

**PERSPECTIVES IN REGIONAL
DEVELOPMENT IN NIGERIA.**

**A Festschrift In Honour of
PROFESSOR ADEBISI
FUNSHO ADEDAYO**

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CHAPTER ONE

Perception and Adaptation to Desertification: Local Insight towards Resilience Building of the Vulnerable Households in Katsina State, Nigeria

BY

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Introduction

Societal perception had been awash with conflicting definitions of desertification since it was first used as an environmental term by Aubreville (1949) in his report on climate, forest and desertification in Tropical Africa. Glantz and Orlovsky's (1983) popular review of more than 100 definitions of desertification speaks by itself of the numerous conceptual issues on desertification that evolved during the 1980s. Before then, the concept of desertification was discussed by European and American scientists in the 1920s and 30s in terms of increased sand movements, desiccation, desert and Sahara encroachment and manmade deserts (see Boville, 1921; Coching, 1926; Stebbing, 1935 & 1938; Jones, 1938). Since then and up till date, several more definitions had appeared covering many spatial and temporal scales and representing different viewpoints. For instance, in the early 1990s, United Nations Environment Programme (UNEP) defines desertification as "land degradation in arid, semi-arid and dry sub-humid areas resulting mainly from adverse human impact" (Dregne et al., 1991). This definition introduces the idea that desertification does not need to lead to the development of deserts or desert-like conditions but simply refers to all types of land degradation in the dry lands of the world and that human adverse impact on the environment is considered to be the only cause of desertification (Rozanov 1990; UNEP, 1991). In some other definitions such as FAO (1993), UNCED

(1992), and UN (1994), climatic variations and not only human impact was recognized as important causes of land degradation in the dry lands.

Although, the concept of desertification had acquired a number of contradictory definitions and often had a progressive evolution over time, the most accepted definition in literature states that desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities (UN, 1994; Reynolds and Stafford Smith, 2002). Land degradation is often referred to as the loss of the biological potential of land in which there exists a negative change in productivity and the provision of ecosystem services as well as human benefits derived from the land. Arid, semi-arid and sub-humid areas are referred to as dry lands and are defined by Food and Agricultural Organization (FAO) on the basis of length of the growing season, as zones which fall between 1-74 and 75-199 growing days to represent the arid and semi-arid areas respectively (FAO, 1978). They are also characterized by low, erratic and highly inconsistent rainfall levels, receiving between 100-600mm rainfalls annually. No matter the diverse viewpoints on the definitions of desertification, it is generally considered a serious threat to the environment and human welfare especially of the inhabitants of the dry lands

(Williams and Balling, 1996; Stafford Smith, 2002).

While the literature is awash with plethora of adaptive strategies that have evolved over time and adopted extensively by the vulnerable communities generally across the globe and particularly in Nigeria (Gashua, 1991; Mortimore, 1989b; NEST, 1991; Oladipo, 1993; Stringer et al., 2009), the traditional coping mechanisms which were developed by the people themselves was not much recognized or given little attention. Similarly, the perception of the people prone to desertification could expose the types of local adaptive strategies used and the potentials for their effective implementation could also be derived. In view of this, this work tends to examine the perception of households of desertification prone communities in Katsina State with the hope of identifying the traditional coping mechanisms employed towards building resilience and reducing vulnerability.

Geography of Katsina State

Katsina State was created out of the former Kaduna State on September 23, 1987 which lies between latitude 11.7° and 13.2° N and longitude 6.5° and 9.2° E

(Figure 1). It is located in the semi arid region of Nigeria (NARP, 1994). It bounded in the east by Kano and Jigawa State, in the south by Kaduna State, in the West by Zamfara State and in the North by Niger Republic. Katsina State has three agro-ecological zones with its extreme northern fringes that lies on the arid zone of the Sahel; the vast tropical grasslands of the Sudan savanna from the north through to most of the south; and the Guinea Savannah on the southern margins (Katsina State Ministry of Environment, 2000). It has a total land mass of $24,192\text{km}^2$ out of which only $2,420\text{km}^2$ (10%) are constituted into gazette forest estates, comprising of 96 forest reserves, one grazing reserve, 244 communal forest areas of which 80% have been threatened with extinction by desertification, drought and human activities (Katsina State Ministry of Environment, 2002). Arable land in the area is classified into upland "gona" and bottom valley land "fadama". The upland is used mainly for rainfed agriculture while the valley bottom soils are cultivated mostly in the dry season (NARP, 1994).

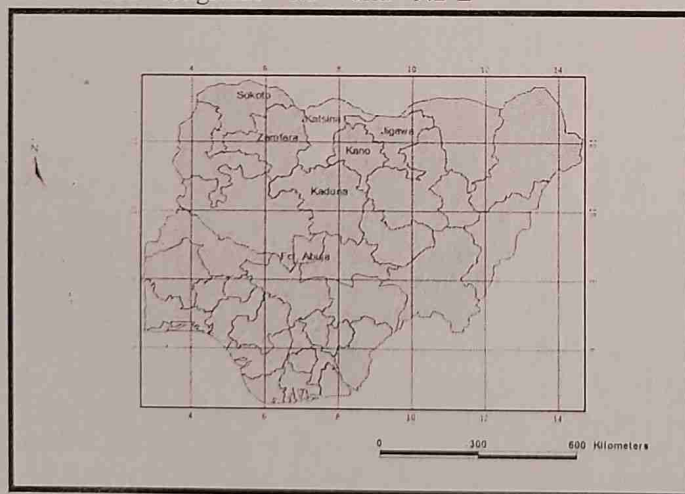


Figure 1: Location of Katsina State within Nigeria
Source: Adapted from Inkani, 2015.

Katsina State falls into two climatic zones – Tropical continental and Semi-arid continental. Tropical continental climate is found in the southern part of the state from Funtua, Sabuwa, Dandume down to Dutsin-ma area. The total annual rainfall figure in this zone ranges from 1000mm around Funtua to over 800mm around Dutsin-ma. It has mean annual temperature ranging between 29°C-31°C. The semi-arid continental climate is found around Kankia, charanchi, Kurfi and Batsari areas down to the extreme north of the state around Daura, Baure, Zango, Kaita, Mai'adua, Mashi, Jibia and Sandamu local government areas. This zone has total annual rainfall figures ranging from 600mm around the extreme north-east to 700mm around Kankia. The temperature of this zone is high especially at the peak of dry season when temperature reaches about 38°C-40°C and above some times (Adamu, 2000).

Basement Complex and Sedimentary Formations are the two broad geological formations in Katsina State. The Basement Complex is sub-divided into Migmatite Gneiss Complex and Schist Belt and accounts for over 80% of the total area of the state. The Migmatite Gneiss Complex, dated Archean to Early Proterozoic (2700-2000 Ma), is the most widespread in distribution across the state. The areas of Sedimentary formation are underlain by Sedimentary rocks of Cretaceous and lithologically consist largely of coarse and mottled feldspatic grits which favours formation of aquifers at deep ground layers with wells giving reasonably good yields. The bulk of Katsina State is located within the crystalline area and only at the northernmost tip of the state is Cretaceous Sediments. The soil of Katsina State is generally sandy 'drift' deposits overlain the underlying rocks. It has two distinct soil types - clay and sandy. In the southern

part of the state, the covering material is largely clayed soil, redish black or dark-brown colour and very fine in texture of about 5 metres in depth and of medium fertility. The soil of this region is good in the production of crops like maize, cotton, sorghum and guinea corn. In the northern part of the state, the drift deposits are coarser, resulting in light sandy soils of buff or reddish colours of low fertility. Generally, planting is done on the flat with minimum tillage (Adamu, 2000). The soils of the northern part are marginal for efficient arable crop production but good for livestock production. Millet and sorghum are the main food crops grown in this area while the predominant crop mixtures are sorghum/millet/cowpea or groundnut.

The vegetation of Katsina State is generally typical Savannah type classified into three major categories - Northern Guinea, Sudan and Sahel (see Figure 2). The southern part of the state belongs to the Northern guinea Savanna consisting of broad-leaved trees and tall tussocky grasses of guinea affinities. Examples of plant species found in the area include *Butyrospermum parkii*, *parkia biglobosa*, *Entada Africana*, *prosopis Africana* and *Andropogons Gayanus*. The northern Sudan Savanna vegetation is found in some part of south down to northern part of the state. The trees in this region grow deep tap roots and thick barks that make it possible for them to withstand the long dry season and bush fires. The grasses in this area have durable roots which remain underground after stalks are burnt (Adamu, 2000). Example of plant species in this region include *Acacia Senegal*, *Acacia nilotica*, *acacia ataxacantha*, *parkia biglobosa*, *combretum mole* and *fiscus syscomorus*. In the extreme northern part of the state, Sahel savanna is found.

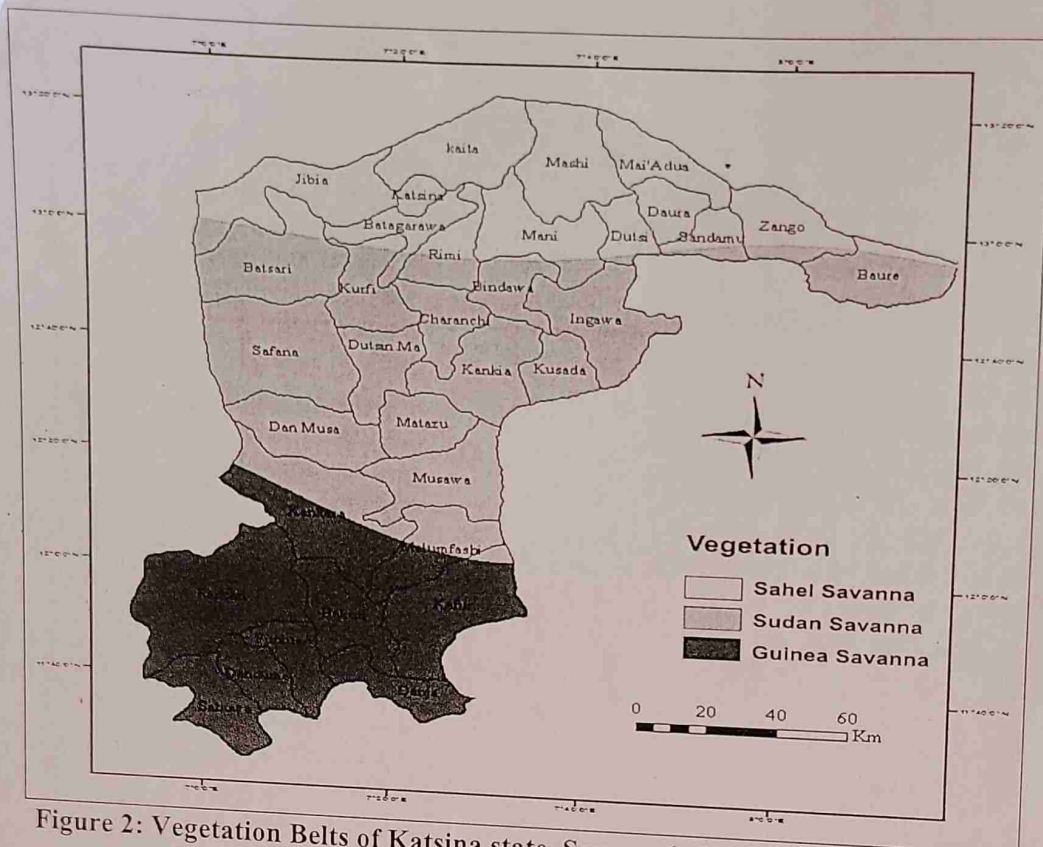


Figure 2: Vegetation Belts of Katsina state. Source: (After Inkani, 2015).

The main perennial ecological problems of Katsina state are desertification, drought, and soil erosion. These are experienced mostly in the northern part of the state. The state is highly desertified in the north, as evidenced by the prevalence of desert plants such as *Acacia* species. Very severe gully erosion of up to 11.8% of the state is also experienced. The state is heavily eroded by wind and water. (Katsina State Ministry of Environment, 2000; Adamu, 2000).

The 2006 population census put the population of Katsina State at 5,792,578 and annual growth rate of 2.2%. Katsina is predominantly Hausa-Fulani State and most people speak only Hausa. A great majority of the people are settled cultivators and traders. A sizeable number of migrants from southern Nigeria, especially the Yoruba and Igbo, are found and dwell mostly in towns (Mortimore, 1989). Agriculture is the main economic activity of the state. In Katsina as in other

parts of the savanna, agriculture is largely rainfed. About 95% of the population is into subsistence agriculture. A wide range of crops are grown which include maize, millet, cowpea, rice, sorghum, sugarcane and groundnut. Livestock production is also widespread in the state. These include cattle, goats, sheep, horses, donkeys, camel, poultry and pigeons (Katsina State Ministry of Environment, 2002). Seasonal migration takes place, especially of able bodied males in the dry season to the southern part of the state in search of part-time jobs. This is known as "cin rani". (Adamu, 2000).

Desertification and the Nigerian Dry Lands: An Example from Katsina State

Desertification as a serious environmental problem of the arid and semi-arid environment otherwise known as the dry lands gained popularity following the severe drought that afflicted the Sahelian regions in Africa from the late 1960s to 1970s and again in the 1980s. During the

period from 1958 to 1975, the mean annual rainfall diminished by nearly 50%, and the boundary between the Sahara and the Sahel shifted southward by nearly 100km (Lamprey, 1975). The problem of desertification in Nigeria has a very long history. For instance, it was recognised as a problem during the British Colonial Government in the early 1930s when it was revealed that Sahara was expanding and encroaching into Sudan Savannah at a rate that would only increase if the trend is not checked. Similarly, about 15% or 140,000 square kilometres of the total land cover of Nigeria were reported to be prone to desertification at that period (FAO, WMO and UNESCO, 1977).

There is a general consensus in Nigeria that desertification is by far the most

pressing environmental problem in the dry land parts of the country. Although, land degradation can occur in any climatic zone, the general opinion is that it is termed desertification when it occurs in arid, semi-arid sub-humid regions that are characterized by variable climates. Desertification is a common occurrence in Katsina State in particular and in Northern Nigeria in general. It is one of the persistent ecological problems of Katsina State. However, areas that fall within the northern part of the state bordering Niger Republic as shown in Figure 3 are obviously more prone to the menace as well as to other environmental issues associated with arid and semi-arid zones like drought.

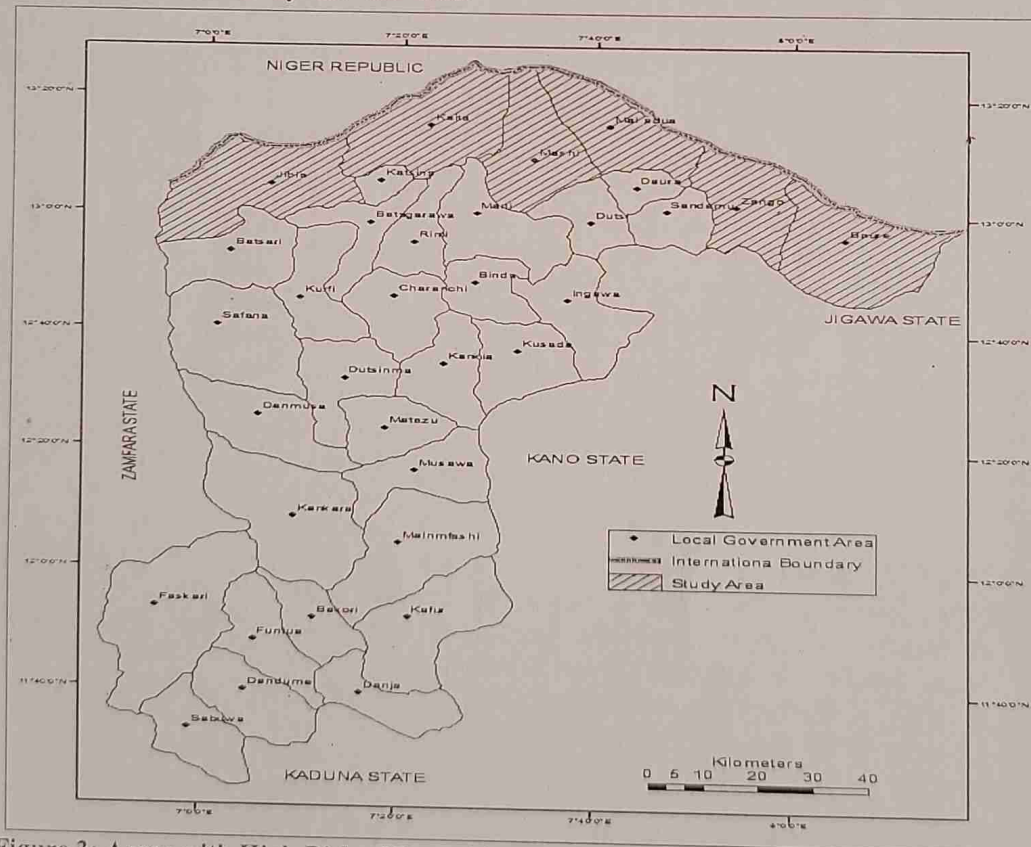


Figure 3: Areas with High Risk of Desertification in Katsina State.
Source: Adapted from Yahaya (2018).

Dry lands are defined as areas with an aridity index value of less than 0.65, that

is, areas in which annual mean potential evapotranspiration is at least 1.5 times

greater than annual mean precipitation. Dry lands cover roughly 40 percent of the earth's land surface and are inhabited by over two billion people, approximately one third of the world's population. About 90 percent live in developing countries. A large share of the dry land population depends on crop and livestock production for their livelihoods. Whereas most areas in dry lands consist of rangeland (65 percent), one fourth, of it is able to sustain cultivation, although with productivity constraints from low soil moisture. Dry land rangelands support half of the world's livestock and provide forage for wildlife approximately within latitudes 10°N and 14°N and longitudes 4°E and 14°E and are desertification problems (NARP, 1994). Oladipo (1993:243) and Bashir (2008) have acknowledged that historical records of droughts have occurred in this particular zone and its frequency in the past was due to high inter-annual variability of rainfall.

Desertification in northern Nigeria is the result of two main factors. The first factor being natural forces of poor physical conditions in terms of soils, vegetation, topography and inherent extreme variability of climate as manifested in unreliable rainfall and frequent droughts. Among the natural forces, rainfall plays a variable role that depends on its duration, the seasonal pattern of its occurrence, and its spatial distribution. Evidently, researches have shown that northern Nigeria is characterized by high inter-annual variability of rainfall and declining annual rainfall total. Both the amount and area of the secondary rainfall maximum in Nigerian dry lands had declined with time (Oladipo, 1993; Adefolalu 2007; Odjugo, 2010). An analysis of the trends and fluctuations of annual rainfall variability in Katsina State revealed a decrease of 220.20mm at the rate of 3.67 per annum in Katsina and its immediate environs (Abaje *et al.*, 2012). This implies that Katsina State has been experiencing a general decrease in the period of wet season yearly

(Millennium Ecosystem Assessment, 2005). In the dry lands of Nigeria, desertification poses one of the greatest environmental challenges and constitutes a major barrier to meeting basic human needs (UNCOD, 1977; Oladipo, 1993; Nasiru, 2007; Okoye and Ezeonyejiaku, 2010). A preliminary report by the consultative committee on Desert encroachment in northern Nigeria concluded that about 48% of the region was being seriously affected by desertification (Gadzama, 1991). The dry lands of Nigeria of which Katsina State is inclusive lie

by nature prone to recurrent and persistent periods of drought and as well faced with and an apparent increase in desertification process.

The second factor consists of a range of anthropogenic causes that help in the process of desertification. More specifically there are four primary causes, notably over-exploitation, over grazing, deforestation and poor irrigation practices. In Nigeria, overgrazing and over-cultivation have been reported to be responsible for the conversion of 351,000 hectares of land into desert each year. For example, from 1978 to 1992, in Katsina state, the area of land used for intensive agriculture increased from 36.8% to 69% and forest decreased approximately from 1.1% to 0.1%. Livestock densities are high, majorly owned by nomadic Fulani, who retained large herds for security. Human pressure on the land particularly in the marginal areas has continued to take its toll on the environment, resulting in desertification. Similarly, the demand for fuel wood causes the removal of trees, shrubs, herbaceous plants and grass cover from the fragile land, thereby accelerating the degradation of the soil to desert-like conditions (FAO, 2006). In Nigeria, more than 70% of the nation's population depends on fuel wood. Katsina alone, a northern state, has its over 90% energy from fuel wood (Mohammed *et al.*, 2013).

Desertification is associated with a number of physical manifestations, such as sand dunes, that have conjured up images of deserts expanding uncontrollably, fuelled by population growth and inappropriate resources use technology. It is mainly recognised by the significant reduction of water retention capacity of the soil, vegetation cover dwindles or disappears completely, land becomes eroded or covered in sand, wind-borne sand that destroys infrastructure and land eventually becomes unproductive. In a study by Yahaya (2018), the sand dunes are now reported to have covered many parts of Katsina State and they are already jeopardizing agricultural and other economic activities in these areas.

Perception and Adaptation in the Context of Desertification

Perception of people toward an issue could expose the urgency with which the problem needs to be understood and help in developing effective strategies. Also, the types of policies to be formulated and the potentials for their effective implementation could be derived from the perception of the affected people towards the subject of the policy. It has been noted that public support or opposition to a policy is significantly influenced by the perception of the problem and how the policy affect the people (Leiserowitz, 2006). Perception as used in the context of desertification refers to public understanding of the term desertification especially of the vulnerable communities comprising of natural resources-dependent households in a fragile ecosystem characterised by high inter-annual rainfall variability.

Desertification is a gradual phenomenon operating on a time scale of several years or decades. It may not be readily apparent even to the local people if human intervention in the environment has not been drastic. The perception of the people of Katsina State on desertification has been documented by Yahaya and Ishiak

(2014) and Yahaya (2018) in their perception and vulnerability study. It was revealed in those studies that the people of northern Katsina considered desertification as a challenge to sustainable crop production which was perceived to be caused by climate change, deforestation, environmental mismanagement (bush burning, faulty irrigation practice, uneconomic agricultural practices etc) and an act of God. Climate change resulting in reduced annual precipitation over the years is rank as the first and most important cause of desertification in the area. The active role of climate was acknowledged among the factors that trigger desertification process in the area. It is surprising that while the people acknowledged deforestation as part of the causes of desertification, a considerable percentage of them, especially of the rural communities still depend on fuel wood for cooking. Similarly, desertification was perceived as an act of God which had been destined to affect their land. This is regarded as a significant factor contributing to the occurrence of desertification in the study area. This can however be attributed to the fact that majority of these areas had Islamic/Quranic education. Their religious ideology could have influence them to believe that desertification couldn't have happened if not destined by God and not by the relative role of climate, droughts and human impacts.

Adaptation to environmental hazards has long been recognized as inherent characteristics of human race throughout history. In dry lands communities, ecosystems have being undergoing various processes of degradation commonly described as desertification which has prompted the people to respond in a variety of ways. The goal of the adaptation measures is to increase the capacity of the people to survive the menaces of desertification. However, approaches to adaptation tend to be either actor-oriented or resilience-based. Actor-oriented

which is regarded as managed, policy-driven adaptations (for example, through early warning systems) and a resilience-based approach is considered autonomous, locally-driven adaptations (such as a change to the dominant livelihood activity). Conventionally, local level adaptations are thought of as reactive, while policy-driven adaptations tend to be planned (Smit et al., 1996; Burton et al., 2002). Local level adaptations are regarded as responses undertaken autonomously by the local communities as a regular part of structural changes made in ecological, social and economic systems for their survival. This includes a change to the dominant livelihood activity, land use, cropping pattern, crop varieties among others. On the other hand, most government policies at international and national level represent Policy-driven adaptation. National Action Programmes (NAPs) developed by parties to the United Nations Convention to Combat Desertification (UNCCD) that declare themselves affected by desertification was a good example of policy-driven adaptation to desertification. The need for NAPs is embodied in the UNCCD (1994) text, which states that affected parties should highlight the key challenges they face in relation to desertification and drought, and present a strategy through which these challenges will be addressed. The notion of adaptive capacity built on understandings about resilience has a broader application, encompassing deliberate changes in response to or anticipation of environmental changes including drought and desertification. While adaptation is critical in dealing with the unavoidable impacts of desertification, it should be approached from a site-specific perspective. For what may be effective adaptation for one community may undermine the ability of others to adapt through spatial spill-over and negative externalities (Osborne et al., in review). For example, land use shifts towards the cultivation of new species in

one area may alter the dominant biodiversity, undermining the provision of ecosystem services such as pollination in other areas. Successful adaptation may therefore be viewed as those actions that decrease vulnerability to the barest minimum and increase resilience overall to the greatest possibility in a timely manner.

Local Insight towards Resilience Building to Desertification

For dry land populations whose livelihoods are often tied to subsistence agriculture and the natural resource base, successful adaptations should build resilience and decrease vulnerability to multiple threats of dry land hazards such as desertification, drought, soil erosion and so on. Vulnerability as defined by Kumpulainen, (2006) refers to the susceptibility of people, communities, and regions to natural, human made, or technological hazards. It is also seen as the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (Blaikie et al. 2004). Vulnerability thus depends on a number of factors which include the degree of exposure, sensitivity, adaptive capacity and resilience of the people concerned. Resilience is seen as the ability to self-organize, learn and adapt to risk hazards (Carpenter et al. 2001; Turner et al. 2003). According to United Nations International Strategy for Disaster Reduction (UNISDR, 2009), resilience refers to the transformative process of a household or community exposed to hazards to resist, absorb, accommodate and recover from hazards in a timely and efficient manner.

Evidence abounds in literature that people in the dry lands communities have been adapting to desertification through early planting, crop rotation, intercropping, planting tolerant crop varieties, changing crop varieties, fertiliser application and livelihood diversification among others. (Adger et al, 2005; Nelson et al, 2007; Smit et al, 2000 and Stringer et al ; 2009).

In northern Nigeria to be precise, people's responses to the hazards of drought and desertification have been noted. The adaptive strategies include among others: minimum tillage of the lightly sandy soils of the Sahel; cross-ridging to conserve water; dry planting in which seeds are planted while waiting for the rain in order to make maximum use of moisture from the very unpredictable, but usually heavy, first rains; planting of early-maturing and drought resistance crop varieties; intercropping; alternative employment; liquidating accumulated assets, such as livestock during drought; mobilizing social networks by which wealth is distributed from the relatively rich to the common people; and migration into the cities and neighbouring countries (Gashua, 1991; Mortimore, 1989, NEST, 1991 and Oladipo, 1993).

Local insight towards building resilience to desertification may involve blending scientific practices with local/traditional coping mechanism. Indeed, studies have shown that the people of Katsina State have developed a variety of traditional methods as survival mechanisms to the hazards of desertification. Evidently, Yahaya (2018) revealed that the people of northern fringe of Katsina State have devised indigenous strategies of coping with desertification which includes the following:

- i. Harvesting of crops on the stand such that the stalk will hold the soil together. The stalks are later cut down and arranged bellow the furrows during the onset of rains in order to increase soil nutrients. The other way is to harvest the stalks but stumps are left to hold soil together for the prevention of wind-induced erosion that aid desertification processes due to near absence of vegetation cover. Similarly, they have also resorted to ridges making in rows in opposite directions of wind in order to reduce the ravages of winds and storms-

induced desertification processes. The people claimed to have learnt these strategies from their fathers and they continue to employ it and pass it on from generation to generation. Planting of trees is another way in which the people of the area have responded to check desertification. They claimed to have being planting trees with the help of the state government especially in their farms, house, and along road sides in order to curb the incidence of desertification. Trees were planted to reduce insolation, increases water infiltration and increases soil fertility which would in turn reduce the effect of land degradation.

- ii. Planting of short-period and drought resistant varieties of crops represents another traditional method of coping with desertification in the area. Farmers have realised the importance of planting a particular short-period black-eye cowpea known in Hausa as "Dan-lla mai hula makka kusa" especially among the people of Mashi, Mai'adua and Kaita local government areas. Because of the relatively short period of cultivation and harvest, they have been able to sell it and make good money from it.
- iii. Reliance on prayers offered to the Almighty God, the ultimate controller of the universe, begging for His divine intervention and infinite mercy has equally form part of the methods commonly employed by the people. The people of the area affirmed that it has become a common thing in most communities through the years to see people of various age categories gather at prayer grounds and mosques to pray for rains. They asserted that in several instances, the prayers were thought to be answered. Although the prayers were believed to be efficacious, the tendency for such prayers as reduced in recent years compared to about two decades ago (around 1989) after the

1981-1984 drought when the impact is most serious in the area and hence people and animals were put under great stress and peril. It may not be surprising that prayers were offered since desertification was believed by the people to be an act of God.

- iv. Borrowing is also one of the important traditional coping measures employed by the people. When financial crisis arise, the people resorted to borrowing to ameliorate the suffering resulting from poor crop yields and household food insecurity. The households of the vulnerable communities claimed to have been borrowing grains from other households with surplus which is usually paid back after the harvest of the succeeding year. Borrowing of cash from neighbourhood and seeking assistance from politicians and religious institutions has always been the norms in the area. Mobilizing social networks by which wealth is distributed from the relatively rich (known in Hausa as masu dan hali) to the common people (known in Hausa as talakawa) is also among the variety of adaptation strategies employed in the area to cushion the effects of desertification.

Conclusion

The process of desertification is a continuous one which integrates climatic elements with human activities in transforming productive land into an ecological impoverished land generally considered as land degradation. As such, developing adaptive capacity to minimize the damage to livelihoods from climate variability required looking inward to strengthening local adaptation methods to complement desertification mitigation efforts by the government. It therefore becomes necessary that existing government agencies and commissions saddled with the responsibilities for the strategic planning and co-ordination of policies related to curbing desertification

in Katsina in particular and Nigeria in general should integrate traditional coping methods employed by the people of the area within the socio-economic framework of improving the wellbeing of the people. Such local/traditional methods need to be studied, translated to scientific terms, validated, strengthened and incorporated into development planning of existing strategies. If this is done, it will improve the stability of environmental conservative measures and thus reduces the vulnerability of the people and strengthen their ability to recover from desertification hazards in a timely and efficient manner.

References

- Abaje, I.B., Ati, O.F. and Iguisi, E.O. (2012). Recend Trends and Fluctuations of Annual Rainfall in the Sudano-Sahelian Ecological Zones of Nigeria: Risks and Opportunities. *Journal of Sustainable Society*. 1(2): 44-51.
- Adamu, I.A. (2000). State Survey of Katsina. In Mamman A.B., Peter S.W., and Oyebanji J.O. (Eds.), *Nigeria: A people United, A Future Assured*. Volume 2, pp. 291-302. Nigeria: Federal Ministry of Information, Abuja.
- Adefolalu, D.O.A. (2007). Climate Change and Economic Sustainability in Nigeria. *Paper presented at the International Conference on Climate Change, Nnamdi Azikiwe University, Awka* 12-14 June 2007.
- Adger, W.N., Arnell, N.W. and Tompkins, E.L. (2005) Successful Adaptation to Climate Change Across scales. *Global Environmental Change*, 15: 77-86.
- Aubreville, A. (1949). Climats, forêts et désertification de l'Afrique tropicale. -Soc d'editions géographiques maritimes et coloniales, Paris. pp 351.

- Bashir, D. (2008). Sustainable Management of Drought and Desertification in Nigeria. