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EFFORTS IN DESERTIFICATION CONTROL IN THE SAHEL OF NIGERIA

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ABSTRACT

Purpose: The purpose of this paper is to show the extent of desertification and land degradation as threat to sustainable environmental, agricultural and land development in the Sahel of Nigeria with its consequences on the livelihoods of the people.

Design/methodology/approach/: Several desertification attenuation projects in Nigeria employing different methods for maximum benefits obtainable from the objective of the particular project. Specific methods, including satellite studies, have been used. It is noted that environmental impact assessment or community reconnaissance and needs assessments were part of all the project activities.

Findings: Desertification has reached an alarming state in Nigeria. The *frontline* desert threatened States constitute 40% of the land mass of the country. With desertification process exacerbated by a period of prolonged drought of about 20 years, climate change and human activities, it is becoming increasingly difficult to obtain sustainability in the management of the fragile lands and the region's ecosystem. Strategic interventions in combating desertification in Nigeria have attenuated detrimental social, economic and environmental impacts on the affected communities resulting in increased agricultural yields. Programmes and projects have strengthened the resilience of the people, participating in sand dune stabilisation, Great Green Wall Sahara Sahel Initiative (GGWSSI) and

shelterbelts development. Government has sustained inputs in environmentally friendly agriculture and also encouraged synergetic collaborative activities with national agencies, international agencies and national institutions.

Originality/value: These results/activities give evidence to the increased public awareness of environmental degradation due to desertification in Nigeria; the realisation in environmental stabilisation needs with ready participation of the communities for improved livelihoods in arid agriculture; resulting in internationalising these problems for Nigeria.

Keywords: desertification in Sahel of Nigeria; drought; climate change; fragile ecosystem; deforestation; environmental impact assessment; reconnaissance; environmentally friendly agriculture; ecosystem management; community resilience; shelterbelt; sustainable management; synergetic collaboration.

INTRODUCTION

Desertification, according to the United Nations Convention to Combat Desertification (UNCCD) refers to land degradation in arid, semi-arid and sub-humid areas resulting from factors such as human pressure on fragile eco-systems, deforestation and climate change. The terms desertification and land degradation are mostly used interchangeably and closely linked to drought.

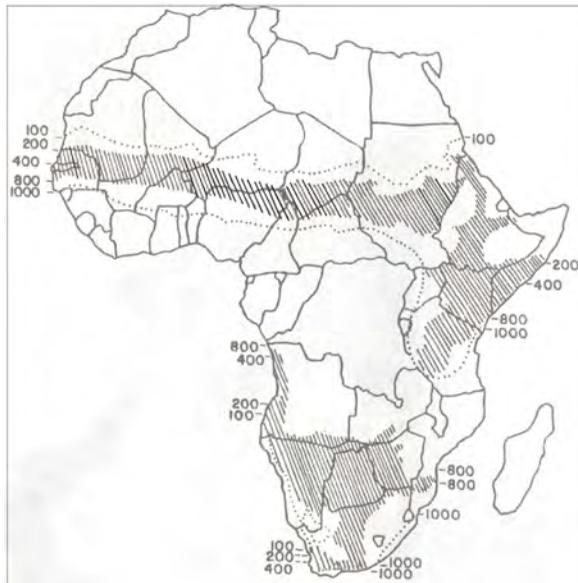
Desertification is caused by a combination of factors that change over time and vary by location. These include indirect factors such as population pressure, socioeconomic and policy factors, and international trade as well as direct factors such as land use patterns and practices and climate-related processes. The causes of desertification may be summarised as unsustainable management of resources and inputs such as – over grazing of rangelands; improper farming and irrigation practices; excessive application of fertilizers and chemicals; deforestation, forest fires and fire wood collection; urbanisation; mining and change in land use patterns. Socio-economic factors include land tenure, fragmentation and common title; also weak participation of private sector; poverty and food insecurity. Institutional and legal factors include weak enforcement of legislation; weak institutional capacities and capabilities of the public, NGOs, CSOs or private sector and weak coordination mechanisms among them; weak participation of different stakeholders in the decision-taking decision-making processes; lack of information and appropriate data; lack of proper awareness and appreciation among the people, media, legislators and decision makers; low interest and budget allocation to combating desertification, lack of proper implementation of national policies, strategies and commitments to combating desertification and applying the proper incentives, policy tools and instruments; weak regional cooperation; ambiguity and overlap over responsibilities. Natural factors include climate change and weather factors; population growth and pressure are all apparent.

