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Industrial Development and Natural Resources Depletion in Nigeria

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Abstract
A number of Nigeria's natural resources are being depleted at very fact rates, making their availability unsustainable for sustainable industrial development. The Nigerian soils are generally light texture and low in Cation Exchange Capacity (CEC) which ranged from 2.40 to 5.95 mc/100g of soils. Various soil fertility studies have shown that most Nigerian soils have pH ranges from 4.2 to 8.4 with a combined calcium content which varies from 0.5 to 5.55nc/100g and generally low potassium content (0.07 to 0.45) and an organic matter that varies from 1 to 2.55%. The level of micronutrients are low with fertility and productivity indices varying between 31-90% and 2-58% in most cases. Soil fertility and nutrient content are fast depleting by various factors which includes low use of mineral fertilizers, gully erosion, soil salinity, desert encroachment and others such as inappropriate agricultural practices, oil spillage, over population and lack of land use planning. Also, on the increase is groundwater depletion, deforestation which occurs at about 300,000-400,000ha per annum, loss of biodiversity which is threatening 484 plant species in 112 families of the 4,600 plant species in Nigeria. Fisheries resources are also depleting. Both the inland freshwater and the oceans are experiencing serious onslaught of the fish population with species such as the Atlantic cod and haddock already depleted in the salt waters. On the inland waters, fish production is being decimated on annual bases with production in the 80's less than half of the 1950's. The mineral resources have been mined since 1906. Currently, large scale exploration of limestone, marble, rock aggregates along with gold, oil and gas are on-going causing a lot of havoc to the environment. There is need to halt or reduce these occurrences in order to put industrial development on a sustainable path.
Keywords: natural resources, depletion, minerals, biodiversity, deforestation.
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1.0 INTRODUCTION

Natural resources, including materials, water, energy, and land are the basis of all life on earth. The earth and its treasure base is experiencing a siege from all aspects of human endeavour, ranging from misuse, abuse and degradation of environment. Without constant use of natural resources, the economy and the society cannot function. Thus, in a broad sense, natural resources include everything that is derivable for the use of man from any part of the universe. In the physical sphere, they include energy from sunshine, and gravity as well as mineral deposits and the rain. In the biological sphere, they include domesticated as well as wild plants and human resources. In view of the high demand for the resources overtime, the consumption has had deleterious effect on the environment globally. The climate is changing, freshwater resources, fish stocks and forest are shrinking. Fertile lands are being destroyed and species are becoming extinct as a result of unsustainable application of the resources (SERI, 2015). Today, man, extracts and use around 50% more natural resources than only 30 years ago. Estimated present utilization is about 60 billion tonnes of raw materials a year and this is expected to grow to about 100 billion tonnes by 2030 (SERI, 2015).

The major problem of natural resources over exploitation and depletion is caused by the continuous high levels of resource consumption in the developed countries and rapid industrialisation of countries such as China, India and Brazil. Many of the problems that threaten mankind survival on earth result from increased production of waste and emissions, and, increased human use of land area (SERI, 2015).

Primary commodities, including agricultural and mineral resources, are the major source of income and employment for a number of developing countries. The development of these resources has assisted nations to increase their Gross Domestic Product (GDP) while at the same time, depleting the resource base. For most of the commodity dependent countries, reliance on natural resources has led to contraction of a number of the resources.

The natural resources are divided into renewable and non-renewable resources. Renewable resources naturally regenerate to provide supply units within at least one human generation. They are resources that can be replaced or renewed as they are used. Some renewable resources are inexhaustible (for instance, solar power from the sun). Others can be exhausted if the rate of depletion is greater than the rate of renewal. For example, forests are non-renewable, if the rate of depletion exceeds that of replanting. Other resources are also renewable to a point. For instance, any particular species is technically renewable if its members can keep breeding, but if productions falls below, a minimum level of viability, it leads to extinction and permanent loss of the resources, making it possible for some renewable resources to be depletable or exhaustible. Generally, at inception, exploration, exploitation and consumption of the resources were effectively contained within the carrying capacity of the environment and its renewable potential. However, with passage of time, population increase, sophisticated

technical progress and their overall impact and pressure on the environment have necessitated a rethink. It is therefore clear that there is need for sustainability in the use of natural resources.

In Nigeria for instance, there is both cultural diversity and ecological diversity. With about 250 distinct ethnic nationalities, the ecosystems ranged from the southern mangrove swamps, rainforests to savanna woodlands, and semi-arid Sahel regions in the north. The country is characterised by various landscapes, climate, soil, vegetation ad regional dichotomies. As a matter of fact, the country can be studied as a paradigm of the paradox of development in Africa. There is rapid depletion of and degradation of the ozone layer, soil resources, as well as air and water pollution, amongst others. Pollution and deforestation, soil erosion, oil spills and uncontrolled human activities make the environmental situation a grave one. In the last 45 years, the demand for the earth natural resources has doubled due to increase in living standards in rich and emerging countries and increasing world population. This has also increase the use of the planets resources, including the freshwater, forest resources, biodiversity, minerals resources, etc. Oil depletion is also an increasing phenomenon. It has been predicted that growth in demand for oil will outstrip supply by 2025 (Quah, 2015). Currently, extraction is going at a larger scale than discovery, globally. Also, large scale exploitation of minerals that began in 1760 in England has grown ever since and virtually most of the world's mineral ores are still being extracted from mines over fifty years old as miners dig deeper for lower grade ore and using technology to extract minerals. Virtually, all basic industrial metals (copper, iron, bauxite, etc) as well as rare earth metals are facing output limitations. Based on existing resources today, a number of mineral resources are projected to enter decline production in the next 20 years (Quah, 2015). Coupled with this, mineral resources are also depleting as new discoveries are obtained more slowly than exploitation. Also there is significant long term trend over the 20th century in the use of non-renewable resources such as minerals to supply a greater requirements of the raw materials inputs to the non-fuel, non-food sector of the economy (Quah, 2015). Examples of this is the greater consumption of crushed stone, sand and gravel in construction as a result of rising affluence which leads to higher demand for better living standards.

From the above, the problem of over consumption and consequent depletion is becoming more critical as various discussions globally are highlighting the importance of declining crude oil, and shortages of crucial minerals such as Zinc, Copper and Phosphorous (Mag-doff, 2011, Heinberge, 2007). Global ecosystems and the ecological services they provide are also being degraded. Freshwater resources and forests are shrinking, many species are under threat of extinction and fertile lands are being eroded (UNEP, 2007). The possibility of natural resources to carry the world's population, most especially the ten billion people projected to be on earth in the middle of this century has been observed not to be environmentally possible or socially or economically sustainable (SERI, 2015).

As a result of the above, achieving sustainable use of resources has become a major topic of international discuss as the need for the globe to move towards a more sustainable use of natural resources has become imperative. The G8 countries, with the highest level of economic development, recently reiterated the goal to reduce their greenhouse emission by 80% by 2050. This type of intervention is required in all aspects of natural resource utilisation (Schmiat-Bleek, 2009). While the rate of resource utilisation is higher in developed countries, the ripple effect is being felt in developing countries who are the major exporters of primary natural resources (Ogunwusi, 2013; 2015). For example, people in rich countries consume up to 10 times more resources than poorest countries (SERI, 2015). On average, an inhabitant of North America consumes around 90kg of resources each day, while in Europe, average consumption rate is around 45kg per day. In Africa, the consumption rate is only around 10kg/day. Nevertheless, most African countries in view of their reliance on trade in natural resources and commodities for their foreign exchange earnings continue to unmitigatedly extract their natural resources for export, leading to more overexploitation, resource degradation and poverty. Unfortunately, studies on linkages between natural resources, human capital and economic development reflect a consistent pattern of relationships. Gylfasson (2001) studied 65 natural resource rich countries including Nigeria and came out with the findings that only four countries managed to attain long term investments exceeding 25% of Gross Domestic Product (GDP) and per capital growth income exceeding 40% per annum on average between 1970 and 1998. The countries are Botswana, Indonesia and Thailand. This paper examines the situation in Nigeria. It outlines impact of natural resources extraction on resource depletion and the implication for national industrial development. The necessary actions required to be taken to promote sustainable of the nation's natural resources are outlined.

2.0 Economic and Industrial Development Patterns in Nigeria

Globally, natural resources have provided the fulcrum for the industrial development aspiration of nations. From the Stone Age up till today, the per capital consumption of natural resources has risen by a factor to 15 to 30, as shown by the cultural history of mankind (SERI, 2015). While the recent history of economic development in Nigeria does not in most cases, go back to the hunter-gathering stage, it has always been stipulated that the minimum consumption of hunter gatherer society had a per capital consumption of natural resources of about one metric tonne per year, which was equal to about 3kg per day (Fischer-Kowalski *et al*., 1977). The resources were mostly used for food, basic housing and weapon for hunting (SERI, 2015). This eventually rose to about 4 tonnes

per annum, per person, in view of increased requirement to accommodate feed for animals kept for milk, meat and farm animals in agrarian societies, building requirements, farm implementation for ploughing, etc and cooking items including wood for energy generation (SERI, 2015). Thus, the history of renewable natural resources utilisation had been a continuous phenomenon in Nigeria far before the amalgamation. This development has had pressure on natural resources of what presently constitute the space called Nigeria.

While there is no history of economic and industrial policy instituted by the British administration between 1914 to 1943, historians have shown that between 1943 to 1959, the pre-independence period of Nigeria featured craft industries involving artifacts of wood, brass and bronze, leather, textiles, iron works, pottery, canoe carvings, bronze work, and embroidery. These industries featured at close proximity with the available raw materials and following superior completion of the factory system of production, they declined; particularly as the motive of the imperial government was to obtain industrial raw material for their country (Dagogo, 2014). Valorisation initiatives introduced by the colonialist led to establishment of palm oil mills, palm kernel crushing mills, cotton ginneries, oil seed mills, power driven sawmills, etc., to become pioneer factories followed by finishing operation factories such as printing, publishing, baking, furniture works, etc (Dagogo, 2014). During this period which saw the introduction of Aid to Pioneer Industries in 1952 and Industrial Development (Income Tax Relief) in 1958, there was extension in the period for claiming tax holiday and introduction of pioneer industry status. A number of European Firms entered into manufacturing of light consumer goods such as beer, soft drinks, cigarettes, etc.

