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RESEARCH ARTICLE

ASSESSMENT OF ENVIRONMENTAL DEGRADATION IN NIGERIA A CASE STUDY OF SAHARA DESERT IN NORTHERN NIGERIA

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ABSTRACT

Environmental degradation is a process which lowers the current and/ or the potential capability of land to produce goods or services in terms of qualitatively. Soil degradation and deterioration of the physical chemical and biological characteristic of soil is one facet of environmental degradation since soil is an integral component of environment. The rate at which environmental degradation occur differs from a climatic zone to another in terms of its causes, short and long term consequences. The northern states of Nigeria (11 states) which is 43% of Nigeria land mass are the most vulnerable for environmental and soil degradation. Some environmental degradation indicators identified in Northern Nigeria includes wind erosion, drought, deforestation, desertification, alkalinisation, salinization on the degradation of the environment, deterioration of vegetation cover and its biodiversity, soil crusting, sealing, salinization and hydrological degradation. The country is losing over 350,000 ha of the land yearly to desertification as a result of degradation. The main driving forces of these process includes scarcity or insufficient of rainfall and wind erosion. These effects can be overcome by increasing the number of adequately equipped metrological stations, irrigation, comprehensive ecological survey on soils, water and vegetation, scale afforestation projects, Shelter belt construction, Biochar amendment, green walling etc

INTRODUCTION

Environmental degradation is the impoverishment of terrestrial ecosystem that can be measured by reduced productivity of desirable plants, undesirable alterations in biomass and the diversity of the micro and macro fauna and flora, accelerated soil deterioration, and increased hazards for human occupancy. Soil degradation, caused by land misuse and soil mismanagement, has plagued humanity since the dawn of settled agriculture. Many once thriving civilizations collapsed due to erosion, salinization, nutrient depletion and other soil degradation processes. The unwise use of the natural environment due to ignorance, poverty, overpopulation and greed amongst others has led to the degradation of the environment. The changes (degradation) occur as Nigerians attempt to adjust their seemingly endless wants and desires for food, shelter, recreation, infrastructural facilities, and so on to the land and other resources available to them (NEST, 1992).
When a fragile ecosystem is exploited beyond its carrying capacity, the system breaks down. This is the problem of the arid and semi-arid region of Nigeria which constitutes about one-third of the entire land area. Indeed, it has imposed physical and biological constraints on the area such as drought, low and variable rainfall, sparse vegetation, thin, droughty and infertile soils mainly of Aeolian origin which are highly erodible and compactible, high atmospheric evaporability induced by high wind velocities and low relative humilities. High carrying capacity of man and animals coupled with the use and overuse of the fragile resource based which have led to serious land degradation. (Aruleba and Ayodele 2007). The worsening problem of desertification is quite glaring as studies by (Babalola1998) reveals that an estimate of between 50 % and 75 % of Adamawa, Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe, and Zamfara States in Nigeria are affected by desertification and are particularly vulnerable to wind erosion. These states, with a population of about 50 million people, account for about 43 % of the country's total land area. With the country losing over 350,000 hectares of land yearly to desertification, it could not afford to watch while arable land is being lost to desert encroachment. Deforestation, overgrazing, soil compaction by human and animal traffic and repeatedly running over of the land with heavy machinery have exposed large tracts of land to the climatic elements resulting in desertification or the expansion of desert-like condition (Aruleba and Shittu 2004).

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The development of water resources for irrigation in order to maximise the water environment of the plants has brought in its wake the attendant global problem of salinization, alkalinization and waterlogging. This paper examines the phenomenon or process and the effects of drought, desertification, alkalinization salinization on the degradation of the environment in the arid and semi-arid region of Nigeria and to proffer some solutions for land use. The Nigerian government has put in place various National Policies, Institutional and Legislative Framework, Sectoral Programmes, and Partnership Building to address the problem of environmental degradation, drought and desertification. Apart from the Federal Government programmes, all the eight states bordering the desert have also taken bold steps to check the spread and expansion of the desert. The effect of the advancing Sahara Desert is more directly felt in the extreme northern parts of Nigeria. This portion of the country extends from about latitude 12N to the boundary of the Republic of Niger. The area already exposed to the effects of desertification in Nigeria is estimated at about 326,000 square kilometres. (11 states mentioned earlier).

