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Impact of Human Activities on the Soils in Edo North Region of Nigeria

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Abstract
This study which benefits from field data and valid soil literature examines the impact of human activities on the soils found in the Edo North Region of Nigeria. Using environmental attributes such as colour, texture, soil biodiversity, water percolation and retention, and variety of crops grown on the soils, the study identifies fertile, dark-loamy, soft-grey alluvial, silt-sandy, mixed gravel and sticky brown-red soils in the region. It observes that anthropogenic activities which span surface construction of socio-economic facilities, reckless burning of solid wastes, chemical elimination of surface grasses, pipeline vandalism and seasonal migration of animals cause adverse impacts on the soils which range from surface degradation through vital resource pollution to soil infertility. Based on the findings, the study recommends that the region's soils which deserve diligent use, maintenance and protection by experts and workers should be shielded from all levels of environmental degradation. This would result to suitable soil climate for the production of adequate food and cash crops, sustained revenue generation from the agro-sales and promotion of holistic development of the region in accordance with standard environmental principles.
Keywords: Impact, Human Activities, Soils, Edo North, Nigeria

Introduction

The soil is a major component of the earth's ecosystem. It forms at the interface of the atmosphere, lithosphere, biosphere and hydrosphere. The United States Department of Agriculture (1962) defines soil as a collection of natural bodies occupying parts of the earth's surface which support plants and possess properties owing to integrated effect of climate and living matter acting upon the parent material as conditioned by relief over some periods of time. Faniran and Areola (1978) consider the soil as autonomous natural body of minerals, organic matter and nutrient constituents which result from the reciprocal interaction of the country rock with environmental factors of climate, topography, plant and animal lives, and differ from the underlying material in morphology, physical, chemical and mineralogical characteristics. Aziegbe (2004) defines the soil as a dynamic natural body composed of minerals, organic materials and living forms in which plants grow. The soil, as Susan (2009) puts it, refers to the naturally occurring and unconsolidated upper layer of the ground made of humus, living organisms and weathered rocks. Chapman (2012) sees the soil as a complex medium consisting of inorganic materials such as sand, silt, and clay minerals, organic matter both living and dead, water and air, relatively organized and subject to dynamic processes and interactions. In this study, the soil is considered as the upper body of interacting natural surfaces, organic and inorganic in contents, derived from the parent material and influenced by relief and acted upon by climatic forces, erosion and deposition through different periods of time.

A completely formed and developed soil as observed at any place in the world comprises four major components: the inorganic or mineral fraction, organic matter, water, and air. The relative proportion of these four components greatly influences the physical, chemical and biological properties of the soil. Chapman (2012) observes that the greater portion of the typical topsoil consists of solid inorganic and organic materials while the other part consists of interstices between the solid particles. However, the influence of the organic component on soil properties is often far greater than its small proportion suggests. Most agricultural soils contain between 1% and 10% organic matter and are referred to as inorganic soils because of the low organic content. Air and water fill the interstices between these solid soil particles. The relative proportion of air and water fluctuates greatly and they are inversely related to each other. As rainfall occurs, water fills the interstices, expelling much of the air. As water gradually drains away and it is used by plants, air refills the pore spaces (FitzPatrick, 1983; Brady and Weil, 2007; Chapman, 2012).

Soil being a broad component of the natural system performs some essential functions in the use and management of the environment by the humans. It serves as a medium for plant growth, providing plants with support, essential nutrients, clean water, warm air and suitable temperature. It acts as a reservoir for water and influences the quantity of water in our rivers, lakes, ponds and subterranean aquifers. It carries out a filtering and transforming role for materials added to the soil. This enables it to protect the quality of air we breathe and the water we drink. It helps to recycle dead plants and animals into nutrients which are consumed by all living things. Soil provides suitable habitat for living organisms. Of course, a handful of soil may be home to billions of organisms belonging to thousand of species (Chapman, 2012). Soil provides raw materials such as clays, sands, gravels, and minerals which are used for construction of infrastructures. It provides a physical base for the foundations of buildings, roads, railways, tarmacs and ports. It preserves a diverse range of archaeological remains

which are vital resources for understanding archaeological history. Soils serve as suitable surfaces for vast agricultural production in terms of food and cash crops, livestock, poultry, fish and fibers. The sale of these agricultural produce generates domestic and foreign currencies for nations and countries of the world. Above all, soils serve as natural resources for human creation, sustenance and survival as well as permanent residences for humans after the realization of their diverse earthly missions.