The post-independence administration also continued the march towards industrial development of the country. The First National Development Plan (1962 – 1968) saw the initiation and inception of the import substitution strategy which entailed local manufacturing of goods hitherto imported, and stimulated indigenous ownership and management of industries (RMRDC, 2004; RMRDC, 1994; Aribisala, 1993). This led to establishment of industries such as food, confectioneries, beverages, tobacco, textiles, weaving apparels, plastics, rubber products, soaps, detergents, metal and leather products. The consumer goods production dominated manufacturing activities and accounted for 70 – 75% of the Manufacturing Value Added and employment in the sector. By 1965, the medium and large scale industries in Nigeria had increased from 150 plants at independence to 380. Similarly, the share of manufacturing in GPD rose from 4.2% in 1960 to 6.1% in 1964. The major problem associated with the industrial development pattern was high dependence on imported inputs, most especially, raw materials, technology and managerial expertise. The second National Development Plan, 1970 – 1974 focused on even development as the war ended in 1970. The focus of industrial development was to promote even development and fair distribution of industries in all parts of the country, to ensure rapid expansion and diversification of industrial sectors in order to increase income realized from manufacturing activities, create more employment opportunities, promote the establishment of heavy industries in strategic sectors that can earn foreign exchange, to continue the programme of import-substitution, initiate indigenous manpower development schemes in the industrial sector, and to raise the proportion of indigenous ownership of industrial investment (Federal Ministry of Information, 1970). Most of the industries were owned by the government as the period coincides with the oil boom years.

The industrial programmes of this era were characterized by investment in heavy industries. These industries include: oil refineries, petrochemicals, liquefied natural gas, fertilizer, machine tools, aluminium smelting textiles, iron and steel and motor assemblies. The poor performance of these industries that continued to bleed cash, the phenomenal preference of foreign goods in lieu of local ones, and the sudden crash in oil prices left the federal government with accumulated debt obligations to discharge (Ikpeze *et al*., 2004; Aribisala, 1993). The greatest development of the period was, perhaps, the introduction of the indigenization policy as contained in the Nigerian Enterprises Promotion Decree of 1972, which reserved certain categories of industrial activity, mostly services and manufacturing, for Nigerians (Ikpeze *et al*., 2004). Similarly, Nigerian Enterprises Promotion Board was set up to administer the decree, while Bank of Commerce and Industry (a public sector Bank) was established to provide leveraged buyout-type financing for Nigerian purchasers.

Nevertheless, the sudden drop of oil prices in the international market has a devastating shock on the industries particularly as they were mostly import-dependent, and there was need for government to rationally allocate its limited resources and foreign exchange in the face of dwindling oil revenue. The then prevailing policies of import licensing and exchange rates control resulted in acute shortages of industrial inputs with adverse consequences on industrial production and capacity utilization. The sourcing and sale of import licenses became big business for many rent seekers (Iwuagwu, 2011).

With its involvement in all industrial and economic and activities, coupled with the over-regulated financial system, government was stretched too thin to play its legitimate role of creating enabling environment, given that a classical economic changes were necessary to turn the economy around. The same year, economic stabilization act was promulgated, which effected reforms in exchange control, and fiscal and monetary policies such as; the banning of the importation of certain items including frozen chicken and removal of 29 other items from general license to specific import license, introduction of the import duties or increases in the rate in 49 import items, among others (Dagogo, 1999).

According to Iwuagwu (2011), this was background to the introduction of the Structural Adjustment Programme (SAP) in 1986. Essentially, SAP was introduced amidst a gloomy background of mounting external debt, unhealthy investment and the failure of the regime of stringent trade and exchange controls, which had been pursued in the previous two decades (FRN, 1986). SAP was designed to among other things encourage the use of local raw materials and intermediate inputs, encourage the development of local technology, assist in maximizing the growth of value-added manufacturing activity, promote export orientation, generate employment through active private sector participation, remove constraints that hamper industrial development, including, deficiencies in infrastructures, manpower and administration, and to liberalize controls to facilitate indigenous and foreign investment (FRN, 1986). In order to build a competitive economy, privatization and liberalization of aspects of economic activity were pursued, and import licensing regime was abolished. At the same time, industries were encouraged to integrate backwards (or look inward) in order to source their raw materials locally.

The 1988 industrial policy was initiated. The objectives were to provide greater employment opportunities through industry; increase export of manufactured goods; ensure dispersal of industries, improve technological kills and capability available in the country, increase local content, attract foreign capital and, increase private sector participation in the manufacturing sector (FMI, 1988). To achieve this, private sector participation in the industrial sector was pursued while commercialized government holdings in existing industrial enterprises, serve as the catalyst in establishing new core industries, provide and improve infrastructures, improve regulatory environment, improve investment climate, establish a clear set of industrial priorities; and harmonize industrial policies at the Federal, State and Local Government levels (FMI, 1988). This led to increase in capacity utilization from 30 per cent at the end of 1986, to 36.7 per cent by mid-1987 and further to 40.3 per cent in 1990 and 42.0 per cent in 1991(Dare-Ajayi, 2007). A practical example is the emergence of Nnewi Auto Technology SME Cluster. It was also instrumental to the upsurge of Small and Medium-scale Enterprises (SMEs).

On the other hand, the financial liberalization policy associated with SAP led to inflation and low purchasing power of consumers, which ultimately forced industries to reduce staff strength and in some cases wind up. Also, trade liberalization under SAP caused massive inflows of all sorts of finished foreign product (second-hand or sub-standard) into the country resulting in low patronage of local products. Government's effort to consolidate the gains from SAP led to adoption of the National Rolling Plans. The plans began with the 1990 - 1992 rolling plan and an Industrial Master Plan (IMP), designed to address shortage of industrial raw materials and inputs, infrastructure challenges, inadequate linkage among industrial subsectors and administrative and institutional problems. Other efforts include the establishment of industrial estates and entrepreneurial development programmes (EDP) and a new industrial policy by Federal Ministry of Industry in 2003. The overriding objective was to accelerate the pace of industrial development by radically increasing value-added at every stage of the value-chain, as government pursues knowledge and skill intensive production on the basis of available best practices (FMI, 1988). The Bank of Industry (BOI) was established to lend to the industries, while Nigerian Agricultural Cooperative and Rural Development Bank (NACRDB) was set up to facilitate the availability of primary industrial inputs through the provision of medium to long term funds for agriculture and agro-allied industries.

In 2001, an appraisal of the various past schemes and incentives aimed at promoting SMEs disclosed that finance is by no means the only of core constraints to SME development, and that managerial and technical incompetence was as important as the perennial lack of funds (Sanusi, 2003). Government's reaction to this revelation was to shift from the usual debt financing to equity financing. Facilitated by CBN, it was known as Small and Medium Enterprises Equity Investment Scheme (SMEEIS). These developments set the pace for resource based industrialisation in Nigeria.

3.0 Industrial Development and Natural Resources Depletion

In the course of exploitation of natural resources in Nigeria for development, a lot of environmental impacts have been observed. These ranges from overexploitation of resources, destruction and degradation of ecosystems and pollution. In most cases, the overexploitation of the resources has been done in an unsustainable way, causing an increasing concern as these threatens human existence (Klawitter, 2014). In the quest for industrialisation and urbanisation in Nigeria, large scale exploitation of natural resources and their consumption have resulted in weakening, deterioration and exhaustion of the resources (Aina and Salau, 2012). Some of the problems caused by the present trend of raw materials exploitation are species extinctions, oil spillage, gas flaring, soil erosion, coastal degradation, ozone depletion and groundwater contamination among other things (Gray, 2012).

The developmental goods built on a process of generating wealth that produce natural, human and institutional capital which is the source of income and wellbeing often lead to resource depletion and degradation. There are certain other factors such as socio-political, cultural and demographic, leading to resource depletion. Inefficient resource utilisation is one of the banes of problems causing depletion. More than 300 million Africans still lack access to safe drinking water and 14 countries on the continent suffer water security. Out of the 55 countries in the world with domestic water use below 50 litres per day [minimum requirement set by World Health Organisation

(WHO)], 35 are in Africa. Meanwhile Africa has seemingly abundant water resources that are not being efficiently utilised. With 17 large rivers and more than 160 major lakes, Africa uses 40% of its annual renewable water resources for agriculture, industry and domestic purposes. Presently, about 50% urban water is wasted as is 75% of irrigation water. Another major issue is the role of poverty and other socio-economic problems on natural resources reduction and on environment. Poverty and environment have been linked in a downward spiral in which people are forced to deplete the environment as a result of overutilization of resources. Poverty contributes to environmental degradation in most of the agriculture based developing countries.

In Nigeria's quest for economic growth, ecological perspectives have be relegated to the background in a number of cases with respect to resource utilisation. Many parts of the country have experienced natural hazards, including the Sahelian drought of 1972 – 1973; the increasing incidence of floods, the destruction of cocoa and arable farmlands in southwest Nigeria, gully erosion in the east, etc. More importantly is the continue deterioration of soils through nutrient depletion and erosion. In urban areas, productive land is lost in the search of earth materials for construction and in economic competition from urban and industrial uses of land (Areola and Ofomata, 1978). Thus, in the absence of adequate planning, the use of land and exploitation of natural resources have been fully unguarded and uncontrolled. Furthermore, there has been little improvement in traditional land and resource management practices (Areola and Ofomata, 1978). The oil boom increased the spending power of government and provided funds to implement numerous projects some of which were established without due regard to the ecological condition of the land.

4.0 Impact of Industrial Development on Natural Resources Depletion in Nigeria

The impacts of economic and industrial development in Nigeria on natural resources depletion have been phenomenal. The situation is further compounded by the export of natural resources in primary forms with little or no value addition. The major impacts of industrial development on natural resources depletion in Nigeria are subsequently discussed.

