on every mining company by the Government.
5. An EIA mining team should comprise geologists, ecologists, engineers (either mining or mechanical or both), vegetation environmentalists or foresters, sociologists, Human Right Activists and Medical personnel.

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