In pursuit of soil utilization for robust and sustained socio-economic development in Nigeria, ecological safety and environmental protection should be adhered to by the various development agencies and immediate rural-urban communities. Also, authentic human prudence should be exercised in the processes of agricultural production, resource extraction, refining in industries, utilization, and waste disposal on the topmost earth's surface. In Nigeria, these essential environmental principles are deliberately violated by its development agencies with specific reference to rural areas. Consequently, diverse challenges which relate to deforestation, denudation of soil resources, decimation of essential biodiversity, inundation of farms, failed crop production, soared food prices, and starvation with its diverse socio-economic impacts, inter-alia, have emerged (Okhakhu, 2016).

Soil is the physical product of the mutual interactions among parent material, climatic essentials, relief, existing organisms, plant and animal residues and time. Therefore, a fully developed soil is best observed from the assessment of its physical and chemical properties carried out on its soil profile (Moss, 1969; Thomas, 1969; Young, 1976). Anchored on this model, Aziegbe (2005) examined aspects of the soils of Ekpoma Region in Edo State, Nigeria. The study specifically assessed the physical and chemical properties of soils and their implications for proper agricultural planning and development of the region. The findings revealed that the soils in the region were essentially suitable for brink making and production of cocoa, rubber and oil palm. In contrast to the physical and chemical analyses of soil profiles which characterized previous studies, this current study examines the major types of soil and assesses the human activities and their impacts on the soils in the Edo North Region of Nigeria.

Research Methods and Materials

Field data and valid soil literature were used in the study. Edo North Region in Nigeria served as the study area. Reconnaissance and field surveys were both carried out in the region. 1000 structured questionnaires were administered randomly to the respondents at their different work places and normal residential quarters to obtain genuine data on human activities on the soils. Specifically, 830 questionnaires were administered in five Local Government Areas and each received 166 copies except Akoko-Edo where 170 copies were distributed owing to its vast area and rugged terrains. Sixty trained field assistants assisted in the administration of field questionnaires which spread from September 2016 to August 2017 owing to wide surface coverage, frequent convective rains, deplorable roads, and inadequate funds to remunerate the services of the field assistants and workers. Direct and random interviews of the respondents were carried out to augment the initial data provided in the questionnaires. Physical observations were also undertaken to identify the different human activities on the region's soils. For ease of analysis, the region was divided into four major zones: the North, East, West and South (see Table 2). In all, 880 questionnaires were retrieved from the field, and these provided 88% coverage of the region.

The field materials used for soil studies in the zones were two soil microscopes, shovels, diggers, white trays, and a measuring tape. First, the soils in each zone were dug and extracted using shovels and diggers. Four pits were dug in each zone. These added up to 16 pits in all the zones. This act exposed the soil profiles from the top through the sub-soil to the bottomless parent material. Both the extracted soil particles and exposed soil layers were examined using the two microscopes in accordance with the Soper and Tyrell (1985) methods. The soil colour, variety of living organisms in the soils, resistance to denudation, and the rate of water percolation and retention in the soil interstices were observed. Second, the measuring tape was used to take measurements of the exposed depths of soil profiles from the surface to the subterranean layers. The extracted soil particles were placed on the white trays and examined layer after layer to have further in-depth knowledge of the living organisms and their mutual activities in the soils using microscopes. Finally, the feel method (Rowel, 1994; White, 1997; Chapman, 2012) was used to assess the soil texture. Direct physical surveys enabled authentic assessment of the crop varieties cultivated and harvested in the four zones within the year a reality. The results and discussions of these assessments are shown in Tables 1, 2, 3, and related paragraphs in the study. After the completion of the surveys, the sixteen dug pits were covered to avoid soil degradation. The soil literature was obtained from the published texts available in the author's library and learned journal articles placed in the internet. The cause-effect analysis and prescriptive approach were adopted in the discussion.

The Study Area

The Edo North Region is one of the three Senatorial Districts and the second largest political unit in Edo State, Nigeria. It consists of six Local Government Areas which are Akoko-Edo, Etsako Central, Etsako East, Etsako West, Owan East, and Owan West. The region is bounded in the North, East and West by Kogi and Ondo States and in the South by Uhumwode, Esan West, Esan Central, and Esan North East Local Government Areas. The study area occupies the northern part of Edo State characterized by sedimentary rocks which are anchored on

relatively stable, crystalline basement rock formations. Limestone, sandstones, basalts and granites are realistic specimens of these rocks. The boulder rocks are broken down using accurately placed dynamites into fairly portable rock fragments. These fragments are processed into smaller rocks and stones using the quarrying machines installed in small-scale industries. The rocks and stones are sold in return for domestic revenues while the remains are used for surface constructions the commonest of which are roads, buildings, recreational spots, market surfaces, village squares and erosion mitigations in friable areas.

In Okpella and Igarra in the north, there are landforms of huge socio-economic values. First, limestone, granites, sandstones, basalts and chalks are extracted from these landforms. Second, fertile soils and relief rains which are most essential for agricultural activities are induced. Owing to fertility of the north soils, extensive agricultural activities which incorporate shifting cultivation, crop rotation, primitive ranching, orchard farming and mixed cropping are practised by the farmers. Nonetheless, climate-induced gradual denudation of the landforms coupled with effective micro-organic activities on the immediate crust over the years has led to emergence of varied soil profiles such as fertile dark loamy top soils, water retentive dark sub-soils, and the relatively stable subterranean parent material in the area. As gradual denudation takes place on the upper fertile soils in some parts, new top soils are gradually being formed in the other parts. This implies that some soils are denuded to create other new soils. This is the concept of soil processes referred to at the outset of the study. Other settlements in the west such as Afuze, Otuo, Uzebba and Sabongidda-Ora have distinct level plains with intermittent undulating surfaces which are much useful for agricultural activities, construction of durable roads, suitable markets, energy facilities and stable housing projects.

The region descends from the north towards the east where undulating flood plains are found owing to the presence and influence of the River Niger. Settlements like Agenebode, Anegbete, Ekperi, Idegun and Ogozima occupy vast undulating surfaces known for extensive rice, plantain, banana, vegetable, fruit, oil palm and cocoa production. Fishing, snail and fish farming are also prominent occupations in the location. The influence of the River Niger extends towards the south zone where its tributary, the River Orle, spurs frequent occurrence of rainfall vis-à-vis soil fertility in Auchi, Aviele, Egono and Agbede. Extensive farm activities which produce yams, cassava, sweet potatoes, rice, maize, vegetables, fish, snails, poultry, goats, and cattle are carried out in this location. In the centre, the region descends from the Fugar Hills towards the Uzairue undulating plains which encompass Ayogwiri, Irekpai, Ikabigbo, Iyora, Afashio, Afowa, Ayua, Elele and Jattu where robust agricultural activities are practised as climate dictates seasonally.

Besides Rivers Niger, Orle, Egeno, and Agbede which drain the north-east and south of the region, there are other influential Rivers like Ogio, Ukpegi, Abotse and Elele. The banks of these rivers form vast fertile alluvial plains which are used intensively for diverse agricultural and recreational activities. Also, the alluvial sands are extracted, processed, and utilized for construction of houses, roads, rural markets, and health facilities by the residents and government. The rivers provide fish, crabs, snails, snakes, crayfish, water, jobs, transport routes, rainfall, habitats for diverse flora and fauna, and fresh breezes during the seasons.