4.1 Soil Depletion

Nigerian economic and industrial development aspirations have always been premised on the use of the natural resources and towards promoting increased agricultural production and productivity. These have had impact on the soil in the country. The evolving knowledge of the nature and properties of soils have served in better articulation of the potentials and limitation of soils to compactible land use over the years. A thorough idea on soil pedology and agronomy are important indices in most fertility surveys since soil data provide basis for guiding variety of land applications (Morgan, 1989). Nigerian soils are generally light textured and low in cation exchange capacity (CEC) with a clay content that range from 9 to 43% in more than 60% of the area. The CEC range from 2.40 to 5.95mc/100g of the soils, the value being less than 5 in the majority of the area (Agboola, 1986). The soil pH ranges from 4.2 to 8.4, with a combined calcium and magnesium content which varies from 0.5 to 5.55mc/100g; and a generally low potassium content (0.07 to 0.45) tending to be lowest in sand stones and an organic matter that varies from 1 to 2.55%. According to Nigeria Country Profile, the soils are of medium to high potentials, although, under improved farming systems, the soil productivity could be improved (Agboola, 1986). The zones and their coverage under improved farming system are shown in Table 1. Study on micronutrients availability in Nigerian soils is a recent exercise as most fertility workers centre their works on nitrogen, phosphorous and potassium. In a study reported by Domchang *et al* (2014) on the status of fadama soils under cultivation in Lushi and Federal Low Cost Housing Estate in Bauchi, Nigeria; the level of micronutrients in the two soils were observed to be low. The availability or deficiencies of other nutrients elements in the soil are related to zn and cu availability, requiring amendments of zn and cu and/or application of recommended quantities of other key nutrient elements to enhance availability of the micronutrients for optimum yield of crops.

Also from the work reported by Tekwa *et al* (2011) on the soil nutrient status and productivity potentials of lithosols in Mubi Area of North Eastern Nigeria, the soil properties was observed to be generally low in nitrogen, phosphorous and high in potassium contents. The lithosols in the study area was categorized as PII, PIII and PV according to Requier *et al* (1970) or S2, $S_{3\text{-}s}$ and $S_{3\text{-}d}$, N_1 and N_2 according to FAO (1976). This indicated that the soils were between good to marginally suitable with slope, stoniness, shallowness and drainage as much as soil nutrients as limitations. These may be the reasons why the soils are being cultivated without significant crop returns (Landon, 1991).

From the results, the fertility (31-90%) and productivity (2-58%) indices rating of the lithosols in Mubi area were reported to be generally adequate for rain-fed agriculture and orchard as shown in Table 2. In addition the soil fertility can be improved to between 55 and 100% and the productivity potential of the soils, between 21 and 81% (Table 2). According to Tekwa *et al* (2011), these improvements in the fertility and productivity potentials of the land imply an opportunity for the soils to potentially support such crops as rice, wheat, sugarcane, onion and cabbage for Digil and Madanya locations; guinea-corn, maize, millet, beniseed and cowpea for Muvur, Vimtim, Gella and Lamorde locations; and orchards in all locations.

Likewise, in a study carried out by Onwudike *et al* (2016) to evaluate the fertility status of soils in Ahiazu Mbaise, Imo State under three land use types, results showed that irrespective of the land use, soils of the study area were moderately acidic with high sand fraction (>70%) resulting to poor moisture retention and total porosity. The chemical properties showed low organic matter content (15.8 - 29.1g/kg), low total nitrogen (0.7 - 1.5g/kg) and available phosphorus (3.1 - 5.6mg/kg). The exchangeable bases were low and below the critical limits with predominant exchangeable H and Al. soil nutrient depletion followed this order: fallow land > palm plantation > cassava cultivated land. Results also showed little variability in soil physicochemical properties in the three land use types. Results of the nutrient index and fertility rating also showed that soils of the study locations were extremely poor in fertility with a fertility rating of 1 and nutrient index of 1 in the three land uses, signifying poor fertility status when compared to standard ratings. To improve the quality and fertility level of the soils in these locations, Onwudike *et al* (2016) recommended urgent need to adopt strategic management measures and agronomic principles that will improve the fertility levels. Likewise, in a study reported by Aliyu and Ray (2014), on the comparative study of soil fertility rating under crop cultivation in Gombe, it was reported that under groundnut farm, available phosphorous rated as moderately low has the mean value of 29 ppm which scores three marks, while organic carbon, exchangeable Na, Ca, and CEC are rated as very low. This variable has the mean of values 0.85, 0.88, 4.93 and 6.25 respectively which scored two marks. Exchangeable K, Mg and total nitrogen were rated as extremely low with values of 0.38, 2.88 and 0.03 ppm respectively, which scored one mark under the same land. The study showed that the extremely low level of the exchangeable K is due to the fact that leafy crops such as groundnut generally contain about 2% K in their dry matter and large amounts are removed when they are harvested. The mean value for nitrogen, 0.03, was rated as extremely low. This was attributed to the accelerated erosion and leaching since these invariably result in the loss of nitrogen. Land under maize in the study area showed that the organic carbon, exchangeable Na, Ca, are rated as very low, which score two marks with mean values of 0.78, 0.70 and 4.60 respectively. The mean value for total nitrogen, potassium and magnesium were 0.03, 0.36 and 3.13ppm respectively, rated as extremely low with the score of one mark; while available phosphorous and CEC are rated as moderately low with the mean value of 28ppm and 7.0 respectively with the scores of three marks. This resulted in total marks of fifteen (15) for maize. The mean values of 0.67, 0.60, 4.60 and 6.0 were obtained from organic carbon, exchangeable Na, Ca and CEC respectively, under beans in the study area. These values were rated as very low with the scores of two marks. Total nitrogen, exchangeable K and Mg are rated as extremely low with mean values of 0.02, 0.35 and 2.73ppm respectively with a total score of one mark while, available phosphorous was rated as moderately low with three score and mean value of 26ppm. This has a total of 14 marks for land under beans. Groundnut and beans score the same marks with the same fertility rating. This indicated that they have the same fertility in the study area which may be due to the fact that they do not enjoy the application of both organic and inorganic fertilizer and also have the same type of management. Land under maize proves to have higher fertility rating than the land under groundnut and beans. The higher fertility may be due to the frequent application of both organic and inorganic fertilizer to the land irrespective of the problems of erosion and leaching. Beans and groundnut areas have the same fertility problems; firstly, the release of nutrients in the area is low. Secondly, the ability of soils in the area to retain nutrients is low as a result of leaching. The studies reported here indicated that fertility under the reported soils in Bauchi, Mubi, Ahiazu, Mbaise in Imo State and in Gombe State under various agronomic practices were low, indicating the need for better land and crop management practices. As these areas cover nearly all the ecological zones in Nigeria, it can be surmised that there is need for deep and detailed assessment of Nigerian soils to ascertain their fertility status and management practices required for improved productivity. Some of the factors responsible for soil depletion in Nigeria were discussed subsequently.

4.1.1 Nutrient Depletion

The lack of soil management practices by farmers, climatic and environmental factors have had serious deleterious effect on Nigeria's soils. Much of Nigeria's land is being degraded as a result of intensification of land use for agricultural production, which is necessary to satisfy increased food demands. Agricultural production in most cases is practiced without the adoption of proper management practices and external inputs. Overcoming the problems that lead to degradation requires a good understanding of interplay among biophysical, agroclimatic, economic and human factors that determine the management of natural resources and prevailing farming systems (IFDC, 1999). According to IFDC (1999), analysis of crop production and nutrient depletion estimates for the period of 1993 to 1995 indicated that agricultural production in Africa had been stagnant or declining with soils losing high amounts of nutrients. In the semi-arid, and Sudano sahelian areas that are more densely populated, soils are losing 60 – 100kg NPK annually. The soils of these areas are shallow, highly weathered and subject to more cultivation with low use of mineral fertilizers 0 – 6kg NPK/ha/year. Water availability and intensification of land use due to population pressure have restricted crop diversification and the use of proper management practices. In addition, the length of growing season is very short, less than 140 days, increasing pressure on land. Other important agricultural areas such as those located in the sub-humid and humid regions and in the savanna and forest areas show high variably of nutrient losses. A very clear observation is that the continued lack of

application of required nutrients is causing soil nutrient depletion and reduction of agricultural productivity. Major factors contributing to the depletion of nutrients are soil erosion for phosphorous and soil erosion and leaching for Nitrogen and potassium. Nutrient gains in most of the soils are low and occur through mineral fertilisation, nutrient deposition and nitrogen fixation. These low gains contribute to high rate of depletion. In addition to the application of mineral fertilizers, long term management practices, such as use of soil conservation measures, recycling of crop residues, livestock management and use of organic fertilizers will be required. Thus, it is imperative that the government must take lead in confronting the problems of nutrient depletion, land degradation and decline in the productivity of agriculture. According to IFDC (1999), significant policy changes will be required to establish an environment conducive to the efficient use and availability of agricultural inputs and the improvement of local extension services and farmer support. Periodic assessment of agricultural areas should be conducted to identify regions and sites where nutrient depletion or extensive use or accumulation severely limits crop production, degrades agricultural land and causes serious environmental disturbances.

4.1.2 Gully Erosion

Erosion is one of the surface processes that sculpture the earths landscape and constitute one of the environmental problems globally. Gully erosion has had significant negative impact on the utilisation of the soils. This is particularly severe in Abia, Imo, Anambra, Enugu, Ondo, Edo, Ebonyi, Adamawa, Kogi, Delta, Jigawa and Gombe States. To reduce soil erosion rate on farmland, reliable and proven soil conservation technologies could be adopted including ridge planting, no-till cultivation, crop rotation, mulches, living mulches, agroforestry, terracing, contour planting, cover cropping and installation and installation of wind breaks (Primentel, 1995). According to Abdul-Fatai *et* al (2014) the prevention of the processes or mechanisms that result into or advance to gully erosion should be of paramount importance to all the stakeholders in environment management in the country. Control measures to stem gully erosion that are incipient are most effective when erosion is still at an early stage (Obidimma and Olorunfemi, 2011). Organic carbon, chemical properties, textural characteristics and moisture content of the soil have been suggested as the most useful factors to be considered in a detailed survey and control of gully (Osadebe and Enuvie, 2008). Thus, these factors and others should be carefully examined in the erosion-prone regions of the country in a bid to better design preventive measures. Other measures that could be used to curb the menace of gully erosion as suggested by Abdulfatal *et al* (2014) include:

i. Improvement of farming practices that reduce the gully erosion processes to the barest minimum.
ii. Prohibition of the dumping of refuse on the river channels and floodplains.
iii. Adoption of cultural method of erosion control such as planting of plantain and banana on the floodplains have also been found to be effective in controlling erosion. Grasses species such as Eulaliopsiss binata (Babiyo), Neyraudia reynaudiana (Dhonde), Cymbopogon microtheca (Khar), Saccharum pontaneum (Kans) and Thysanolaena maxima (Amliso), Arunduella nepalesis (Phurke) and Themeda species have been suggested by Ojha and Sherestha (Ojha and Sherestha, 2007) as suitable especially for slope stability.
iv. Creation of effects of human activities on both floodplain and river channels.
v. The government at all levels in Nigeria should take it as matter of urgency to yield to addressing issues relating to erosion especially gully erosion at an early stage so as to avoid loss of lives and their properties.

Gully erosion occurs in a number of ways. The formation have different mechanisms, modes and conditions of formation; some of which are directly related to the underlying geology and the severity of the surface processes operating on the surface geology and soil cover. Ezechi and Okagbue (1989) reported that the nature of the underlying bed (or geology) has a bearing on the initiation and propagation of gullies. Observations have also shown that gully erosion, in Nigeria, is more predominant in the sedimentary terrains and perhaps in the basement/sediment contact areas. This accounts for why its occurrences is more skewed to the south-eastern Nigeria where most of the gullies take the advantage of the loosely consolidated and sometimes friable rocks such as the Ajali Sandstone in Auchi area of Edo State of Nigeria. Anambra State is the most affected of all the State, in Nigeria where Angulu, Nanka and Oko communities are the worst hit. The causes of gully erosion with respect to the geologic settings are numerous and these include tectonism and uplift, climatic factors, geotechnical properties of soil, among others. Anthropogenic causes include farming and uncontrolled grazing practices, deforestation, and mining activities.

The impacts of gully erosion in Nigeria are enormous. Among these are loss of farmland due to drastic decrease in agricultural productivity and ultimately food shortage. Others include loss of vegetation as its continuous expansion encroaches into areas that are hitherto, leading to falling of trees and exposure of more surface areas to gully activities loss of life, isolation of villages and consequent formation of infertile and barren land (Abdulfatai *et al*., 2014). There is adequate information in the literature on the amount of soil eroded by water in different areas and soils in Africa (Lal, 1995a, Bishop and Allen, 1989; Lal, 1984; Charreau and Nicou, 1971). Many different factors interact to determine the amount of soil loss occurring at a particular time and place. The impact of the most important factors had been described by the Universal Soil Loss Equation (USLE) (IFDC, 1999).

4.1.3 Soil Salinity

Salts have been a known problem for thousands of years, particularly in arid and semiarid areas where there is insufficient rainfall to leach salts from the root zone. This problem usually arises when the total amount of salts which accumulate in the root zone is high enough to negatively affect plant growth. Excess soluble salts in the root zone restrict plant roots from withdrawing water from the surrounding soils, effectively reducing the plant available water (Bauder and Brock, 2001; USDA, Natural Resources Conservation Service, 2002). Under irrigated agriculture, salts are added continuously to the soils with each irrigation event (Qadir *et al*., 2005). Saline soils refer to soils with electrical conductivity above 4dS/m and usual contain sufficient soluble salts that adversely affect the growth of most crops. Sodic soils refer to soils with exchangeable sodium percentage above 15 with sodium salts capable of alkaline hydrolysis and are mainly Na Co_3 (Allotey *et* al., 2008). These two main groups of salt-affected soils differ (physically, chemically, biologically, as well as their geographical and geochemical distribution) and therefore, require different approaches for their reclamation and agricultural utilization. Soil salinity is a major threat to the sustainability of irrigated agriculture (Ghassemi *et al*., 1995). Approximately 932 million ha of land worldwide are degraded due to salinity and sodicity, usually coinciding with land available for agriculture. Of this area salinity affected 23% of arable land while saline-sodic soils affect a further 10% (Szabolcs, 1989).

Soil water salinity can affect soil physical properties causing fine particles to bind together into aggregates. This process is known as flocculation and is beneficial in terms of soil aeration, root penetration and root growth (Neumann, 1995). Saline soils contain sufficient soluble salts to suppress plant growth through a series of interacting factors such as osmotic potential effect, ion toxicity and antagonism, which induce nutrient imbalances (Neumann, 1995). Salinity imposes serious environmental problems that affect grassland cover and the availability of animal feed in arid and semi-arid regions. Salt stress undesirably affects plant growth and productivity during all development stages. Aslam (2006) pointed out that tree planting is the cheapest and most simple natural biological approach to controlling salinity. Changes in salinity and sodicity affect soil physical and chemical properties, which subsequently alter nutrient cycles and decomposition processes (Wong *et al*., 2005). The risk of erosion is increased, while soil physical and chemical properties are altered, impacting upon aggregation and nutrient cycling as well as biotic activity.

Soils affected by salinity, are characterised by rising water tables and waterlogging of lower lying areas in the landscape. Sodic soils are high in exchangeable sodium, slake and disperse upon wetting (Nelson *et al*., 1996). In addition, a few studies are available that unambiguously demonstrate the effect of increasing salinity and sodicity on soil C dynamics (Nelson *et al*., 1997; Pankhurst *et al*., 2001; Sarig *et al*., 1993). Generally, responses to salinization have been of two general kinds; engineering the environment to manage increased salt in the soil by irrigation and drainage management, or by "engineering" the plants to increase their salt tolerance. Salt tolerant plants may also ameliorate the environment by lowering the water table in salt affected soils (Pitman and Lauchli, 2002). The coastal areas of Nigeria get affected heavily by soil salinity. It also occurs in small patches in the semi-arid belt of Northern Nigeria. The major effect of soil salinity is reduction in agricultural productivity, especially of crops that are sensitive throughout the ontogeny of the plant. Among the factors that contribute to high soil salinity are net breeze from high tide especially between June and August and direct watering of crops with saline water. Salinity problems can be controlled by use of irrigation system that supplies the farmland with freshwater and the draining of water table of saline water of farm lands (Bresler and Hoffman, 1986). In addition, there is need to create salinity control units in farmlands (Backlund and Hoppes, 1986).

4.1.4 Flooding

One major problem that is fast becoming chronic with respect to soil depletion in Nigeria is flooding. Flooding occurs in Nigeria in three main forms. These are coastal, river and urban flooding. The experience of year 2012 is particularly devastating as flood washed away several farmlands in 20 States of the Federation. Urban planning, removal of obstructions in floodplains, proper waste management to avoid blockage of drainage systems, and construction and maintenance of more drainage channels should be adopted to eliminate man-made flooding (Babatolu, 1997). Particular, the government at all levels should engage in the provision of integrated drainage systems in informal settlements, which are often regarded as being outside accepted urban regulation and planning systems while they are, however, recognised as farmlands (Douglas *et al*., 2008; Oriola, 1994).

Occurrences and reoccurrence of prolonged rain shows and the resultant floods all over the world in the recent time are becoming concerns to research and governments. In the rainy seasons, it is usually common story to read about in the dailies and magazines in United States of America and even in Nigeria. The frequency of this phenomenon is no longer news. There are three schools of thought about the preponderance of floods all over the globe, especially in the tropics. The first is of the opinion that there is global warming and climate change that is directly and or indirectly increasing the amount of rain and ice melting that is increasing the amount of runoff. In this case, the only source of water that results in great runoff (flood) in West Africa, and indeed, South Western Nigeria will be rain water. The second school of thought is of the view that there have been a lot abuses heaped on the physical environment and that the soil is only responding to the abuses heaped on it. The abuses include

but not limited to poor planning of the physical environment for the built up areas and others. The third school has it that it is the combination of both global warming and climate change, and the abuses of man on the environment that are the causes of prolonged and torrential showers of rains and the resultant runoff that lead to devastating floods in America, Europe and Africa including Nigeria.

4.1.5 Desert Encroachment

Desert encroachment is another factor depleting the fertility of Nigerian soils. Nigeria is presently losing about 351,000sq.km of its land mass to desert which is advancing southward at the rate of 0.6km per year. In Nigeria, entire villages and major access roads have been buried under sand dunes in the northern portions of Katsina, Sokoto, Jigawa and Borno States. Between 1972 – 1978, Borno State suffered a protracted drought, making it one of the most threatened land areas in Nigeria. The control of decertified lands can be achieved by rehabilitating the land. This could be done by passing rivers through them and planting big desert trees and legumes which survives in the intense drought situation, as well as fixing nitrogen to the soil (Xue-Yong *et al*., 2002). According to Sinha *et al*., (1997), controlled grazing, introduction of fast growing exotic species of trees and grasses from isoclimatic regions of the world for stabilization of shifting sand dunes, creation of 'microclimates' through shelterbelt plantations, and creation of 'fencing and enclosures' for regeneration of indigenous species can be adopted in desert prone areas. However, the government needs to make and enforce laws guiding the control of desertification in order to successfully tackle the problem.

The combined effects of the discussions above is the decline in soil fertility which can be described as the intrinsic ability or capability of the soil to provide plant nutrients and water in adequate amount when required for food growth and development of the crops (Agboola, 1986).

