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SUSTAINABLE DEVELOPMENT AND UTILIZATION OF THE RED/BROWN EARTH (LATERITE) IN SOUTH-EASTERN NIGERIA

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ABSTRACT:

The study was specifically conducted in Akwa Ibom State located at the Southeastern corner of Nigeria. The aim of the study was to highlight red/brown earth otherwise known as laterite as an important natural resource that many communities in the study area are blessed with. The study revealed that the laterite is available in industrial quantity in Obot Akara, Ibesikpo Asutan, Uruan, Itu, Etim Ekpo, Ika, Ikono, Ikot Ekpene, Uyo, Etinan, Abak, Nsit Ibom, Nsit Atai, Nsit Ubium, Ukanafun, Oruk Anam, Essien Udim, Mkpat Enin, Ikot Abasi and Okobo Local Government Areas of the State. The paper has exposed the various uses of laterite. It also discussed how laterite could be harnessed, developed and utilized without serious damage to the natural ecosystem for the socio-economic advancement of the region.

Keywords: Laterite, Red Earth, Brown Earth, Resource utilization, Sustainable development, ,Akwa Ibom State, South-Eastern Nigeria

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1. INTRODUCTION

Economics growth is a function of the presence, quality and quantity of basic natural resources within particular areas or economics regions (Nwogwogwo et al., 1997). The logic is that where basic natural resources are developed, investment capital would be attracted thereby increasing income and capital. In the south eastern Nigeria in particular, there are many natural resources in abundant supply including fossil oil. The fossil oil seems to be the only focus for exploration, extraction and development. Thus becoming the object of conflict the three tiers of government, the multinational development companies and the communities (Okurebia and Daniel, 2013). As a result, many solid mineral resources have become ineffectively utilized. This may probably imply that the more of a thing one has, the less one is likely to appreciate its significance. However, some efforts have been made to develop some of the solid mineral resources found locally (Udom, 1991), but many are still undeveloped and underdeveloped. One of such is the red/brown earth known as Laterite.

The most unfortunate scenario is that the region which is blessed with preponderances of natural resources is having a significant portion of its population living in abject poverty. It becomes true rather than ironical that people could live in the mist of abundance but languish in poverty. Little wonder that Harrison (1973) found it difficult to make a distinction between poverty and resource(s) under-utilization.

2. AIM AND OBJECTIVES OF THE STUDY

This paper sets out to highlight red/brown earth otherwise known as laterite as an important natural resource that many communities in the state are blessed with. It exposes the various uses that the resource can be put to. It also discusses how this resource could be harnessed, developed and utilized without serious damage to the natural ecosystem for the socio-economic advancement of the region.

3. THE STUDY LOCATION

The study was specifically conducted in Akwa Ibom State. Akwa Ibom State is one of the thirty-six States in the Federal Republic of Nigeria with the Population of over 3.5million people (Mbat, Ibok & Daniel, 2013). It was created on 23rd September, 1987. There are 31 Local Government Areas including Uyo the State Capital. The State is strategically located at the Southeastern corner of Nigeria between latitudes 4^o30^1 and 5^o 33^1 North and longitudes 7^o 30^1 and 8^o 25^1East (see Fig.1). It is sandwiched between Abia and Rivers States to the West, Cross River State to the East, Abia State to the North and Atlantic Ocean to the South (Daniel, 2012).

According to Usoro (2011), published geological maps of the Geological Survey of Nigeria 1:250,000 sheet 79 (Umuahia) indicates that Akwa Ibom State consists of stratigraphic units ranging from Maastrichtian to Plaistocane. Within this framework, four distinctive units are recognized. Three of these belong to the coastal Plain Sands and Beach Ridge Complex and the remaining one to the Shay Fancies of the North East of the State. Laterite profile or red

Fig. 1: Locating Areas Very Rich in Red/Brown Earth on the Map of Akwa Ibom State

Fig. 1: Locating Areas Very Rich in Laterite on the Map of Akwa Ibom State

and brownish earth characterize the materials over the bedrock of Akwa Ibom State especially in Obot Akara, Ibesikpo Asutan, Uruan, Itu, Etim Ekpo, Ika, IkonoIkot Ekpene, Uyo, Etinan, Abak, Nsit Ibom, Nsit Atai, Nsit Ubium, Ukanafun, Oruk Anam, Essien Udim, Mkpat Enin, Ikot Abasi and Okobo Local Government Areas (see Fig. 1). The natural red/brown earth, which is present in abundance in the local soil structure, is a very viable resource material that should be more fully developed to enhance, economic, social and the physical well being of the people.