The region experiences convective and relief rains which total annual amounts soar from 1,200mm to 1,952mm.The convective rains characterized by intermittent lightning, cool winds and thunderstorms are the most frequent, heavy and evenly distributed across the region compared to the relief rains. A double rainfall-cycle occurs during May-June and September-October yearly. The mean annual temperature is 28^0C with a corresponding mild humidity that varies from 50% to 74% seasonally (Okhakhu, 2005). In the rain-fed south of the region, the rainforest is observed, and this is characterized by a deciduous, 3-layer canopy formation. In the north of the rainforest exists the scanty guinea savanna. Farming, hunting, trading, river transportation, basket weaving, production of palm oil, latex extraction, mining and quarrying of rocks, construction works, and tertiary activities are the major occupations of the people. Based on their origin traced to the Ancient Benin Kingdom, the people living in this part of Edo State are called the Kukuruku Afenmai.

Results and Discussion

Types of Soil and Related Physical Properties

Five major environmental features, specifically colour, texture, composition of living organisms, rate of water infiltration and retention in the soils, physical resistance of the soils to agents of denudation and variety of crops cultivated, raised and harvested within the specific zone were used to determine the types of soil in the Edo North Region of Nigeria. Based on field surveys, Tables 1 and 2 depict the results.

Table 1.Environmental Features Used to Determine the Types of Soil in Edo North Region

S/N	Five Major Environmental Features Used to Determine the Types of Soil in Edo North
1	The colour and texture of the soils examined
2	The composition of the living organisms present in the soils during assessment
3	The rates of water infiltration and retention in the soils as observed
4	The physical resistance of the soils to water, wind, and animal denudation
5	The variety of crops cultivated and harvested in the specific zone assessed

Source: Field Surveys, 2017

At Okpella, Imiegba, Okpekpe, Igarra and Ojirami in the north, dark loamy, silt, mixed gravel and spongy textured soils constitute the upper two layers identified. Coarse gravel texture forms the deep subsoil layer. Beneath the subsoil horizon, at a depth of 2.8m, is the cool, reddish brown sticky clay soil. It extends endlessly deep down. The spongy textured, soft loamy and dark top soil contains decomposed remains of dead plants, animals and micro-organisms. The living organisms observed in the north soils are higher fauna and flora, many varieties of plant roots, bacteria, algae and fungi. A colony of vital insects, burrow animals such as rats, rabbits, earthworms, eelworms, millipedes, centipedes and protozoan are also found in the top soils. There is uneven level of water infiltration and retention in the subsoil horizon owing to the spongy-gritty particles: the positive result of relative compactness of most tropical forest soils which is not an exception in this region.

The preponderance of diverse plants with dark-spongy and coarse-gravel particles prevents all agents of denudation in the north soils. Both shallow and deep rooted crops are grown on the soils. These include melon, groundnuts, maize, rice, cassava, yams, cocoyam, pears, cherries, oranges, pawpaw, mangoes, cashew, cocoa, rubber, kola-nut and oil palm. Based on field surveys, we classify the north soils as dark loamy, silt-sandy, mixed gravel and sticky clay soils.

Eastwards where we have settlements as Agenebode, Ekperi, Idegun and Anegbete, field surveys show the top surfaces as thick dark loamy, soft-grey alluvial and spongy textured soils. The sub-soils indicate much of grey-plastic and gritty textured particles. These particles are largely fertile alluvial soils. Beneath the sub-soils are the fined textured and red sticky clay soils which are water retentive owing to heavy rainfall and influence of the River Niger in the area. Different plants, animals, insects, useful bacteria, fungi, algae and allied micro-organisms are found on the east soils. Microscopic surveys revealed that the spongy textured aggregate particles make water infiltration and retention relatively balanced in the location. In view of these features, there is sustained seasonal resistance of the soils to water, wind and animal denudation. Both cash and food crops are produced in the region. The cash crops include cocoa, kola-nut, oil palm, rubber, cashew, and plantain. Tomatoes, pepper, oranges, mangoes, pears, pawpaw, rice, maize, cocoyam, cassava, yam, melon and groundnut constitute the food crops, and these are largely cultivated on the thick dark loamy and soft alluvial soils observed in the area.

Table 2.Types of Soil Observed in the Edo North Region, Nigeria

S/N	Location	Types of Soil Identified in the Edo North Region
1	North	Dark loamy, silt, mixed gravel, sticky clay soils
2	East	Thick dark loamy, soft-alluvial, sticky clay soils
3	West	Dark loamy, brown gravel, sticky clay soils
4	South	Thick dark loamy, sandy, silt, brown clay soils

Source: Field Surveys, 2017

In Warrake, Ihievhe, Afuze, Otuo and Sabongidda-Ora in the west, field surveys indicate the presence of thick dark-loamy, brown gravel textured and sticky fine-red clay soils which provide habitats to different flora, fauna, micro-organisms, insects, useful bacteria, fungi and protozoan. The soils receive and retain surface run-off at a balanced state as indicated through the soil profile assessment. Similar agricultural crops grown in the east are cultivated and raised in the west except in extensive tomato, pepper, rice, cassava, yam, and melon production. The west soils are also much resistant to agents of environmental denudation.

The south of the region comprises Aviele, Egeno, Igbira Farm Camps, and Agbede, while Jattu, Auchi and South Ibie occupy the central plateau and the fertile undulating plains which are habitats to extensive cocoa, oil palm, rubber, cashew, plantain, pear, mango, yam, rice, cassava, and maize production. The top soil which depth extends from 01cm-28cm is a body of thick, dark-loamy and gritty sandy soils. The sub-soils are composite dark, mixed spongy and silt-sandy particles which rest relatively upon a huge horizon of fine brown-reddish clay soils. Microscopic surveys and direct field assessments of extracted soil particles showed the existence of many round, flat, and pot-worms, pseudo-scorpions, spiders, woodlice, springtails, grasshoppers, moths, butterflies, beetles, flies, ants, termites, slugs, snails, millipedes, centipedes, earthworms and eelworms on the upper and sub-soil layers. Higher plants and animals also thrive on the dark-loamy, clay soils. The presence and huge influence of Rivers Orle, Egeno and Agbede facilitate the frequent occurrence of rainfall which percolates the soils and remains in the interstices as capillary water most useful for sustained soil fertility and favourable crops production. In essence, the denudation of the west soils is warded-off by the thick loamy, spongy textured, sticky-silt and gritty clay soil particles. Tables 1 and 2 show the details of these field results.

Human Activities and their Impacts on the Soils in the Region

Table 3 presents the observed human activities on the major soil types identified in the Edo North Region of Nigeria. Rural agriculture at 14.32% and construction of houses, village squares, markets, footpaths and state roads at 23.87% placed 1st, 2nd, and 3rd positions in the order of human engagement, preference, patronage, contribution and service provisions in the region. Rural agriculture provides food and cash crops, industrial raw materials, jobs, income and stable human health through balanced nutrition. The built houses, village squares, markets, footpaths and state roads ensure adequate human protection and safety, serve as hubs for exchange of innovative ideas and goods for money, and facilitate reliable means of movement for the people and their agricultural produce. These activities, as clearly assessed, could also induce grave physical challenges on the fertile soils. The grasses, bushes and allied vegetal resources are cut-off at the expense of rural agriculture and construction of houses, village squares, markets, and state roads. Heavy vehicles and caterpillars contracted and used for these constructions might cause physical hardening and compaction of fertile soil particles. Adequate circulation of breezes, stable water percolation and retention for vegetal use, and vital activities of fertilizing organisms might be impaired in the top and sub-soils. The deforestation of soils and consequent burning of dried vegetal resources could cause loss and extinction of biodiversity and vast soil denudation where vital organic matter and inorganic minerals needed for crops growth and survival are washed off.

Accurate scientific inference suggests that these occurrences may lead to failure of agro-produce the effects of which are high market prices of the few available goods, excessive starvation of residents, prevalence of malnutrition, ill health, family chaos, reckless incitement of youths to violent acts, and poverty induced crimes in the region.