4.1.6 Others

Soil fertility decline is a deterioration of chemical, physical and biological properties of the soil and subsequent reduction in providing the crops with adequate nutrients and water. Apart from soil erosion, this could be caused by decline in soil organic matter and biological activity; soil degradation and loss of physical qualities, reduction in availability of major nutrients and macronutrients and increase in toxicity, due to acidification or pollution. According to FAO (2011), Nigeria soil is losing its fertility rapidly. This is compounded by the problem that Nigeria soils have inherently low fertility and do not receive adequate replenishment as it falls under the sub-Saharan Africa countries with low mineral fertilizer consumption of about 10kg nutrients (N, P_2O_5, K_2O)/ha per year compared to world average of 90kg, 60kg in the near east and 130kg per year in Asia. Despite the inherent low fertility, Nigeria lost an average of 24kg nutrients/ha per year (10kg N; 4kg P_2O_5, 10kg K_2O) in 1990 and 48kg nutrients/ha per year in 2000. This is equivalent to 100kg fertilizers/ha per year. The declining soil fertility can be adequately managed by proper soil rotation, bush fallow, application of the right fertilizer and proper management of farmlands. Other myriad causes of soil degradation in Nigeria include deforestation, inappropriate agricultural practices, oil spillage, overpopulation and lack of land planning act that protects rich land from being converted to other uses (Teminski, 2012).

4.2 Groundwater Depletion

Underground water resources are becoming very important globally because of the unsustainable abstraction of groundwater (Shah and Villholth, 2007). The issue of groundwater became prominent when global water consumption increased by nearly 100% within a space of 50 years (1950 – 2000), mainly as a consequence of agricultural irrigation (Shah and Villholth, 2007). According to OECD (2012) agriculture is responsible for the use of 70% of all freshwater including groundwater. Thus, one of the most critical depleting resources facing the world is a lack of freshwater which normally, is considered a renewable resource.

Although, Nigeria as a whole is rich as surface water resources, it is deficient in groundwater resources (Ayoade, 1975). This is because extensive area of the country is covered by crystalline rocks of the basement complex which are poor aquifers. These rocks cover about 50% of the country but at present contribute little to underground water supply. The basement complex consisting mainly of igneous and metamorphic rocks are neither porous nor permeable, except in areas where the rocks are cleared, shattered, jointed or fissured (Ayoade, 1975). These types of rocks have porosities of only from 1 – 3% and permeability is small and disconnected (Azeez, 1972), although, when weathered, the weathered mantle provide avenue through which water can percolate.

Groundwater development in Nigeria began as far back as 1917 when it was discovered that Nigeria has two types of groundwater formations. These are the pore type water in stratified rocks and fissure type water found in crystalline rocks. The access to groundwater has been instrumental to partial success of millennium Development Goals 7c(MDG 7c) which aim at reducing by half the number of people in the world without access to clean water and improved sanitation. The target for water was reached in 2010. Despite this, about 75% of the population within the sub-Sahara Africa rely on groundwater sources for clean, drinking water (Omole, 2013). As a result and due to rapidly increasing population in Nigeria, which tripled within 50 years (1960 – 2010), the population directly impact on demand for water. In most cases, the highest demand for water arises from municipal water supply, industries and agriculture (Omole, 2013). This development is giving the authentic cause to worry as Nigeria

experienced earth tremors in the Federal Capital Territory in 2018 and a few locations such as in Kwoi, Kaduna State, Saki, Oyo State and Ibgogene in Bayelsa State in 2016 as a result of overdependence on aquifers. Water extraction and recharge unbalance from aquifer were causing hydrological instability along the fractures. This is mainly due to the existence of 110,000 boreholes within Abuja metropolis and about 330,000 metric tonnes of water drilled daily (Onu, 2018).

Due to lack of capacity on the part of institutions responsible to meet with the ever increasing demands for water in Nigeria, there has been heightened and unrestrained exploitation of groundwater. Nearly anyone that can afford to sink a well has gone ahead to do so without recourse to expert advice on hydro-geological data, safe yield, technology, or excess draw down in water table (Edreivie, 2006). This chaotic situation has given rise to affiliated problems such as the involvement of unqualified well drillers and capital loss. With frequent reports of failed wells, failed pumps, and groundwater contamination arising from drilling mud and septic tanks interferences, capital flight arising from the systemic failure would be enormous when quantified.

In Nigeria, all land and mineral resources within it are held in trust for the people by the Governor of each State Government through the land use Act of 1978. By extension, it could be deduced that all water resources ought to be held in trust also. However, this is not clearly defined. The act allows persons who wish to build on a piece of land the right of ownership for 99 years, once a certificate of occupancy had been obtained. This may be renewed at expiration. However, if crude oil or gold is discovered on the same land, the State reserves the right of ownership of such resources and the right to revoke such certificate of occupancy in order to secure the resource in public trust. It is therefore imperative that control of groundwater resources within each state should be tied to the 1978 land use act. That is, groundwater should be accorded the same protective status as precious resources such as gold and crude oil. Therefore, special permits should be attached -to rights to own a well (Omole, 2013). The licensing should impose additional responsibilities on prospective well owners in order to make them exploit the wells sustainably and with the full knowledge that the ground water resource is not theirs to abuse at will.

According to Maggdoff (2011), there are ancient fossil aquifers that contain water that fell literally thousands of years ago. These aquifers, such as in Saudi Arabia and in North Africa, need to be viewed for what they are – non-renewable or fossil water. There are also aquifers that are renewable, but which are being exploited far above their renewal rate. The aquifers in the U.S. Great Plains (the Ogallala aquifers), in north-western India, and northern China are all being exploited so rapidly, relative to recharge rates that water levels are falling very fast. This means deeper wells must be drilled and more energy used to raise the water from greater distances to the surface. Drilling deeper wells is clearly only a temporary solution. In addition, there is so much water taken, mainly to irrigate crops, that China's Yellow River, the Colorado River in the United States and Mexico, and the Euphrates and Tigris Rivers in the Middle East rarely reach their normal outlines to the sea. Thus, the situation with water makes it clear that even a renewable resource can be overexploited with detrimental consequences.

Presently, a number of countries where there is no adequate groundwater are searching other regions of the world, in land grabs, to grow food for their people due to the instability and the severe pain caused by the rapid rise of food prices on international markets in 2007 – 2008 and 2011 – 2012. The spikes in food prices over the last five years have encouraged major importers to bypass international markets to buy needed food and to assure supplies by obtaining land in other countries. It is estimated that since 2000, 5 percent of Africa's agricultural land has been bought or leased under long-term agreements by foreign investors and governments. These agricultural land grabs are partially, an issue of water. The land purchases and leases include the implicit right to use water that in some cases may actually exceed the quantity of locally available water. All land grabs displace people from their traditional landholdings, forcing many to migrate to increasingly marginal lands or to cities in order to live. The results are more hunger, rising food prices, expanding urban slums, and frequently increase carbon dioxide emissions.

4.3 Deforestation

Deforestation is one of the major factors depleting the world's natural resources, both directly and indirectly. Directly on the forest resources itself and indirectly on the environment, on resources such as water, soil, flooding and quality of air in an environment. Although, forest are renewable resources, unsustainable management practices including poverty have made most of the world's primary forests, a fast depleting resource. Deforestation has negative implication for sustainable economic development and has impacted negatively on social aspect of countries, specifically regarding economic issues, agriculture, conflict and most importantly, the quality of life. This is so as the world's forests provide a wide array of goods and services, many of which are of global significance. The goods and services provided by these forest ecosystems include wood, fibres, food, watershed, erosion control, climate regulation, medicine, and recreation (Olukayode, 2010). Tropical forests are especially rich in species due to their complexity. Rainforest are estimated to support the highest biodiversity of all terrestrial ecosystems (Gantry, 1992; Leigh *et al*., 2004) including an estimated half of terrestrial and 25% of global biodiversity (Myers *et al*., 2000). According to available statistics, Nigeria has the highest rate of deforestation in the world, having lost 55.7% of its primary forest. The annual rate of deforestation in Nigeria is 3.5%,

approximately 350,000 – 400,000 per annum (Mongabay.www.mongabay.com). A study conducted from 1901 to 2005 gathered there was a temperature increase in Nigeria of 11^{o}C, while global mean temperature increase was only 0.74^{o}C. The study also indicated that within the same period of time, the amount of rainfall in Nigeria decreased by 81mm, all as a result of deforestation. Studies also show that from 1990 to 2010, Nigeria nearly halved its annual amount of forest cover from 17,234 to 9,041 ha. This development has generated discussion on the future of wood supply in Nigeria (RMRDC, 1989; FAO, 2004). According to Adeyoju (2011), the forest estates which stood at 10% of the country's land area in 1996, is now less than 6%. Also RMRDC (2010) reported that useable volume of wood down to 30cm diameter in the reserved forest area was 293,775,500m^3. This was not significantly different from 473,509,205.9m^3 reported by Akindele *et al* (2001). When this is juxtaposed with total wood requirement which was projected at 59,955,000m^3 in year 2010 by Bourgione (1991), wood shortages are imminent in the country in the next few years. Although, these estimates were for volume of wood above 30m^3, it is imperative to stress that the volume of fuel wood required on annual basis is also increasing. The combination of extremely high deforestation rates, increased temperature, and decreasing rainfall are all contributing to desertification in the country. The carbon emissions from deforestation currently account for 87% of the total carbon emission from the country (Akinbami and Lawal, 2013).

4.4 Loss of Biodiversity

Biological diversity, often referred to as bio-diversity refers to the life forms on earth and include millions of plants, animals and micro-organisms, the genes they contain as well as the intricate ecosystem they help build into the living environment (Aju, 2010).

In Nigeria, biodiversity is influenced by its enormous geo-diversity. The country is characterised by a story climatological gradient north to south which defines the ecological zones (Aju, 2010). This make the country to be classified into six ecological zones defined as Sahel, Sudan, Guinea, and derived Savanna and lowland rainforests, freshwater swamp and mangrove forests. According to NBSAP (2002), the Niger Delta region contains the third largest remaining tracts of mangrove forests in the world. A study by the Federal Environmental Protection Agency (FEPA) in 1992 indicates that Nigeria possess more than 5000 recorded species of plants and 22,000 species of animals. The study identified about 200 species of lower plants and over 5103 higher plants. This makes Nigeria the 11th in Africa in terms of plant diversity. Also 205 of these plants are endemic in Nigeria; the 9th highest number among 42 African countries. According to NEST (1992), the northern region has 39 endemic species, Western and Central region has 38, while the highest degree of endemism occurs in lowland forests of Southeast which has 128 of the endemic species. Animal biodiversity in Nigeria according to FEPA (1992) included 247 mammalian species, 900 bird species, 135 reptalian species, 109 amphibian species, 77 molluscs and bivalves, 10 annelids, 648 fish species and about insects. The study also list 1489 species of micro-organisms. Nigeria is also a hotspot for primates ranking in the world. The primate diversity is 23 species and 13 genera.

Further studies shows that between the root crops of the South and the grain crops in the North, there are over 300 edible plants in Nigeria (NEST, 1991). Only a few of these crops, perhaps less than 20 are handled in real large tonnages. Some of the major raw materials that can provide the fulcrum for expanding the nation's foreign exchange generation base are the Timber and Non-Timber Forest Products (NTFPs), (Bee and Mc Mermott, 1989; FAO, 1983, 1994a; Gupta and Guleria, 1982).

To compound the problem, as a result of pressure on the resources, forest products are being depleted at an unprecedented rate due to increasing human population pressure and demand. In Nigeria, approximately 400,000 ha of forests are destroyed or seriously degraded annually, principally, through agricultural expansion, uncontrolled livestock grazing, logging and fuel wood collection. As a result, there is real possibility of extinction of many indigenous plants species through deforestation and forest degradation. Gbile *et al* (1981) reported 484 plants species in 112 families of the 4,600 plant species in the country to be endangered. About 205 of the species are endemic and their loss will mean extinction from the earth's surface (Okafor, 1993). These developments are impacting negatively on rural economy as a result of aggravated poverty as the economy of households of people living in rural communities depend on forest products (Clarndom, 2001; Belcher *et al,* 2005; FAO, 2006). At the national level, the importance of NTFPs to expanding the foreign exchange generation potentials locally cannot be overemphasized. During reckless deforestation a considerable number of wild animals are killed and their habitats destroyed, altering their feeding and grazing patterns. In Nigeria, animal biodiversity is concentrated in the savanna and the high forest areas. Although a few detailed studies have been conducted on the effect of climate change on terrestrial animals in Nigeria, Hulme (1996) predicted that climate change could alter the range of antelopes in the country. Out of the world's antelope biodiversity, more than 90% of the 80 species are concentrated in Africa (Macdonald, 1987). Also about one third of African birds migrate on a seasonal basis within Africa, and an additional one tenth migrates annually between Africa and the rest of the world (Hockey, 2000). If climate conditions or specific habitat conditions at either end of these migrating routes change beyond tolerance of the species, Africa will incur significant losses of biodiversity.

Loss of biological diversity results from various causes, some of which are natural but aggravated by human activities such as climate change (SCBD, 2002). The earth is subjected to many human induced natural pressures that have significantly altered, degraded, displaced and fragmented terrestrial ecosystems, often leaving biologically impoverished landscapes (SCBD, 2001). The main causes of species extinction as a result of human activities are introduction and competition from invasive exotic species, habitat destruction and conversion, overexploitation, agricultural and urban expansion, overgrazing and burning. Current rates of species extinction related to human activities far exceeded normal background rates (Pimon *et al.,* 1995). Current estimates suggest that 400 - 500 vertebrates, about 400 invertebrates, and approximately 650 plants have become extinct in the past 400 years. Currently 12% of birds, 24% mammals, 30% fish and 8% of plants are already threatened with extinction (SCBD, 2001). Based on gross estimates of total number of tree species in the world, 3,609 species are vulnerable while up to 77 species are extinct. According to Pimon *et al* (1995), current extinction rates are much higher than the rate at which species evolve. Some of the causes of biodiversity loss are Rapid environmental disturbances, Pollution, Population growth, Deforestation, Agricultural development, Uncontrolled forest fires, Fuel wood collection, Logging activities, Urbanisation and Political unrest and war.

4.5 Fisheries Depletion

The challenge of biodiversity conservation and management is not limited to terrestrial habitats alone but also to the aquatic environment. The depleting nature of aquatic resources have been a topic of discussion by many authors (Sugihara, 1980; Marais, 1988; Thief *et al*., 1995; Jordan *et al*., 2012). FAO (2004) reported that out of the 600 marine fish stock monitored by the organisation, 3% are underexploited; 20% are moderately exploited; 52% are fully exploited; 17% are overexploited; 7% are depleted and 17% are recovering from depletion. Tables 3 to 6 shows that in the Northwest Atlantic, Cod and Haddock have been totally depleted by fishing companies from the US and Canada (Table 3). In the North East Atlantic, the Atlantic salmon, trouts, smelts and Atlantic Cod have been vastly depleted by companies from Norway, Finland, Denmark, Sweden, Netherlands, UK and Belgium (Table 4). Also the table indicted that Haddock, Pollock, hakes, etc have been overexploited and depleted by companies from Norway, UK, Iceland and Russian Federal.

In West Central, Atlantic, fishes such as Grouper, Sciniads, Snapper, Albacore have been fully exploited to overexploited (Table 5). The same is also true of Caribbean spiny lobster, redspolted shrimp and stromboid conchs which had been fully depleted (Table 5). In East Central Atlantic, the common sole, various other flatfish, flounders, halibut and sole like fish, the Senegalese hake, common octopus and various other octopus have been fully overexploited by various companies from Europe, South East Asia and African countries such as Nigeria, Senegal, Mauritania and Morocco (Table 6). The same sad stories are repeated in other world oceans such as the Mediterranean and Black Sea, Pacific Ocean and Southern Oceans.

The situation in inland waters in Nigeria is not different from what operates in the international waters. Boulanger (1901) listed 1976 species of African water species comprising 185 genera and 43 families. Ita (1993) reported 268 different fish species in 34 well known Nigerian freshwater rivers, lakes and reservoirs which constitute about 12% of Nigeria total surface are of about 98,185,000 ha. More recently however, significant reduction in the availability of these species have been reported as a result of environmental pollution and other human activities. According to Ita (1993), fish production in 1980's was less than half of the 1950's and fish catching production was only a quarter of that in the 1960's. In a study reported by Oguntade *et al* (2014) on the fast disappearing fish species along two rivers between latitude 4^{o} 51 ^{o}N and 4^{o} 54 ^{o}N and longitude 6^{o} 11 ^{o}E and 6^{o} 13' E of Brass and lower Nun river in the Niger Delta Area around Anyama Ijaw in Bayelsa State, it was observed that total fish species composition comprised of fifty three individuals from 18 families. The typically brackish water fishes found at the Brass and lower Nun Rivers included the families of *Sciaenidae*, *Clupeidae*, *Penaeidae* among others are probably Stenohaline fishes and may have moved within narrow limits of salinity changes. This is consistent with the report of Moses (1987), who noted that during flood, some fish species could move to another aquatic habitat with different characteristics. From the two study areas, total fish species composition comprised of fifty-three individuals from eighteen families (Table 7). The Sciaenidae and Clupeidae were the most abundant comprising of seven and five species each, respectively while the Palaemonidae, Sphyraenidae and Bagridae were the least of abundant fish comprising one individual each. The 53 species identified belonging to 18 families is an indication of good biodiversity, being highest in the Sciaenidae and Cichlidae. Dominance of Pseudotholythus and tilapia species may be attributed to gear selectivity (mostly gill net).

The result is similar to the findings of Allison and Okadi (2009) and Sikoki *et al* (1998) who encountered 25 species in 14 families and 24 species belonging to 16 families in the same area of Num River Niger Delta. However, Shilbeidae and Cyprinidae were the dominant families they reported. The presence of Shilbeidae and Cyprinidae in Nun River and Brass were also reported by Oguntade *et* al (2004). However, Oguntade *et al* (2014) did not show the presence of Distichodontidae, Gobidae, Elopidae, Mormyridae and Anabantidae were not observed in their study, which indicated that they were part of the fast disappearing groups.

The fast disappearing species which is accompanied by low catch (Table 7) identified in the socio economic

analysis of the study showed that environmental degradation and overfishing are fast depleting fish population and species availability in the Rivers.

Oguntade *et al* (2014) reported that decline of biodiversity in the studied waters could therefore be attributed largely to human factors in the last 5 - 10 years. This kind of human impact has earlier been reported by Kone *et al* (2003) in the GO River (Ivory Coast) and Gratwicke *et al* (2003) in the upper Mangame River of Zimbabwe. Some other common species or strains identified by the fisher folks as fast disappearing in local dialect such as 'Sala', 'Gbolo', 'Nda', Ofoun', 'Benioke', 'Odubemi', 'Tomi', 'Asakabumoun', 'Ikoloko', 'Irim', and 'Ekwekwey' are yet to be identified. Recent experience from IUCN (1996) is that wherever fish faunas are studied, more species than suspected turn out to be threatened (i.e. species are at risk of extinction), or cannot be re-recorded at all.

In Nigeria, artisanal inland fisheries do not only serve as an important alternative source of animal protein, but also crucial to the economy, contributing about 5% of the GDP. The inland artisanal fisheries accounted for over 85% of domestic fish production between 1991 and 2003 with a total fish production of 615,507 metric tonnes in 2007. Artisanal fisheries earn foreign exchange for the country, employment creation, income generation, while it is also a source of raw materials for the food and animal feeds industries (Sogbesan and Kwaji, 2018). Overall in 2008, world exports of fish and fishery products, reached a record level of US$102 billion.

In Nigeria, the total export earnings from fish was USD 50 million while import value was USD 375.03 million in 2001. Currently there are a number of growing concerns about problems with the management of fisheries resources and fishing methods which are placing excessive strains on water ecosystems which are major sources of fish.

Despite many institutional reforms made to stem the decline in fisheries resources of Nigeria, the sector has not been able to bridge the gap between fish demand and supply. Among the problems are unsustainable fisheries practices among which are catching wild fish that are not sustainable in the long run which could be through threatening of the fish stock by overfishing or threatening the environment the fish need to thrive. This is being done through electrofishing, use of gears with small mesh sizes, poisons, dynamite fishing, etc. Other unsustainable practices include overfishing which occurs when more fishes are caught than the population can replace through natural reproduction, destructive fishing practices which is the use of fish gears in ways or places such that one or more key components of the ecosystem are obliterated, devastated or ceases to be able to provide essential ecosystem functions. Others are illegal, unreported and unregulated fishing practices (IUU) which is often an organised criminal activity, professionally coordinated and truly global. Species extinction in Nigeria has been associated with habitat modification, perturbation and destruction. These may come inform of altercations in ecohydrological regime, habitat area, habitat quality, water quality, substrate quality and biotic interactions and energy source. Also inadequate control of the oil industry leading to pollution has led to the disappearance of fish populations as was been reported for Bonga Oilfield Spillage in 2011 in which 30,000 barrels of crude oil spilled and spread along the Atlantic coast for 185km, displacing over 30,000 fishermen from their trade.

4.6 Mineral Resources Depletion

Solid mineral resources of Nigeria are very extensive and widely distributed. According to the Ministry of Mines and Steel Development, over 34 minerals present in about 450 locations have been identified and are at various stages of exploration and exploitation. The mineral resources are utilised in many ways. Principally, they are used as raw materials for industry by wide range of processing, building and manufacturing industries, power generation, steel production, fertilizer, etc. Mining commenced in Nigeria in 1902 by the commissioning of mineral surveys of the Southern and Northern Protectorates in 1903. Coal exploration began as early as 1906. By 1919, Geological Survey of Nigeria was established to take over the work of the surveys of the Southern and Northern Protectorates. Coal and cassiterite was the major mineral mined for export. Coal was used to generate electricity and to power the Nigerian railway trains. By 1920, coal production reached 180,122 long tonnes (183,012)t. Nigeria's peak coal production was in the late 1950's and by 1960, production peaked at 565,681 long tonnes (574,758t). However, diesel has replaced coal in railway system and gas replaced coal for power generation. The civil war of the late sixties adversely affected the coal industry and the mines were mostly abandoned. Attempts to mechanise the industry in the 1970's to 1980's were ultimately unsuccessful (Damisa, 2018) as a result of problems of implementation and maintenance. At present, coal is being mined in Maiganga, Gombe State for cement making and at Okaba in Kogi State for electricity generation (Damisa, 2018).

Gold mining in Nigeria began in 1913 and peaked in 1943. Production declined during the World War II when about 1.4 tonnes of gold were produced and not much production has been officially recorded since then. Tin and its associated minerals (columbite, tantalite) are mined on the Jos Plateau. Columbite and tantalite are used to produce the elements niobium and tantalum. Bitumen deposits are found in Lagos State, Ogun State, Ondo and Edo States. While technical and economic evaluations of these deposits are on-going, it is believed that there are over thirteen billion barrels of oil in these tar sands and bitumen seepages.

Apart from the above, a number of other mineral resources are being exploited at various levels in Nigeria. Most of these minerals and the level of exploitation are shown in Table 8. Some of the mineral resources such as

lead and gold have been exploited since the early part of the last century and have made significant contributions to the revenue and socio-economic development (Kogbe and Obialo, 1976). Other minerals such as monazite, xenotime, zircon, thorite and molybderate have also been mined and exported. More recently, oil and gas (from 1957), limestone, marble and rock aggregates have been playing an increasing role in national socio-economic development, because they generate appreciable internal revenue and/or foreign exchange earnings (Aigbedon and Iyayi, 2007). They have mostly overshadowed other economic minerals by generating over 90% of the export earnings and more than 50% of the national revenue (Iyayi and Aigbedon, 2007).

Despite the contributions of minerals development to economic and industrial development aspirations locally, it is unbelievable to say that the quantity and quality of most of the minerals deposits in Nigeria have not been ascertained. This has placed great constraint on development planning for large scale exploitation and deployment of most of these mineral resources.

Globally, the problem of resource depletion is raging. It has been stipulated that some mineral resources as a result of their availability in traces and the fact that they are not presently being recycled globally, their extractable reserves may run out within the next 100 years. According to Henckens (2016) examples of such minerals are: Molybdenum, Antimony, Zinc, Gold, Rhenium, Copper, Chromium, Bismuth, Boron and Tin.

While the issues of minerals depletion have been discussed widely**,** a number of available options make light of the issue. Among the anti-depletion school of thought is that exploration and development may lead to the discovery and proving up of previously unknown mineral deposits. They are also of the opinion that technological components in exploration increase the discovery rate of mineral deposits and at the same time reduce discovery cost. Second, it is stipulated that technological change sustains minerals production. Technological improvements in mining and mineral processing reduce costs and permit profitable mineral production from previously uneconomic mineralised rock. In addition, it was reported that when a mine is physically depleted, recycling can be thought of as an extension of primary mining. This had been employed extensively with aluminium, copper, iron and steel, lead and zinc. Fourth, a scarce resource can sometime be replaced by an abundant substance such as in the situation where aluminium can replace copper in the long distance transmission power lines. Finally, the school of thought believed that even when a mineral is depleted, its value may persist if an appropriate portion of the proceeds are invested on human or manmade capital.

One major negative attribute of mining in Nigeria is environmental damage. To a large extent, the scale of operations involved in exploration, mining and processing of a mineral determines the intensity and extent of environmental degradation. Thus in general, a greater damage is witnessed in localities where miners do only manual winning of minerals. For example, large-scale mining of tin and associated minerals in the Jos plateau has resulted in a high degree of degradation of arable land, vegetation and landscape, as well as other environmental problems. Other localities affected by large-scale environmental damage are the Niger Delta as a result of oil and gas exploration and exploitation; Sagamu, Okpilla, Ewekoro, Ashaka and Gboko owing to quarrying of limestone and the establishment of Portland cement manufacturing company; and in Enugu as a result of coal mining.

On the other hand, the environmental damage caused by small scale quarrying of laterite, clay, gravel, and stone in numerous parts of the country by private entrepreneurs is less but difficult to control. A special mention must be made of the environmental degradation caused by the illegal mining of gemstone. As a result of the uncontrolled manner the illegal miners operate, a lot of damage is done to the environment by haphazard pitting and trenching of the ground in many areas. This results in a kind of artificial bad land topography which consequently renders the land impossible to cultivate for agricultural purposes (Iyayi and Aigbedon, 2007).

5.0 Recommendations for Action

It is obvious that natural resources in Nigeria are depleting at a very fast rate. As economic and industrial development of the country depend on these resources, it is expedient that urgent actions are required to reduce the rate of depletion of both the renewable and nonrenewable resources through concrete actions by relevant bodies and collaboration with local and international organizations with requisite expertise. Among the line of actions that can reverse these trends and put natural resources on sustainable path of development include**:**

- The need for adequate data on various natural resources availability and demand locally. This should include development potentials in terms of reproduction or rejuvenation of the resources, sustainable patterns for harvesting for use and optimal management potentials. This development cut across all renewable and non-renewable natural resources in Nigeria, as renewable resources are fast becoming unrenewable in view of the rate of harvesting and disappearance. Most data on natural resources are old where available and should be updated. Fortunately, Nigeria has relevant bodies mandated to handle the development of these resources. This should be taken as an urgent assignment.
- On individual resources basis, soil depletion should be taken as a very serious issue in the country in view of the high dependence on agricultural production and productivity locally. Fortunately, the federal ministry of agriculture has many research institutions with requisite mandates that can collaborate with institutions such as African Development Bank to carry out soil fertility studies all over Nigeria with the primary

objective to replenish the soils and recommend appropriate management practices for soils in various ecological zones. In view of its mandate of promoting optimal production of industrial crops for use locally, the Raw Materials Research and Development Council should be a partner in this exercise.

- Ground water depletion is now a phenomenon of global concern. Groundwater depletion is going on at a very high rate in Nigeria in view of the high dependence on it for agriculture, industrial and domestic application. The issue of groundwater should be controlled by the Ministry of Mines and Minerals Development at the Federal and States levels. it has become imperative that agricultural land grabs by other countries should be adequately controlled as most land development by foreign countries for agricultural purposes is one of the major factors diminishing groundwater resources in Africa.
- Deforestation has become a critical issue globally. In Nigeria, the rate of depletion, estimated at 350,000-400,000ha per annum is considered too high to make the resource renewable. As at present, available data on resource depletion and an estimation of available forest biodiversity is too old for any meaningful planning. There is need for concerted efforts by the Federal Ministry of Environment to initiate new development plans for Nigeria's forest resources. As at present, wood is being exported while concerted efforts on regeneration are too slow and weak. Efforts should be made to compartmentalize the forest resources and areas outside them for sustainable development of both economic, non-economic and non-timber forest products. Sustainable development and use of nation's bamboo resources should be encouraged through adequate policy.
- The nation's biodiversity in general is undergoing serious onslaught. The last detailed survey on the nation's biodiversity resources was reported by FEPA under the Ministry of Environment in 1992. This data is now grossly inadequate and must be updated for planning purposes in view of the importance of biodiversity in research and development and in new and emerging areas of applications.
- Data on Nigerian fisheries is also old. In view of its role in food security and industrial development, new concerns must be raised about the depletion of both freshwater and ocean fisheries in Nigeria. New initiatives are taking place globally on fisheries development and Nigeria cannot afford to lose its priced fishes to depletion at this stage of its development. Issues such as overfishing in both water bodies should be addressed at both local and global levels by agencies such as NIMASA and the Institute of Oceanography in collaboration with the fisheries department of the Ministry of Agricultural and Rural Development.
- The mineral resources exploration has advanced considerably in Nigeria. This has mainly brought out statistics on minerals deposits locally. However, relevant data on quantity of minerals available in various deposits has mainly remained in most cases, an estimation. This is not good for planning purposes. Also data on minerals mining and exploitation is scarce, unavailable and conjectures where available. The need for a consolidated exercise to bring out authentic data on mineral resources availability and rates of exploitation has become important in order to encourage investment and sustainable development of the sector.

6.0 Conclusion

The issue of natural resources depletion in Nigeria is real. This is not good for sustainable development, most especially in a country that depends mostly on agriculture for employment generation, industrial development and foreign exchange earnings. The interdependence between various available resources such as biodiversity for development of improved plant species; minerals such as phosphate, etc. and animals for better agricultural production and productivity should be exploited. This is not possible for now as available data is scarce and in most cases not representative enough. The need for collaborative development of the nation's natural resources cannot be over emphasized in view of the linkages involved. This can only be promoted by the government at all levels in terms of policy and fund requirements.

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Table 1: Soil Zones and their Coverage under Improved Farming Systems

S/N	Soil Type	Area in S Sq. Km	%
1.	Very high productivity	5,474.18	5.52
2.	High productivity	72,848.73	45.53
3.	Medium Productivity	48,530.73	30.27
4.	Low Productivity	15,576.27	9.73
5.	Very Low Productivity	17,685.82	11.05
	Total	**160,119.82**	**100.00**

Source: Agboola (1986). "Planning for Soil Productivity without Planning for Soil Fertility Evaluation Management"

Table 3: Fish Status in the North-West Atlantic

Fish	Status	Main fishing countries	Tons caught
Atlantic cod *gadus morhua*	Depleted	Canada, USA, Greenland	55,000
haddock *melanogrammus aeglefinus*	Depleted	Canada, USA	23,000
Alantic herring *Clupea harengus*	Ranging from underexploited to recovering	Canada, USA	259,000
American lobster *Homarus americanus*	Ranging from fully exploited to overexploited	Canada, USA	82,000

Source: FAO (2004)

Table 4: Fish Status in the North-East Atlantic

Fish	Status	Main Fishing Countries	Tons Caught
Atlantic salmon *Salmo salar*	Ranging from fully exploited to depleted	Norway, Finland, Denmark, Sweden	2,000
Salmons, trout, smelts, etc	Ranging from fully exploited to depleted	-	7,000
European plaice *Pleuronectes platessa*	Overexploited	Netherlands, Denmark, UK, Belgium	99,000
Other flounders, halibuts and soles	Ranging from fully exploited to depleted	-	176,000
Atlantic cod *Gadus morghua*	Ranging from overexploited to depleted	Norway, Iceland, Russian federation	835,000
Blue whiting *Micromesistius poutassou*	overexploited	Norway, Iceland, Russian federation, Faeroe island	1,589,000
Haddock *melanogrammus aeglefinus*	Ranging from overexploited to depleted	Norway, uk, Iceland, Russian federation	244,000
Pollock Pollachius virens	Ranging from fully exploited to overexploited	Norway, Faeroe island, Iceland, France	370,000
Whiting Merlanguis merlangus	Ranging from fully exploited to depleted	France, UK, Ireland, Netherlands	43,000
Other code, hakes and haddock type fish	Ranging from fully exploited to depleted	-	181,000

Source: FAO (2004)

Table 5: Western Central Atlantic (FAO Area 31)

Fish	Status	Main Fishing Countries	Tons/Year
Grouper	Ranging from fully exploited to overexploited	Mexico, USA, Dominican Rep.	20,000
Scianids	Ranging from fully exploited to overexploited	Venezuela	23,000
Snapper	Ranging from fully exploited to overexploited	Venezuela, Dominican Rep., Mexico, USA	39,000
Albacore *Thunnus alalunga*	Ranging from overexploited to depleted	China, Taiwan	10,000
King Mackerel *Scomberomourus maculatus*	Ranging from fully exploited to (possibly) overexploited	Mexico, Venezuela, USA, Trinidad and Tobago	12,000
Skipjack tuna *Katsuwonus pelamis*	Overexploited	Venezuela, Cuba, St. Vincent	4,000
Yellowfin Tuna *Thunnus albacares*	Ranging from fully exploited to depleted	Venezuela, USA, Cuba, St. Vincent	18,000
Caribbean Spiny Lobster *Panulirus argus*	Ranging from fully exploited to overexploited	Cuba, Bahamas, Nicaragua, Dom. Rep.	29,000
Redspotted shrimp *Penaeus brasiliensis*	Incomplete data, probably ranging from overexploited to depleted	-	-
Stromboid conchs *Strombus spp*	Depleted	Mexico, Turk Caicos, Dom. Rep, Belize	20,000

Source: FAO (2004)

Table 6: Eastern Central Atlantic (FAO Area 34)

Fish	Status	Main Fishing Countries	Tons/Year
Common sole *Solea solea*	Overexploited	Morocco, Italy	4,000
Various other flatfish *Pleuronectiformes*	Overexploited	Spain, Senegal, Morocco, Mauritania	25,000
Other flounders, halibut and sole like fish	Overexploited	Nigeria, Korea, Cameroon, Sierra Leone	3,000
Senegalese hake *Merluccius senegalensis*	Overexploited	Spain	8,000
Other cods, hakes and haddocks	Overexploited	-	5,000
Bigeye Tuna *Thunnus obesus*	Overexploited	Spain, China, Taiwan, Japan	44,000
Common Octopus *Octopus vulgaris*	Overexploited	Spain, Italy	9,000
Various other octopus *Octopodidae*	Overexploited	Morocco, Senegal, Mauritania	63,000

Source: FAO (2004)

Table 7: Identified fast disappearing fish species on Nun and Brass water bodies by fisher folks

Family	Species	Brass	NUN
Sciaenidea	Pseudotolithus typus	√	√
	P. senegalensis	√	√
	P. elongates	√	√
	P. moorii	√	X
	P. epipercus	√	√
	Pteroscion peli	√	√
	P. brachygnathus	X	√
Polynemidae	Pentanemus quinquarius	√	√
	Galeoides decadoctylus	√	√
	Polydactylus quadrifilis	X	√
Cynoglossidae	Cynoglossus browni	√	√
	C. monody	√	X
	C. senegalensis	√	√
	C. cadenati	√	√
	C. canariensis	√	√
Clupeidae	Ilisha Africana	√	√
	Ethmaiosa fimbriata	√	√
	Sardinella maderensis	X	√
	Pelonula leonensis	√	√
Carangidae	Chloroscombrus chrysurus	√	√
	Caranx hippos	√	√
	Trachinotus maxillosus	X	√
	Selene dorsalis	√	√
	Caranx crysos	√	√
Penaeidae	Parapenaeopsis atlantica	√	X
	Penaeus notialis	√	X
	Penaeus monodon	√	X
Portunidae	Callinectes pallidus	√	√
	C. marginatus	√	√
	C. amnicola	√	√
Palaemonidae	Nematopalaemon hastatus	√	√
Sphyraenidae	Sphyraena guachancho	√	√
Lutjanidae	Lutjanus goreensis	√	√
	Lutjanus dentatus	√	X
Cichlidae	Tilapia guineensis	X	√
	T. mariae	√	√
	T. melanopleura	√	√
	Hemichromis fasciatus	√	√
	Sarotherodon melanotheron	√	√
	Tilapia dageti (wesafu)	√	√
	Oreochromis niloticus	√	
Cyprinidae	Labeo senegalensis	√	√
	Labeo coubie	√	X
Bagridae	Chrysichthys nigrodigitatus	√	√
	Bagrus docmak	X	√
Schilbeidae	Schilbe mystus	√	√
	Schibe intermedius	√	√
Characidae	Brycinus nurs	√	√
	Alester baremozee	√	X
Mokokidae	Synodonlis budjeti	√	√
Drepanidae	Drepane Africana	X	√
Palinuridae	Palinurus Regius	X	√
18 Families	53 Species	44 Species	47 Species

Source: FAO (2004)

Table 8: Minerals currently being exploited in Nigeria

S/N	Mineral Name	Locality	Current Level of Exploitation
1.	Iron	Itakpe	L
2.	Tin	Jos Plateau, Nassarawa	M,S,M
3.	Niobium/Tantalum	Jos Plateau, Saki. Idiko-Ile, Oro	Won as by-product of tine mining
4.	Monazite	Jos Plateau	Won as by-product of tine mining
5.	Xenotime	Jos Plateau	Dormant
6.	Gold	Itagunmodi, Birnin Gwari, Dangbala	S
7.	Lead	Ishiagu, Enyigba, Ameka, Ameri	Presently Dormant
8.	Silver	Ishiagu, Ameka, Ameri	M, Won as by-product of lead (galena) mining
9.	Zinc	Ishiagu, Enyigba, Ameka, Ameri	Won as by-product of lead mining
10.	Limestone	Ashaka, Ewekoro, Nfamosing, Nkalagu, Kalambaina, Igarra, Dangbala, Ikpeshi, Atte, Okpilla	L
11.	Marble	Burum, Igbetti, Igarra, Jakura, Kwakuti, Okpilla, Ikpeshi	M,M (Presently Dormant), L
12.	Feldspar	Gwoza, Warake	M
13.	Gypsum	Wurno, Fika Area Ikpeshi, Warake, Azara	S
14.	Barytes	Omi Adio, Ozubulu, Naragua, Kano, Ikorodu, Lagos, Ire	S
15.	Clay	Badagry, Igbokoda, Ughelli	L
16.	Glass Sand	All parts of the Federation	L
17.	Construction Sand	All parts of the Federation	M, S
18.	Construction Stones	All parts of the Federation	L,M,S
19.	Laterite	Ijero-Ekiti, Jos Plateau, Saki, Falansa, Iyano	L,M, S
20.	Beryl	Ijero-Ekiti, Jos Plateau	S, (Mainly Illegal Mining)
21.	Tourmaline	Ijero-Ekiti	S, (Mainly Illegal Mining)
22.	Sapphire	Jos Plateau, Akwanga Area	S, (Mainly Illegal Mining)
23.	Ruby	Jos Plateau, Akwanga Area	S, (Mainly Illegal Mining)
24.	Topaz	Jos Plateau	S, (Mainly Illegal Mining)
25.	Coal	Enugu	L
26.	Oil and Gas	Niger Delta	L,M

L = Large scale exploitation; M = Medium scale exploitation;
S = Small scale exploitation.
Source: Iyayi and Aigbedon (2007)