The purpose of this paper is to show the extent of desertification and land degradation as threat to sustainable environmental, agricultural and land development in the Sahel of Nigeria with its consequences on livelihoods.

LITERATURE REVIEW ON DESERTIFICATION IN THE FRONTLINE STATES OF NIGERIA: EXTENT AND SEVERITY

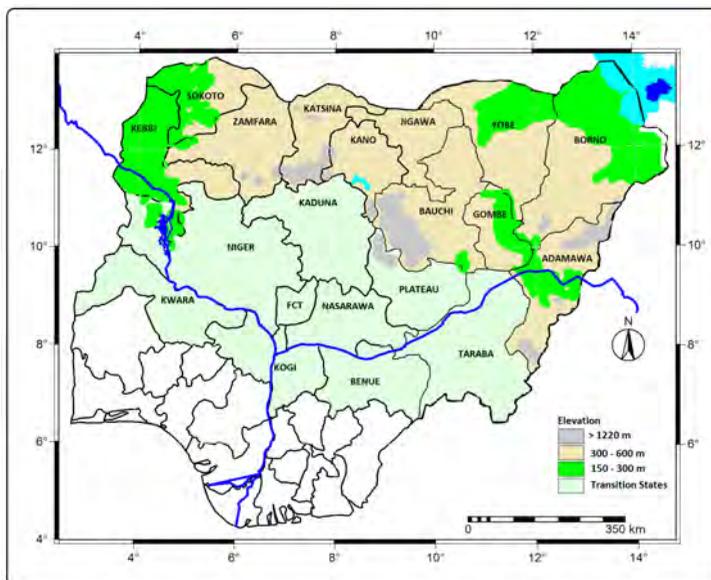
The frontline desert threatened states of Nigeria, occupy some 40% of the land mass of the country in the far north region and lies within the Sudano-Sahelian West Africa which stretches from Senegambia to Somalia in the East – a land mass located within Latitudes 10° to 14° N and Longitudes 3° and 14° East. They are collectively regarded as ‘frontline states’ and they mostly share common boundary

with the Sahelian Niger Republic. Indeed the northern borders are all Sahelian environment (Figures 1 and 2; Table 1). This zone is defined as an area that receives between 200 mm and 800 mm of rainfall per year (Figure 2). The States have a population of about 35 million people and the Sahel is considered one of the most sensitive and delicately balanced ecological systems in the world. With the increased pressure of desertification, exacerbated by a period of prolonged drought of about 20 years (1970–1990) and human activities, it has become increasingly difficult to maintain sustainable development in the fragile lands of the region, particularly in the States of Bauchi, Gombe, Borno, Yobe, Kano, Jigawa, Katsina, Sokoto, Zamfara, Kebbi and Adamawa (Figure 2).



Source: IIED (1989).

Figure 1 Africa, showing the Sahel



Source: Gadzama and Ayuba (2014, In press).

Figure 2 Desertification frontline States and the Buffer Zone States

The middle-belt States of Nigeria located between latitudes 10°N to 11°N that share boundary with the above frontline states serve as the *buffer zone*, because they absorb the pressure of migrating human and animal populations. These States include Benue, Federal Capital Territory (FCT), Kaduna, Kwara, Kogi, Nassarawa, Niger, Plateau and Taraba (Figure 2).

The total land area covered by the frontline States is more than 393,000 km², which when compared with the 140,000 km² estimated from the World Desertification map by FAO, WMO and UNESCO in 1977, shows significant southward migration of desertification. For it is known that the Sahara desert is moving southward at the rate of 0.6 km yearly; amounting to a loss of about 351,000 ha of both crop and rangeland to desertification each year (FGN, 2004; Gadzama, 1995; Tiffen and Mortimore, 2002; Wood and Yapi, 2004). This is evident in the sand dunes that have covered large expanse of agricultural farmlands, livestock grazing land with trees dying within the region and drying up of local oases (BNRCC, 2012).

Between the period of 1976/78 and 1993/95 (Figures 3a–c), sand dunes increased by approximately 17% from 820 km² to 4830 km² (FME_{Env}, 2012). Some villages and major access roads have been buried under sand dunes in the extreme northern parts of Katsina, Sokoto, Jigawa, Borno and Yobe states. An example is the receding Lake Chad. Gully erosion, that hitherto was not a major threat, increased, threatening about 18,400 km² (compared to only 122 km² in 1976/78) (FME_{Env}, 2012; Musa et al., 2008) (Figure 9).

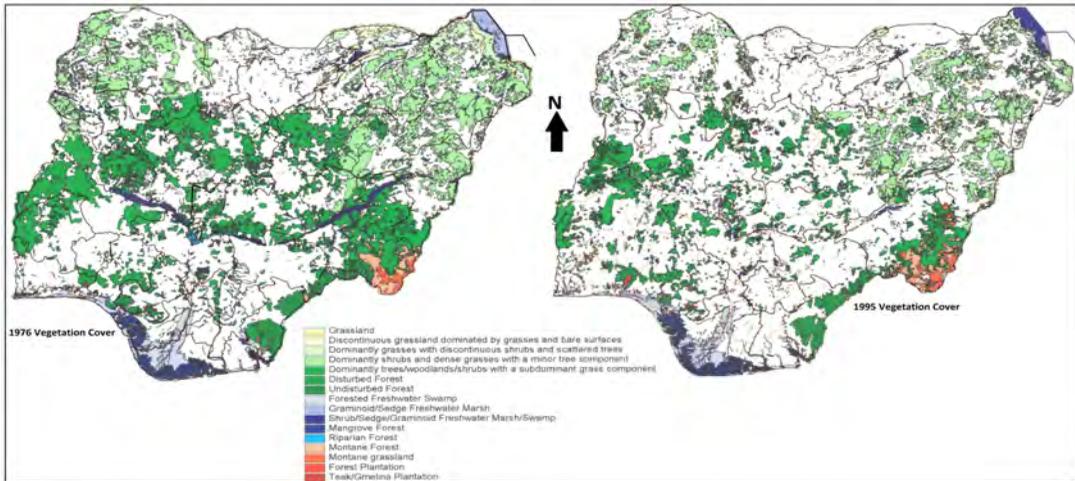
It has been estimated that between 50% and 75% of the 11 frontline states of Nigeria are under severe threat. The pressure of migrating human and livestock populations from these states are being absorbed by buffer states resulting in an intensive use and degradation of the fragile and marginal ecosystems of these areas, even during years of normal rainfall. The buffer states are reported to have about 10% to 15% of their land areas threatened by desertification (FGN, 2004; Gadzama, 1995; Tiffen and Mortimore, 2002; Wood and Yapi, 2004).

This timely land use and vegetation cover studies by Forest Management, Evaluation and Coordinating Unit (FORMECU) of Federal Department of Forestry, for the periods 1976/78 and 1993/1995 showed that the changes in vegetation during the interval period of 15 years (1978 to 1995), was staggering with 32% of the riparian vegetable cover removed by year 1995 (Figure 3a). Forest cover became less than 20% that of 1978 (Figure 3b); the present estimated forest cover for Nigeria is less than 10%. With increased population, it is not surprising that there would be intensive agricultural land use in the region.

Table 1 Front line States of Nigeria affected by Desertification

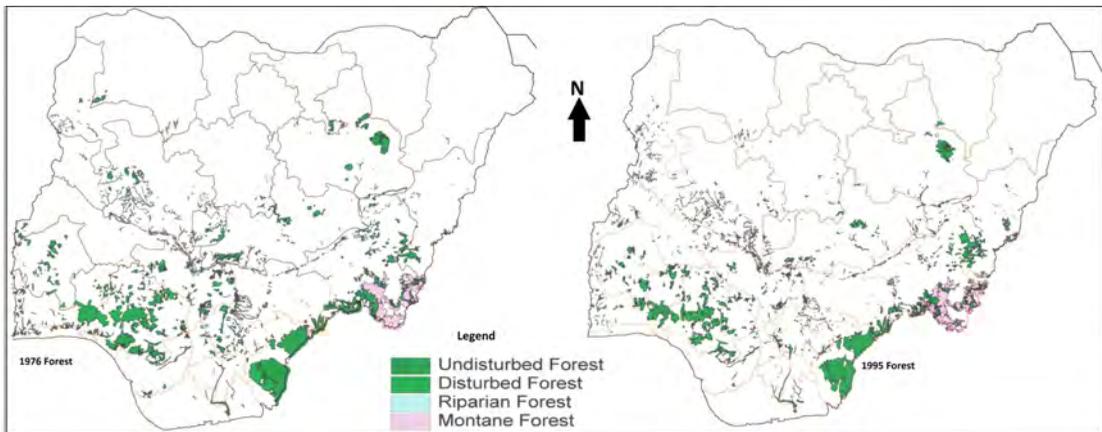
States	Land Area		Population	
	KM ²	% of Nigeria	Number	Density/Km ²
Bauchi/Gombe	64,605	6.99	4,294,413	66
Borno	70,890	7.67	2,596,598	37
Yobe	45,502	4.93	1,411,481	31
Kano	20,131	2.18	5,632,040	280
Jigawa	23,154	2.51	2,829,929	122
Katsina	24,192	2.62	3,878,344	160
Sokoto/Zamfara	65,735	7.12	4,392,391	67
Kebbi	36,800	3.98	2,062,226	56
Adamawa	42,159	4.56	2,124,049	51
Total/Average	393,168	42.56	29,221,47	97

Source: FME (1999).



Source: FORMECU (1995).

Figure 3a Status of Nigeria Vegetation cover between 1976/1978 and 1993/1995



Source: FORMECU (1995).

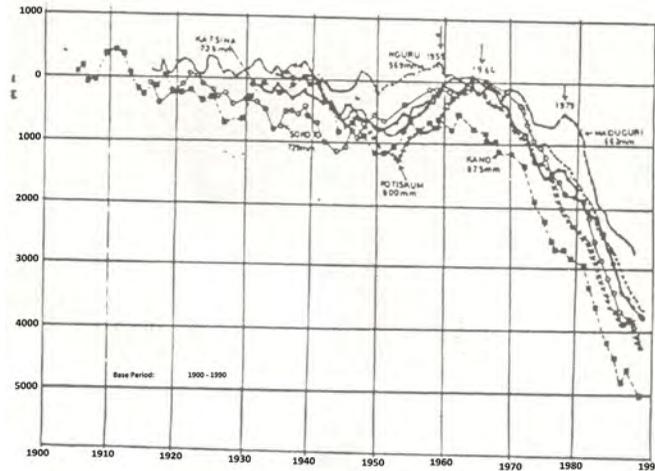
Figure 3b Status of Nigeria Forest cover between 1976/1978 and 1993/1999

Desertification and climate change

It is presently estimated that Nigeria is losing some 351,000 sq km to the desert, representing 40% of its total land mass due to desertification effect (Tables 1). In general, impact of desertification is that more land brought under agricultural production expanded from 503,000 km² to 585,000 km²; an increase of 82,040 km² (16%). Gully erosion, which hitherto was not a major threat, has increased and is threatening 18,400 km² (compared to only 122 km² in 1976/78). Sand dunes have equally increased by approximately 17% from 820 km² to 4830 km² over the period (Ayuba et al., 2007; FGN, 2009). It is now observed that the Sudan savanna ecology is transiting to Sahel (*sahelinization* of the Sudan savanna), while the Guinea savanna ecology is transiting to Sudan (*sudanization* of the Guinea savanna), an indication that desertification intensity is increasing in northern Nigeria.

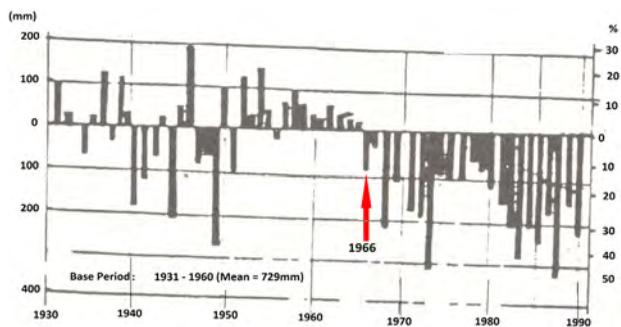
DECREASING RAINFALL AND DESERTIFICATION

In northeastern Nigeria, annual rainfall values have varied considerably over the last century (Figures 4 and 5). Hess et al. (1995) calculated an average decline in annual rainfall of 8 mm yr⁻¹ from 1961 to 1990 during the Sahel drought for the region. Hess et al. (1995) also reported that over the 30-year period, there has been an unpredictable, yet significant decline of 8 mm per year in the mean annual rainfall in the zone; apparently this is associated with the reduction in the number of rain days per season and the consequent reduction in the mid-season (August) rainfall totals. Rainwater is the source of recharge in the region and therefore decrease in rainfall due to climate change will lead to corresponding decrease in recharge which will greatly affect the quantity and quality of potable water from the boreholes.



Source: Thambyahpillay (1991).

Figure 4 Annual Rainfall: Nigerian Sahel Composite of Six Stations



Source: As in 4.

Figure 5 Annual rainfall index in Nigeria

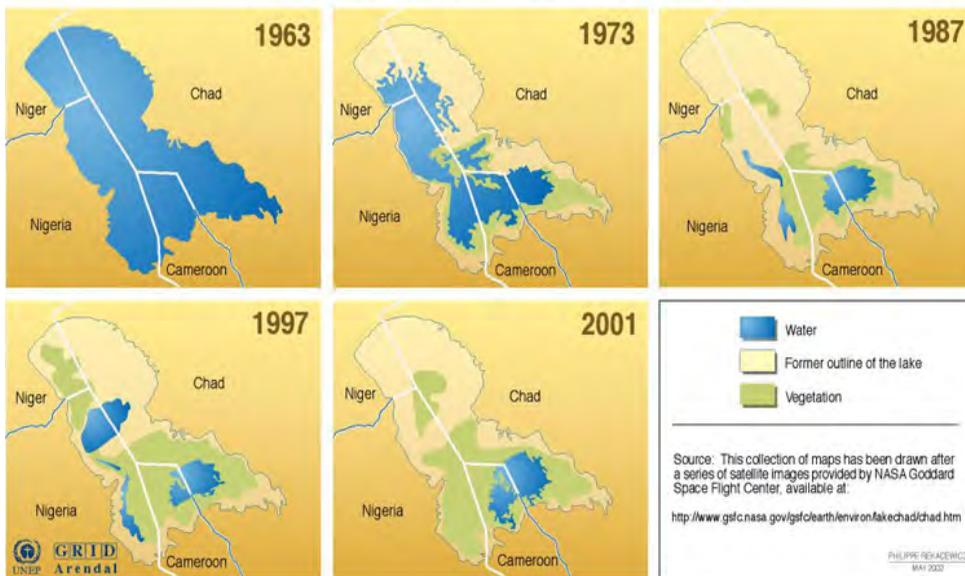
The receding Lake Chad

The Lake Chad Basin serves as a source of freshwater to over 20 million people who depend on it for their livelihood. The Lake with its rich biodiversity also provides a source of fishery, pastoral

and agricultural activities for the inhabitants in the Basin. However, the lake has continued to shrink with desertification. It is estimated (Musa et al., 2008) that between 1963 and 2007, the surface area of the lake has shrunk from 25,000 km² to less than 3000 km² (Figure 6) with little water in the Lake on the Nigerian portion.

From the above review, the major agents of desertification in Nigeria are climate change (especially changes in rainfall patterns), and increased variability of droughts, inappropriate use of technologies in agriculture and land management and land demand by the large population of the country are major factors. The Sudano-Sahelian region is the main livestock production area and the seasonal migration of large herds result in land degradation. Nomadic Arabs from Niger (Renaud et al., 2007) are also recorded as still crossing into the northern parts of Nigeria in Gashigar, Duji, Asaga, Damasak and all border settlements of Borno State. These migrants and present insurgency, pose very special security and socio-economic problems.

The Disappearance of Lake Chad in Africa



Source: Musa et al. (2008).

Figure 6 The receding Lake Chad

METHODOLOGY

Many national and international Agencies have participated in several desertification attenuation projects in Nigeria employing different methods for maximum benefits obtainable from the objective of the particular project. Specific methods will be cited for particular projects mentioned as appropriate. It is however noted that environmental impact assessment or community reconnaissance and needs assessments were initial part of all pre-project activities.

Review of previous interventions against desertification

1. Early control efforts in the 1960s, 1970s and 1980s

Efforts at desertification control in Nigeria started during the colonial era, but the colonialists focused attention on forest reservations (Forest Reserve Ordinance of 1916). Each of the three regions of Nigeria enjoyed territorial power over its forest resources and was equally responsible

for monitoring and supervision of the activities of the native authority. The Federal Government, however, retained the aspects of forestry research and education since 1954. By the late 1970s and early 1980s, the focus shifted to establishment of large-scale monoculture plantations of exotic species (afforestation projects), Tree-Planting Campaigns, shelterbelts development (to *roll-back the desert*), etc. Recently, (with the Forestry Policy of 2006) there is a paradigm shift from the mono-culture plantation to community-based forestry programmes in realisation that local population must be brought on board in the planning and implementation of forestry projects as part of environmental awareness campaign against desertification.

2. Frontline states realisation of the threat of desertification in 1980s

The collaborative efforts of the 11 Northern States in the 1980s have been most appropriate and impressive. In realisation of the serious situation of drought and desertification in the northern parts of Nigeria, the Military Governors of the 11 Northern States, set up a Consultative Committee on Desert Encroachment to assess the extent of the problem, review the efforts made on anti-desertification and recommend on the situation. The Committee had toured all the affected States and submitted their preliminary but discouraging report.

In their core report, the Committee observed that the affected areas could be categorised into

1. critical areas (Zone 1)
2. less critical areas (zone 2)
3. partially deforested areas (zone 3) and
4. special decertified areas (zone 4).

The States in zone 1 (Borno, Kano, Jigawa, Katsina, Sokoto and Bauchi) were adversely affected with areas north of latitude 12°N, over 75% desertified. The general conclusion was that the northern states were in great danger, with average desertification of about 48%. There was also much anxiety over the state of deforestation in the north with its average forest coverage of less than 25% which is considered to be far below the international standard (it is presently estimated to be below 10% in 2009). In 1989 Sokoto, Katsina and Kano States however, in collaboration with the Federal Government, had massive achievements in shelterbelt development. These shelterbelts are now satellite beacons in the zone which are immensely appreciated by the rural farmers that testify that the shelterbelts have enhanced crop yields.

3. Work of Forestry Management, Evaluation and Coordinating Unit (FORMECU) in Northern Nigeria on natural resources degradation

FORMECU played a critical role in conducting an inventory of natural forests and plantations in 28 states of the country culminating in the production of forest management plans for each of the states involved and the development of forest information system to assist in the sustainable management of forests. It also coordinated the National Forestry Action Programme (NFAP) for Nigeria in the 1990s. More importantly, the work of FORMECU (Figure 3a and b) provided critical evidence of the serious vegetation changes and biodiversity loss particularly in Northern part of the country, forewarning on problems of desertification.

4. The Great Green Wall Sahara Sahel Initiative (GGWSSI) for the Sahel in Africa

In 2007, African Heads of State and Governments endorsed the GGWSSI (Figure 7) with the objective of tackling the detrimental social, economic and environmental impacts of land degradation and

desertification in the region. The initiative aim was to support the efforts of local communities in the sustainable management and use of forests, rangelands and other natural resources in drylands. It also seeks to contribute to climate change mitigation and adaptation, as well as improve the food security and livelihoods of the people in the Sahel. The vision for the Great Green Wall has evolved into that of a mosaic of interventions of tree planting and addressing the challenges facing the people in the Sahel (Figure 7).

The overall goal of the Great Green Wall is a strategic initiative to strengthen the resilience of the region's people and natural systems with sound ecosystems' management, sustainable development of land resources, the protection of rural heritage and the improvement of the living conditions of the local population.

For Nigeria, the GGWSSI is community driven in outlook, as all the 11 frontline States, involving 46 local Governments, running from Kebbi to Borno State, covering a distance of 1500 km long by 15 km wide, would be covered. As a grassroots-based programme, the communities will be supervised to raise 60 million drought-resistant tree seedlings, to be planted for the establishment of contiguous shelterbelt (Figure 8) across the States. More than 100,000 people in the rural areas



Source: FMEnvt (2012).

Figure 7 The Great Green Wall Sahara Sahel (GGWSS) initiative



Source: Gadzama and Ayuba (2014).

Figure 8 Shelterbelt at Danbatta, Kano State. This row of Neem (*Arachzirdah indica*) in combination with gum Arabic trees, provided good wind breaks

will be employed, beside the 1000 forest guards and 450 extension workers that will be required (Federal Ministry of Environment-(FME), 2012).

It is with great anticipation that the above will successfully be implemented to match the great shelterbelts in Jigawa and Kano States developed in the 1960s which are now satellite beacons in the Sahel of Nigeria. Nigeria's GGWSSI was recently launched by the President of Nigeria, Dr. Goodluck Ebele Jonathan in Kebbi State in November, 2014.

Strategic desertification control: taming sand dunes of Nigeria

Sand-Dune fixation

Many communities in the northern-most parts of Yobe and Borno States have been forced to migrate as a result of the encroachment of sand dunes. For example in Tosha village (Yobe State), upland farm yields had gradually decreased over the years as sand dune formation became prominent about 40 years ago. They have now encroached on farmlands near Sansan in Borno State and also threaten the main access road to Damasak (BNRCC, 2012); these sand dunes are being stabilised (Figure 9).

Several techniques have been used to fix the dunes in Nigeria: from the mechanical, to much, aerodynamic, to biological fixation. The more successful methods in the flat land of Borno and Yobe States are the mechanical and biological fixation methods. After dunes have been mechanically stabilised, they can be permanently fixed by planting trees and perennial vegetations. The top 20 to 30 cm of the dune act as a protective screen, thus reducing the loss of the moisture in lower levels that is essential for the establishment and growth of the species planted. In Tosha (Yobe State) and Sansan (Borno State), the biological approach was adopted with the planting of



Source: BNRCC (2012).

Figure 9 Dunes around Tosha village, Yunusari LGA, Yobe State

15,000 seedlings of the early colonising and fast growing *Prosopis juliflora* on the leeward side of the dunes that are threatening the two communities (BNRCC, 2012). The development of large scale Jatropha biodiesel producing farms in the Sahel of Nigeria is now land stabilising prospect (Figure 10).



Source: Gadzama and Folorunso (2011).

Figure 10(a–d) Desertification in Process at Tulumuwa and Kaska, in Yobe State of Northern Nigeria (a) Sand Dune Presence at Tulumuwa, (b) Observing sand dune formation, (c) Hardy Plants, *B.aegyptiaca* and (d) Threatened Oasis at Kaska

DISCUSSION AND CONCLUSION

The outstanding environmental threat in the Sahel of Nigeria is the southward spread of desertification. The sustainable containment of this problem should take into priority the components observed and discussed below in order to encourage sustainable livelihoods in the Sahel and to fight desertification.

As a major limitation, it is the variation in rainfall that creates serious problem in the development of arid lands, where there is the constant danger of over-exploitation of groundwater leading to the threat of emptying the reservoir, low water level and deterioration in water quality. In Nigeria, River Basin Development schemes have profoundly altered water flows, drainage patterns and ecology of many areas in Borno, Kano and Sokoto States, leading to social, economic and political problems. Therefore environmental impact assessment for thorough multi-disciplinary investigation on possible problems of loss of arable lands, displacement of the local population, destruction of forest and wildlife resources, possible increase in water-borne diseases is eminent (Carter et al., 1990). Consequentially, Carter et al. (1980) endorsed the small-scale development approach now being adapted by the ADPs. The large-scale mechanised and irrigated food production enterprises are now left for the River Basin Development Authorities (RBDAs) that should now provide the farmers with resources, infrastructures and technical inputs.

In arid agriculture which always impacts on environment, and in the effort to sustain appropriate livelihoods, the following factors must be taken into consideration in order to set the right goals and priorities in maintaining a proper balance between food production and environmental quality. These factors include availability of water, climatic change and its impact, soil parameters, land use and socio-cultural trends.

Although the livestock population in Nigeria is estimated at 26 million goats, 14 million cattle and 10 million sheep, this data is outdated and little is known of its changing distribution in the country, with possible effects on the environment. Mention had earlier been made to overgrazing on environmental quality. The issues that must be considered are the reduced potentials of grazing lands due largely to ecological degradation, irrigation works, settlement expansion and infrastructural development encroachments (Okaiyeto, 1987). Any attempt to settle the nomadic pastoralists and the delineation of grazing areas should be preceded by careful studies of the laws and policies of land tenure, rights to land and water. The urgent action now is the immediate census of livestock in the country in order to obtain some baseline data for policy decisions. It must be accepted that the bulk of livestock, especially cattle in Nigeria, came from the Sahelian zone of the country; these animals greatly contribute to desertification if not well managed.

In view of the recurring drought in the Sahel, deforestation, population pressure, fuel wood which is a major energy source of developing economy of the Sahel, is becoming very scarce. The high rate use of fossil energy and the under-development of solar energy and biogas as alternative sources have compounded the problem. It is essential that the fuel wood sources are well managed and replenished as effectively as possible. Energy mixes should be pursued to achieve sustainable energy consumption compatible with environmental requirements (Deilere, 1989). Application of fuel-efficient stoves and charcoal should be encouraged. Renewable energy sources should receive high priority and should be applied on a wider scale than in the past, giving full consideration to their environmental impacts; technologies to develop renewable resources of energy such as wind, geothermal and especially solar, should receive particular attention. International co-operation should facilitate this process.

Also, women in northern Nigeria had become very keen to participate in anti-desertification efforts as the degradation of the environment penalizes them in the domestic tasks, especially in fuelwood supplies, water supplies (both in quality and quantity) and the degradation or reduced availability of cultivable land (Monincart, 1980). Women therefore participated in desertification control schemes on a massive scale. The inputs in the tree planting programmes in Nigeria by the “*Better Life for Rural Women*” Association in 1990s was a commendable example of contribution in National Projects.

CONCLUSION

Desertification and environmental insecurity are accelerating in the north, where an intersection of hotspots leads to increasingly tenuous livelihoods. Climate change is expected to compound the problems even further. The impacts of desertification on ecosystem and livelihoods of the people in the frontline States are enormous and poverty generating.

GGWSSI in Nigeria is a programme that should be given special priority attention by the Federal Government if the problem of desertification is to be attenuated. Its implementation should encompass all stakeholders including but not limited to Federal, States, Local governments, private sectors, villages, communities, women and the nomads.

Monitoring, Evaluation and Coordinating assessment must be enhanced. FORMECU should carry out nature degradation survey in Nigeria for 2010 and 2012 since basic requisite facility and trained personnel exist in FME.

Many dryland peoples have developed resilience under hardship, variability, and risk that is based on historic and current adaptive knowledge and skills (Mortimore et al., 2009). Such skills are increasingly recognised though it is claimed that such capacities are not sufficient to cope with the speed of change, especially with the climate. A strategy is needed that will harness the opportunities in the drylands of Nigeria. Such a strategy should achieve three aims: One that enhances the economic and social well-being of dryland communities; one that enables them to sustain their ecosystem services and one that strengthens their adaptive capacity to manage environmental issues (including climate change), taking into account indigenous adaptive skills.

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BIOGRAPHICAL NOTES

Njidda M. Gadzama is a Professor Emeritus of Zoology and Environmental Science at the University of Maiduguri, Borno State, Nigeria. He is a Noted Academic Leader having served as the Pro-Chancellor of National Open University of Nigeria; Vice-Chancellor, University of Maiduguri and the Acting Vice-Chancellor, University of Port Harcourt. He has published more than 80 scholarly papers in academic referred journals, conference proceedings, written and edited books and monographs. He has published in leading international journals such as *Journal of Experimental Zoology*, *Tissue and Cell*, *Journal of Morphology*, *Journal of Tropical Medicine and Hygiene*, *Insect Science and Its Application*, and others. He is a Fellow of the Nigerian Academy of Science. He was NNPC sponsored Visiting Professor to University of Frankfurt and to Office of Arid Land Studies, University of Arizona.

Haruna K. Ayuba is a Professor of Biogeography/Environmental Science in the Department of Geography, University of Maiduguri having been the Head of the Department and the Sub-Dean of the Faculty of Social Sciences in the same University. Currently, he is the Head of Department of Geography at Nasarawa State University in Keffi, Nigeria. He is a Member of the Nigerian Environmental Study/Action Team (NEST) and Climate Change Support Group, Federal Ministry of Environment. He participated in Higher Education Programme supported by DAAD. He is one of Nigeria's Negotiators to the Climate Change Negotiation in Lima, Peru. He has to his credit over 50 publications in national and international Journals and has consulted widely, having travelled to at least 14 countries.