Realistically, most loamy silt soils receive and retain adequate surface water which is held directly under the forces of adhesion. Loamy silt soils exhibit spongy and fairly gritty textured particles from 0.02mm-0.002mm while the red ribbon, sticky and fine textured clay soils are 0.002mm below. These properties facilitate adequate movement of water, heat and air including micro-organic activities in the soils. As assessed, soil water is needed for plant transpiration, photosynthesis, and dissolution of essential nutrients. Vegetation extracts water and nutrients from the soil. Under natural conditions, it returns most of the nutrients it uses to the soil as litter. Vegetation also protects the soil from water and wind erosion by intercepting rainfall, decreasing the velocity of run-off, binding soil particles together, improving soil structure and porosity, and providing a litter cover which protects the soil surface against raindrop splash. Most construction works on these fertile soils have through successive deforestation, huge surface leveling and extensive removal of soils for covering depressions in other areas impaired these mutual soil functions.

Table 3.Observed Human Activities on the Soils in Edo North Region, Nigeria

S/N	Human Activities on the Soils in the Edo North Region	Freq	%
1	Rural Agriculture	126	14.32
2	Construction of houses, village squares and markets	112	12.73
3	Mechanical and chemical works	72	8.18
4	Construction of footpaths and state roads	98	11.14
5	Pipeline vandalism	84	9.55
6	Construction of boreholes, wells and underground tanks	73	8.29
7	Seasonal cattle-sheep migration and grazing	80	9.09
8	Burning of waste materials on the soils	78	8.86
9	Chemical control of surface weeds and grasses	82	9.32
10	Indiscriminate logging	75	8.52
	Total	880	100

Source: Field Surveys, 2017

Intermittent pipeline vandalism (9.55%), chemical control of surface weeds and grasses (9.32%) and seasonal migration of cattle-sheep to escape ailments and graze fresh pastures on the soils (9.09%) form the 4th, 5th and 6th human activities in the region. In Aviele, Auchi, Jattu, Elele, Iyamho and Iluoke, reckless pipeline damages by vandals have released crude oil and refined petrol into the fertile agricultural soils. These toxic fuels have caused the pollution of fertile soils and water bodies in the settlements. Consequently, soil living organisms and water resources have been decimated and rendered vastly useless. The use of dangerous chemicals to control weeds and grasses on the earth's surface and seasonal migration of animals for protection and adequate nutrition have worsened the state of soil degradation in the region. Soil degradation, no doubt, leads to soil infertility, extensive soil compaction, loss of soil biodiversity and dwindled agricultural production.

The burning of waste materials (8.86%), indiscriminate logging (8.52%), construction of boreholes and underground tanks (8.29%) including mechanical and chemical works (8.18%) placed 7th, 8th, 9th and 10th positions as regards the human activities and their impacts on the soils in the region. These human activities directly exacerbate the deplorable state of rural environmental damage, the result of which is soil infertility which promotes huge loss of beneficial organisms. Abandoned ponds of frightening depths and hugely warped surfaces are found

in the central and southern settlements of the region specifically in Jattu, Afowa, Afashio, Iyora, Elele, Ayua, Aviele, Egeno and Agbede. Over the decades, these ponds have changed into polluted habitats for unhealthy reptiles, rats, rabbits, insects, fish, crabs and snails. These polluted reptiles, insects and crabs have been caught, killed, cooked and consumed by the residents.

Rural agriculture and construction of infrastructures coupled with pipeline vandalism ranked highest (47.74%) among the human activities observed on the soils in the region. Pipeline vandalism thrives in Uluoke, Iyamho, Elele, Jattu and Aviele. The exposed crude oil and refined fuel from the damaged surface pipelines have polluted the surfaces of rivers in Elele, Ayua and Jattu. The alternative sunk wells and constructed boreholes do not yield such naturally clean waters as in the polluted river waters. Indiscriminate logging is largely practised in the west and east of the region where Afuze, Otuo, Sabongidda-Ora, Warrake, Agenebode, Ekperi and Idegun are prominent towns. Reduced furniture items, limited planks for housing and intense heat induced human perspiration are experienced in the settlements. Chemical control of weeds and grasses is widely carried out in the four zones while seasonal cattle-sheep migration and grazing thrive in the north, east and south but relatively minimized in the west. Rural agricultural activity is sustained with crude irrigation vis-à-vis the use of expired fertilizers. This leads to acidification, salinization and cracked compaction of the cultivated soils in the region.

Research Findings

The study observes that five environmental features which are colour and texture, composite living organisms, water percolation and retention capacities, physical resistance to denudation and the variety of crops cultivated and harvested seasonally are used to determine the major types of soil in the Edo North Region of Nigeria.

Based on the significant environmental features selected, extensively fertile, dark loamy, soft grey alluvial, silt-sandy, mixed gravel and brown-red sticky clay soils are recognized in the Edo North Region.

The study observes extensive cultivation and production of food and cash crops which include cocoa, rubber, oil palm, kolanut, plantain, cashew, rice, maize, cassava, yam, groundnut, cherries, pears, and mangoes. This suggests that the region's soils are immensely fertile despite the limitations posed by surface degradation spurred by deforestation, crude oil and fuel pollution, migration of animals and construction works.

It observes extensively fertile upper and subsoil layers in the region which currently serve as suitable habitats to different vital flora and fauna, useful micro-organisms, insects, bacteria, fungi and protozoan which activities are directly relevant to fruitful agricultural production.

The presence and extensive influence of Rivers Niger, Orbe, Orle, Egeno, and Agbede have spurred the frequent occurrence of rainfall which percolates the soils and remains in the interstices as capillary water most required for sustained soil fertility and favourable crops production in the southern part of the region.

The study observes the existence of ten major human activities on the soils in the region. These are rural agriculture, construction of houses, village squares, markets, footpaths, state roads, boreholes, wells and underground tanks, mechanical and chemical works, pipeline vandalism, seasonal cattle-sheep migration for natural protection and adequate grazing, burning of waste materials, chemical eradication of surface weeds and grasses, and indiscriminate logging in the forests.

Rural agriculture and construction of houses, village squares, markets, footpaths and state roads placed 1st, 2nd, and 3rd positions in the order of human activities on the soils, engagement, preference, patronage, contribution, and service provisions in the region.

These observed human activities, the study notes, have induced the decimation of fresh grasses, bushes, and allied vegetal resources thus resulting to physical hardening and compaction of the soil fertile particles. Also, these human activities have significantly impaired adequate circulation of air within the soils, altered the balance of soil water percolation and retention for plants use, and distorted the essential activities of fertilizing living organisms in the soils.

The deforestation of the soils and consequent burning of dried vegetal resources have caused extensive decimation of vital soil biodiversity and uneven soil degradation where essential organic matter and inorganic minerals required for continuous crops growth and survival have been markedly depleted.

The study observes that in Aviele, Auchi, Jattu, Elele, Iyamho and Uluoke, reckless pipeline vandalism carried out by liquid mineral vandals have spilled crude oil and refined fuel on fertile agricultural soils and drinking water bodies resulting to pollution of these indispensable environmental resources.

The study notes that the use of dangerous chemicals to control weeds and grasses on the soils, seasonal migration of animals for natural protection from diseases and adequate nutrition and construction of water reservoirs always exacerbate the deplorable condition of rural environmental degradation which results to soil infertility in the Edo North Region of Nigeria.

The continuous construction of water reservoirs for farm irrigation and application of fertilizers for crops production have resulted to abandonment of numerous water ponds of frightening depths and hugely warped surfaces in the central and southern areas of Jattu, Afowa, Afashio, Iyora, Elele, Ayua, Egeno and Agbede.

Recommendations

The study observes the existence of vastly fertile, dark loamy, soft-grey alluvial, silt-sandy, mixed gravel, and sticky, brown red clay soils in the four major zones identified in the Edo North Region. These fertile soils which require diligent use and protection through private-public efforts should be shielded with cover grasses, crops, adequate trees and occasional compost with farm yard manures. All environmentally degrading human activities which include deforestation, sporadic grass cutting, waste burning outdoors, pipeline vandalism and decimation of vital soil biodiversity spurred by unsupervised surface construction of infrastructures should be prohibited through viable legislation. Also, the careless destruction of crude oil and fuel pipelines by vandals which pollutes fertile agricultural soils and drinking water resources as seen in some parts of the region should be prevented through adequate environmental monitoring using surface detective computers and physical protection anchored on the deployment of specially trained security agents. Community vigilante groups could also help achieve this important objective in the region when successfully mobilized by the grass-root government.

The polluted soil and water resources in the region should be carefully cleaned through detoxification and water treatment techniques. A biennial surface resource sanitation which is coordinated by environmental specialists is suggested. Adequate funding of these measures and mobilization of suitable technology by the government for urgent execution would bring the desired success in this regard. Dubious procrastination must not be infused into the implementation system. In carrying out these measures with other surface constructions in the region, strict adherence to healthy environmental ethics is mandatory.

The dark loamy fertile soils in the region should be used by the rural farmers for food and cash crops production under diligently organized management of extension experts. Consequently, bountiful harvests of cocoa, rubber, oil palm, cashew, plantain, pawpaw, rice, maize, yam, sweet potatoes, ground nuts, oranges, and coconuts, inter-alia, would be realized. These agricultural produce would provide veritable income, gainful jobs, quality raw materials for industries, adequate food for healthy families, new markets for sale of harvests and acquisition of new business ideas, foreign currencies, and future means of life sustenance for the people in the region. Also, the quality of soils could be improved through the use of crop rotation, fertilizer applications, forest regeneration, cover cropping, terracing of hill slopes, irrigation practices, utilization of compost and farm yard manures, seasonal cultivation anchored on authentic climate information, and manual soil leveling which facilitates balanced biodiversity procreation within the soils.

Rural infrastructure provision accelerates the pace of rural development which is a most desirable measure required for the overall development of Nigeria. In the rural environment, however, this development must be carefully organized and managed by specialists in such a way it reaches accord with standard ecological principles which protect against decimation of soil fertilizing organisms, vital soil biodiversity, the creation of polluted ponds of frightening depths and vastly warped surfaces on the natural environment. The technical proficiency of civil and mechanical engineers, architects, quantity surveyors, climatologists, agronomists, soil scientists, economists, lawyers, public administrators, horticulturists and local skilled workers is mandatorily needed to ensure success in this regard.

Adequate socio-economic enlightenment of the rural residents on soil utilization and general guidelines on environmental constructions directed at the overall rural development is suggested. This, carried out, would help change the attitude of the residents towards rural development aimed at promoting healthy environmental stability in the Edo North Region of Nigeria.

These measures require adequate government funding, supply of suitable inputs including technology, effective soil monitoring, assessment, and management by specialists, and the construction of feeder roads to link farm establishments with viable markets in villages, towns and cities. Private and public cooperation is much essential in this regard. Above all, the use of funds and suitable technology for beneficial agricultural production should be anchored robustly on the balanced inputs of climate in the region.

Conclusion

This study has used environmental attributes of colour, texture, living organisms, resistance to denudation, rate of water percolation and retention, and the crops grown and harvested within the year to determine the major soil types and their physical characteristics in the four zones which constitute the Edo North Region of Nigeria. In brief, the soil types identified were observed to be largely fertile, dark loamy, soft-grey alluvial, silt-sandy, mixed gravel, and fine grained, brown-red sticky clay soils which are vastly suitable for the production of both food and cash crops. Also, the ten observed human activities which include construction of infrastructures, migration by animals, pipeline vandalism, and chemical control of surface grasses among others had mixed impacts on the soils found in the region, and these ranged from environmental degradation through surface resource pollution to soil infertility that negated standard ecological principles of soil maintenance and sustainability across the world. Based on the findings, the study suggests, inter-alia, that the region's soils which require prudent maintenance, preservation and diligent management by experts, should be vastly shielded from all grades of environmental despoliation. These measures when holistically realized through joint efforts of the people and government of the

region would create suitable soil climate for the production of abundant food and cash crops and the overall development of the region in accordance with acceptable standard environmental principles.

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