Drought: Drought has often been defined in several ways. All definitions have as a base insufficiency of rainfall, either on a short term or long term basis, repeated or on a cyclic nature. The overall effect on the environment is crop failure or a marked reduction in biological productivity including not only plants but also the animals which are dependent upon them.
Drought can therefore mean a total lack of rain, delayed onset of rainfall, inadequacy of rainfall during peak crop demands (such as flowering and reproductive stages) and abrupt cessation of rain. During the rainy season, dry spells of up to 10 days are not uncommon. Such dry spells immediately after planting and during flowering create water stress in plants resulting in crop failure or much stunted growth and reduced yield. Rainfall analysis carried out by Benoit (1977) revealed that the possibility of dry spell during flowering increases northwards from the Northern Guinea Savannah. Dry spells immediately after sowing or germination (false start of the growingseason) between April and June in the savannahs are more probable (one in every five years) during flowering (Owonubi and Abdulmumin, 1987). Streamflows, ground water levels, hydropower production and irrigation from large reservoir are adversely affected during periods of prolonged drought. The arid and semi-arid regions generally experience drought in all its facets and this exacerbates the desertification process. The sudan-sahelian drought of 1968-1973 had devastating influence on (Winstanley, 1973, Brutung et al, 1796, Ojo, 1985). Severe food shortage, widespread hunger famine came in its wake. Indeed extreme drought conditions occurred in 1972, 1973, 1982 and 1983.

Desertification: This global phenomenon is the intensification extension of desert conditions leading to reduced biological activity with concomitant reduction in plant biomass, in lands carrying capacity for livestock in crop yields and human well beings (United Nations Conference on Desertification, (1977). It has threatened about $^{1}/_{3}$ of the earths land mass and about 55% of the world's area of existing desert is contained in Africa (FAO, 1977). It is one of the greatest threats to increased food production and food security. The process which begins as a mild, negligible ecological aberration has now affected about one sixth of the entire country. The process thrives on the twin interaction of weather and the effect of man's exploitation of land for food production.

Scanty, but torrential rainfall, high wind erosivity, low relative humidity and wide seasonal temperature fluctuations, structureless top soils largely of Aeolian origin are some of the ecological factors of the affected areas. The loose top soils are highly erodible under high wind influences. Thus, the control of wind erosion is a significant soil management practice for combating desertification. The boundaries of the affected areas appear diffuse and not clearly defined. However, in the early 80s, desertification problems were confined to areas north of latitude 12^{o}N. Today, this boundary has moved southwards more than 1^{o} to latitude below 11^{o}N (FORMECU, 1977, Personal Communication. Unless drastic measure is taken, the southward progression would continue unabated. On the weather side of the problem, there seems to be little one can do. Perhaps one major step that has been taken by government is to circumvent drought problems by the construction of large dams for irrigation purposes. The desired impacts on the ecology and food production are not self-evident. The limited success achieved so far has not justified the huge capital outlay on irrigation schemes in the North. Some of the identified constraints include poor water management practices, poor water delivery efficiency, low research input into irrigation schemes, a dearth of irrigation technicians and trained farmers (Maurya et al,1990). Indeed an efficient irrigation scheme in the north may in the final analysis be the panacea for the desertification problem.

High carrying capacity in the affected area has not always allowed a wise and judicious exploitation of the ecology. Population pressure on the land has so reduced the fallow period of the traditional shifting cultivation that adequate natural generation does not occur. Desertification can also be attributed to long periods of over-exploitation of the vegetation, inappropriate agricultural techniques especially improper land cleaning practices, bush burning etc. these effects are exacerbated by drought. Large tracts of land are thus laid bare to the climatic element of rain and wind causing severe water and wind erosion. Heavy sediments which accumulate in streams and rivers reduce their capacities to hold water. This process converts perennial to seasonal streams or rivers, or in some cases, the rivers change courses and disappear altogether thereby reducing water availability for animal and man alike. (Ogigirigi et al, 1987) soil loss by wind and water erosion, constant bush fires and the attendant loss of organic matter lead to soil impoverishment and a significant decline in biological productivity.

Some of the remedial measures that have been suggested and partially put into practise include. Introduction of a comprehensive legislation for protection and management of the human environment e.g. bush burning, overgrazing excessive browsing of young trees, mining operation, deforestation etc. Large scale afforestation, establishment of grazing and browsing reserves, shelterbelt construction, alternative sources of energy for cooking to remove pressure on wood for energy and a comprehensive land use planning of the area (sagua et al, 1987). All these measures are either not in place or have not had any appreciable impact on the problem of desertification. Shelterbelt construction is no doubt one major step to arrest the southward progression of the desert. Shelterbelts are rows of trees grown perpendicular to the prevailing wind direction so as to reduce wind velocity and ameliorate the climate. Unfortunately, not much as been done in this regard. Between 1954 when this fact was first appreciated and the middle 80□s, only about 2000 km of

shelterbelt have been constructed.(Ojo et al, 1987) today, the figure may not be more than 4000 km which is a far cry from what is required. Exotic fast growing and drought resistance species of *Eucalyptus camadulensis* and *Azadirachta indica* (neem) are the preferred trees. It is estimated that only about one percent of the area requiring protection in kano had been covered. High mortality of seedlings either in afforestation programmes or shelterbelt construction has rendered these practises ineffective in some places.

Aruleba and Ayodele (2007) noted that One aspect of desertification which until recently received little or no attention is the potential danger which sand dunes and migrating sands constitute to a rapid spread of the phenomenon. Indeed, they constitute danger to life and property including farm lands. Extensive area of active dunes and migrating sands occur in many places between Sokoto and the west and Borno states in the eastern parts of northern Nigeria. Unless the dunes are stabilized, they developed legs resulting in an increased desertification of the area and posing threat to life and property. In these areas, who lee communities have had to move when the sands or saint came marching in. Highways have been blocked by migrating sands, extensive crop failures have occurred in the field because seedlings have been buried or die when roots are exposed by wind. Babalola (1998) working with other colleagues in the shelterbelts. Research station in kano has developed a technology for fixing sand dunes. This technology, which combines both the biological (tree planting) with the mechanical method (mechanical protection for seedlings at the early stages) holds great promise. It needs to be fine-tuned and tested in several part of the north where active dunes occur.

Babalola (1999) has developed the use of a soil conditional and soil conditioning techniques for afforestation (a sand dune project in northern Nigeria). This involves the use of manure and fadama clay to condition the soils and the use of an alcarsob, called growsoak (trade name). The soil conditioner which is a polyacrynamide has a capacity of absorbing 400 times its own volume of water (anonymous, 1977) increases the water use efficiency of the plants and thus reduces the frequencies of watering or the incident of water stress and plant mortality. Indeed it encourages very rapid growth and survival of plant particularly on sands dunes. Arcarsob best use at the rate of 2.0 kg/m3 is best used in the granular than gel form. Neem and eucalyptus are recommended for sand dune fixation because they are fast growing, drought tolerant and have good root system developments (Babalola 1999) eucalyptus grew significantly better and exhibited lower mortality rate than neem on sand dunes. Sand dunes fixation practise should therefore have more of eucalyptus than neem on active dunes. Other indigenous species can be established as minor crops. However, the allelopathic nature of eucalyptus will necessitate a special arrangement of the eucalyptus, neem and other tertiary local species on sand dunes. Sub soiling of seedlings with alcarsob or a mixture of sand, manure and fadama clay have put most beneficial for the establishment and survival of plant on sand dunes and may be the panacea for crop failure on afforestation and reforestation project in the north. The cheapest and commonest method of mechanical defence for seedlings on sands dune (sand fencing) is the use of twigs and branches of shrubs and trees lined up in close parking (50% porosity) in shallow trenches (about 15cm deep) perpendicular to the direction of the wind. The use of twigs is however not recommended for sand dunes fixation in the north because of the fear of accelerating desertification by deforesting the land. Sand fencing material found to be effective and relatively cheap in the use of corn stalks of guinea corn which are prefabricated into mat forms of 3m length. Corn stalks are woven together to give a 50% porosity using the fibre ropes made from *Borassus ethiopim* (Babalola 1998). The spacing and arrangement of sand fences are also critical in stabilisation practises. Winds speed, directions and length of exposed bare dune on sand-field are important factors. Studies carried out have shown that spacing, ranging between 3m and 5m are effective in reducing wind speed and curtailing both accretion and deflation of sand around plant roots. Arrangements of sand fences should be done in a checkerboard fashion because of the multi-directional nature of the wind throughout the year. Where the spacing of sand fences is appropriate, the height of fences either 1m or 0.5m is not of much consequence. Sand dunes fixation efforts on long bare fields are unproductive unless macro windbreaks are erected in the form of shelterbelts. Sand dune fixation effort should normally followed shelterbelt constructions in such areas. It is worthy of note that shelterbelt construction perse is not sufficient to stabilize sand dune.

Salinization and Alkanization: Salt problems commonly occur in regions with arid and semi-arid climates and tend to decrease the productivity of large agricultural areas. The extents to which salt in the soil solution or sodium on the exchangeable fraction of the soil are in excess are measure of the salt problem. Salt affected soils have excessive concentration of soluble salts (saline-alkali soils) or absorbed sodium (alkali or sodic soils) (Reeves, 1967). The soluble salts that occur in soil consist mainly of the ions. Na^+, Ca^{++}, Mg^+, K^+, Cl^-, SO_4^- HCO_3^-, CO_3^-, BO_3^{3-} and NO_3^-. Whereas these soluble salts released from exposed rocks and minerals are carried downward through the soil profile by rain in the humid environment, in arid regions, leaching may be local and the soluble salts may not be transported far because of the paucity of rainfall. High evapotranspiration rates of arid climates tend to decrease the limited amount of water available for leaching and transporting salts. Irrigation water may also bring salts to an area. Indeed all irrigation waters whether from springs, well or streams contain appreciable quantities of soluble salts. Irrigation water is perhaps the major source of the soluble salts that gives rise to the salinity problems. The severity of salt problem is exacerbating by inadequate natural drainage, either surface or internal drainage. Unless sufficient irrigation water is provided for crop needs in consumptive use and the necessary leaching of excessive salts out of the soil (leaching requirements), saline and alkali problems can also arise.

Saline soils contain enough soluble salts that they decrease the growth of most plant due to high osmotic potential. Such soils have an electrical conductivity (EC) of the saturation extract of at least 4mm ho/cm at 25°C and the exchangeable Na^+ percentage is less than 15. Saline soils are often recognised by the presence of white surface crusts, by damp oily-looking surface devoid of vegetation, stunted growth of plants, tip burn and firing of leaf margins. Salinity reduces water absorption by plants and cause toxicity plants. Alkalinity or sodicity has more hazardous effect on soils and plants. Here, exchangeable Na^+ percentage (ESP) is at least 15% and in extreme cases could be 50-70% of the cation exchange capacity. Affected soils are unable to support any kind of vegetation. Nutrient availability such as Fe, Zn and P are drastically reduced. Soil degradation by dispersion and compaction generally results.

Soils become impenetrable to roots and water giving rise to columnar type of structure. The extents to which all these effects occur in our soils are not well known. This is because of the limited research input into the irrigation systems in the country. Indeed there is a need to keep periodic records of efficiency of water use by conveyance on the field, areas subjected to waterlogging, salinization and alkalinization and areas abandoned because of soil and water quality. Such monitoring is most useful right from the inception of an irrigation scheme.

Wind Erosion: Accelerated erosion is an important factor adversely affecting sustainability of cropping and farming systems.Wind erosion is very critical in the northern part of Nigeria. Soil degradation by accelerated water and wind-induced erosion is a serious problem and will remain so during the 21st century, especially in developing countries of tropics and subtropics. Erosion is a natural geomorphic process occurring continually over the earth's surface. However, the acceleration of this process through anthropogenic perturbations can have severe impacts on soil and environmental quality. Accelerated soil erosion has adverse economic and environmental impacts (Lal, 1998). Economic implications of soil loss include reduction in farm income as a result of fertility decline and consequent adverse impact on crop/ animal production. Saha (2004) described soil erosion as a three stage process: (1) soil detachment,(2) transport, and (3) deposition of eroded particles. Erosion is more serious in the north because of the prevalence of fragile soils of high erodibility, harsh climates of high erosivity, and predominately resource-poor farmers who cannot afford to adopt conservation-effective measures. Erosion affects crop yields and agronomic productivity both directly and indirectly. Directly, it reduces the effective rooting depth and available water and nutrient retention capacities. Indirectly, it decreases use efficiency of inputs and increases the amount of fertilizers, water and energy needed to produce the same yield. Erosion has both on-site and off-site impacts. On-site, it reduces seed germination, stand establishment, and plant growth and vigor. Off-site, through runoff and deposition, it increases risks of inundation, pesticide damage, and seedling burial. Three processes viz. dispersion, compaction and crusting, accelerate the natural rate of soil erosion. These processes decrease structural stability, reduce soil strength, exacerbate erodibility and accenttuate susceptibility to transport by overland flow, interflow, wind or gravity. These processes are accentuated by soil disturbance (by tillage, vehicular traffic), lack of ground cover (bare fallow, residue removal or burning) and harsh climate (high rainfall intensity and wind velocity). The soil erosion process is modified by biophysical environment comprising soil, climate, terrain and ground cover and interactions between them.

Recommendations to Reduce Environmental Degradation

Drought has a significant snow-balling effect on land degradation. Accurate prediction of drought incidence will help to forestall the negative influences. For this reason, government should increase the number of adequately equipped metrological stations with a view to assisting long-term weather forecasting and the incidence of drought. A variable solution to the problem of drought is irrigation. Irrigation however has not had the desired impact on the environment and land productivity. Negative impacts of salinization and alkalinization have been reported. Monitoring of the irrigation environment should normally start with the commencement of any soil irrigation scheme. Where this has not been done, baseline data should be collected immediately. There is a need to carry out a survey of salt affected soils and to attempt to reclaim them. The need to train more irrigation specialist schemes is urgently needed, in order to maximize the desired influence of irrigation scheme on land use. Economic analysis of present schemes should be carried out to guild the future development. There is also a need for comprehensive ecological survey on soils, water and vegetation and the environmental impact on specific project on the environment, this will aid a comprehensive land use planning of the area north of altitude 11 N. In order to reduce pressure on forest land or woodlots, an alternative and appropriate technology of energy source should continue to be sought. Certain types of stoves developed in the last few years are perhaps not having the desired impact. Large scale afforestation projects should be intensified; this will not only ameliorate the climate but also provide fuel wood.

The use of soil conditional, like alcarsob, capable of absorbing water 400times its own volume has great potential in drastically reducing the mortality of planted seedlings and turning once barren land into a green belt. Shelter belt construction and sand dune fixation effort should be intensified now that the technology has been developed. The Centre for Arid Research Information Network (CARIN). This should be established to co-ordinate and sustain research on drought and desertification and dissemination of technical information. the magazine aims will be to identify promising technologies for small-scale farmers, acts as a platform for people to share information and experiences on sustainable livelihoods. The publication will also focuses on issues around climate change adaptation and developments in Nigeria and may be published in English and other Nigerian languages. Existing laws and regulations with regards to bush burning, grazing reserves, deforestation etc. must be reviewed and diligently monitored and enforced to stem the desert encroachment to the barest minimum.

Biochar amendment can also be used for afforestation. Biochar is a name for charcoal when it is used for particular purposes, especially as a soil amendment. Like all charcoal, biochar is created by pyrolysis of biomass. Biochar is under investigation as an approach to carbon sequestration to produce negative carbon dioxide emissions. Biochar thus has the potential to help mitigate climate change, via carbon sequestration. Independently, biochar can increase soil fertility, increase agricultural productivity, and provide protection against some foliar and soil-borne diseases. Furthermore, biochar reduces pressure on forests. Biochar is a stable solid, rich in carbon and can endure in soil for thousands of years. Desert greening is the process of man-made reclamation of deserts for ecological reasons (biodiversity), farming and forestry. Desert greening is more or less a function of water availability. If sufficient water for irrigation is at hand any hot, cold, sandy or rocky desert can be greened. Water can be made available through saving, reuse, rainwater harvesting, desalination, or direct use of seawater for salt-loving plants. These different paths have unique features, i.e.: conserving water is a cheap solution. Reuse of treated water and the closing of cycles is the most efficient because closed cycles stand for unlimited and sustainable supply. Green Wall is a series of human-planted forest strips, designed to hold back the expansion of the Desert. The "wall" will have a belt with sand-tolerant vegetation arranged in checkerboard patterns in order to stabilize the sand

dunes. A gravel platform will be next to the vegetation to hold down sand and encourage a soil crust to form. The trees should also serve as a wind break from dust-storms. The federal government of Nigeria has taken step to strengthen this in some states but should be extended to all the 11 states in the North characterised by desert phenomenon.

CONCLUSION

All these methods highlighted such as by increasing the number of adequately equipped metrological stations, irrigation, comprehensive ecological survey on soils, water and vegetation, scale afforestation projects, Shelter belt construction, Biochar amendment, green walling etc. would give the numerous benefits of increasing the SOM concentration and pool on enhancing ecosystem services and improving the environment. The key factor is the improvement in soil quality with the attendant positive impact on soil processes and properties.

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