4. THE RED/BROWN EARTH OR LATERITE

Laterite is the soil layer that is rich in iron oxide and derived from a wide variety of rocks weathering under strongly oxidizing and leaching conditions. It forms in tropical and subtropical regions where the climate is humid. Lateritic soils may contain clay minerals; but they tend to be silica-poor, for silica is leached out by waters passing through the soil. Typical laterite is porous and claylike. It contains the iron oxide minerals goethite, $HFeO_2$; lepidocrocite, FeO(OH); and hematite, Fe_2O_3. It also contains titanium oxides and hydrated oxides of aluminum, the most common and abundant of which is gibbsite, $Al_2O_3 \cdot 3H_2O$. The aluminum-rich representative of laterite is bauxite. Laterite is frequently pisolitic (pealike). Exposed surfaces are blackish-brown to reddish and commonly have a slaggy, or scoriaceous, lavalike appearance. Commonly lighter in colour (red, yellow, and brown) where freshly broken, it is generally soft when freshly quarried but hardens on exposure. Laterite is not uniquely identified with any particular parent rock, geologic age, single method of formation, climate per se, or geographic location. It is a rock product that is a response to a set of physiochemical conditions, which include an iron-containing parent rock, a well-drained terrain, abundant moisture for hydrolysis during weathering, relatively high oxidation potential, and persistence of these conditions over thousands of years. Nearly all laterites are rusty-red because of iron oxides. They develop by intensive and long-lasting weathering of the underlying parent rock. Tropical weathering (laterization) is a prolonged process of chemical weathering which produces a wide variety in the thickness, grade, chemistry and ore mineralogy of the resulting soils. The majority of the land area containing laterites is between the tropics of Cancer and Capricorn (Wikipedia, 2013).

5. THE ECONOMIC RELEVANCE AND USES OF THE LATERITE

5.1 Source of pigment

The principal earth colours has been used since the dawn of man. In the Paleolithic and primitive cultures, natural red earth were used in cave paintings and for ritualisitic purposes: specifically death ceremonies, because the red colour can easily symbolize blood. They are also used because of their permanence. According to Thomas(2002), some paintings with red earth hues in the Italian City of Pompeii have withstood wind and rain for over a millennium. The red earth pigments can be utilized traditionally by grinding the earth on a rock and using vegetable or animal glues as binders to make paint.

Red earth pigment can also be mixed with water and applied to a wall surface covered with wet lime plaster. As the plaster dries, the pigments bonds to it and become part of the wall's surface. Only pigments that are compatible with lime could be used in this way, and it is the red earth pigments that are not affected by alkalis, so they make a good pair (Davies, 2006).

5.2 Building material

The laterite is a predominant raw material for building construction in Nigeria. Most residential buildings in the rural areas were built with laterite mud a long time ago. However, recent houses are built using cement instead of laterite mud as a building material. The reason for replacing laterite mud walls with cement made walls is that laterite mud walls tend to crack and collapse and bases of external walls usually get eroded during rains. Today, better use of laterite in house construction is possible than has been done in the past. Cement is very suitable for building but is not a local material in that a substantial proportion of the quantity used in Nigeria is imported and it is expensive. Production of cement in the country requires a heavy financial outlay and very sophisticated technology, which is not suitable in present circumstances. Comparatively, red earth presents a great potential for development since it is available in abundance and the techniques for utilization are very simple and within reach of the individual house builder. Above all, it is cheap.

Oluwatudimu(1990) reported some development in the use of laterite for building to include fired clay bricks and stabilized soil bricks. According to him, binding of these bricks in wall construction can be done with lime mortar, which is a suitable substitute for the cement/sand mixture. Adesina and Utaikar (1985) have also confirmed that lime can be derived from limestone through firing at high temperature (1000°C) and the mortar is made by mixing it with sand and water in suitable proportions. Bricks of suitable quality can be cheaply produced in small operation in our rural areas. Laterite, which is "universally" available, can simply be dug up and molded manually into bricks when wet. They are then fired in earthen kilns using firewood as fuel.

Mendie, (1991) has also suggested a process of constructing house with laterite in order to reduce the risk of collapse resulting from termite invasion that usually characterizes earth mud houses of the past. According to him, mud walls treated with "dieldrin" or other preservatives, directly or by adding it to the water when making the mud, set on a good structural foundation made with cement blocks can ensure that termite do not destroy the walls by eating away the internal wood skeleton. He recommends plastering the walls with cement and paint where possible.

5.3 Road construction

laterite is one of the major materials needed in the construction of roads. laterite basement is usually an important aspect of road design: This is the layer of red earth filling, well watered and compacted to give a road solid base. The red earth is best suited for road basement layer because of its chemistry. In any earth pigment, there are three components that are necessary. The first is a principle colour-producing agent, which is non-oxide. The second component is a secondary colour producing agent, which can be calcium, manganese, carbon, or an organic material such as silica or limestone. The third component is a base filler diluents, or carrier of colour and it is a product of low humidity and high temperature. laterite is also a hematite, which is a hydrous ferric oxide. On a side, they are resistant to acids and bases, these contribute to its permanence.

1.1.1. 5.4 Water supply

Bedrock in tropical zones is often granite, gneiss, schist or sandstone; the thick laterite layer is porous and slightly permeable so the layer can function as an aquifer in rural areas. One example is the Southwestern Laterite (Cabook) Aquifer in Sri Lanka (Panabokke and Perera, 2005). This aquifer is on the southwest border of Sri Lanka, with the narrow Shallow Aquifers on Coastal Sands between it and the ocean. It has considerable water-holding capacity, depending on the depth of the formation. The aquifer in this laterite recharges rapidly with the rains of April–May which follow the dry season of February–March, and continues to fill with the monsoon rains. The water table recedes slowly and is recharged several times during the rest of the year. In some high-density suburban areas the water table could recede to 15 m (50 ft) below ground level during a prolonged dry period of more than 65 days. The Cabook Aquifer laterites support relatively shallow aquifers that are accessible to dug wells.

1.1.2. 5. 5 Waste water treatment

In Northern Ireland phosphorus enrichment of lakes due to agriculture is a significant problem (Wood and McAtamney, 1996). Locally available laterite – a low-grade bauxite rich in iron and aluminium – is used in acid solution, followed by precipitation to remove phosphorus and heavy metals at several sewage treatment facilities. Calcium-, iron- and aluminium-rich solid media are recommended for phosphorus removal. A study, using both laboratory tests and pilot-scale constructed wetlands, reports the effectiveness of granular laterite in removing phosphorus and heavy metals from landfill leachate. Initial laboratory studies show that laterite is capable of 99% removal of phosphorus from solution. A pilot-scale experimental facility containing laterite achieved 96% removal of phosphorus. This removal is greater than reported in other systems. Initial removals of aluminium and iron by pilot-scale facilities have been up to 85% and 98% respectively. Percolating columns of laterite removed enough cadmium, chromium and lead to undetectable concentrations. There is a possible application of this low-cost, low-technology, visually unobtrusive, efficient system for rural areas with dispersed point sources of pollution (Wood and McAtamney, 1996).

1.1.3. 5.6 Other Uses of Laterite

1.1.4. Ores: Ores are concentrated in metalliferous laterites; aluminium is found in bauxites, iron and manganese are found in iron-rich hard crusts, nickel and copper are found in disintegrated rocks, and gold is found in mottled clays. Bauxite ore is the main source for aluminium. Bauxite is a variety of laterite (residual sedimentary rock), so it has no precise chemical formula. It is composed mainly of hydrated alumina minerals such as gibbsite [$Al(OH)_3$ or $Al_2O_3 . 3H_2O$)] in newer tropical deposits; in older subtropical, temperate deposits the major minerals are boehmite [γ-$AlO(OH)$ or $Al_2O_3.H_2O$] and some diaspore [α-$AlO(OH)$ or $Al_2O_3.H_2O$]. The average chemical composition of bauxite, by weight, is 45 to 60% Al_2O_3 and 20 to 30% Fe_2O_3. The remaining weight consists of silicas (quartz, chalcedony and kaolinite), carbonates (calcite, magnesite and dolomite), titanium dioxide and water. Bauxites of economical interest must be low in kaolinite. Formation of lateritic bauxites occurs world-wide in the 145- to 2-million-year-old Cretaceous and Tertiary coastal plains. The bauxites form elongate belts, sometimes hundreds of kilometers long, parallel to Lower Tertiary shorelines in India and South America; their distribution is not related to a particular mineralogical composition of the parent rock. Many high-level bauxites are formed in coastal plains which were subsequently uplifted to their present altitude (Valeton, 1983).

1.1.5. The basaltic laterites of Northern Ireland were formed by extensive chemical weathering of basalts during a period of volcanic activity. They reach a maximum thickness of 30 m (100 ft) and once provided a major source of iron and aluminium ore. Percolating waters caused degradation of the parent basalt and preferential precipitation by acidic water through the lattice left the iron and aluminium ores. Primary olivine, plagioclase feldspar and augite were successively broken down and replaced by a mineral assemblage consisting of hematite, gibbsite, goethite, anatase, halloysite and kaolinite (Valeton, 1983).

1.1.6. Laterite ores were the major source of early nickel. Rich laterite deposits in New Caledonia were mined starting the end of the 19th century to produce white metal. The discovery of sulfide deposits of Sudbury, Ontario, Canada, during the early part of the 20th century shifted the focus to sulfides for nickel extraction. About 70% of the Earth's land-based nickel resources are contained in laterites; they currently account for about 40% of the world nickel production. In 1950 laterite-source nickel was less than 10% of total production, in 2003 it accounted for 42%, and by 2012 the share of laterite-source nickel is expected to be 51%. The four main areas in the world with the largest nickel laterite resources are New Caledonia, with 21%; Australia, with 20%; the Philippines, with 17%; and Indonesia, with 12% (Valeton, 1983).

Red Earth pigment can also be used in the production of chalks, pencils or other forms of writing materials. It can equally be used in the manufacturing of rubber, plastic, concrete products, paper, magnetic inks, and fertilizers. Because of its non-toxic nature, it is legal to use in drugs, foods and cosmetics (Hendry, 2006).

6. Development and Management of Red Earth

It has been established that environmental problems such as desertification, deterioration of urban physical quality, land degradation, deforestation, soil erosion and flooding emanate mainly from human activities created in quest to achieve a higher level of development. Therefore, in extracting the red earth precautions will have to be taken to balance development objective against the need to maintain desirable environmental quality.

Any person, company or agency planning a project/activity relating to the extraction and utilization of Laterite would be required to prepare and Environmental Impact Assessment (EIA) report and the report must set our potential impact of the activity on the environment and plans for preventing/mitigating the same as well as clean up plans. All such reports must be approved by the Federal Ministry of Environment.

7. GRANTING OF LICENSING TO MINING

Prospective mining individual/company would be expected to file an application to the Ministry of Solid Mineral Resources asking for permission to undertake mining operation. Such applications will have to be supported among other relevant document by

1) Plan of the Site with correct coordinates
2) Approved EIA Report
3) The organization profile, etc

8. CONCLUSION

This paper may not be all embracing and may not address perfectly all the relevant issues concerning the extraction and utilization of the laterite. Nevertheless, from the discussion, it is clear that laterie is a resource of high value. Many regions of the world are already benefiting from the economic value of the laterite. This expose is expected to incite the indigenous scientists to examine more closely this resource to discover more about the deposits and the contents of the local varieties of laterite for it increased economic uses. It is the hope that through use and research more useful ideas can be developed regarding other uses and toward better management of the surrounding environments. This is very important because balance must always be maintained between development objectives and desirable environmental quality.

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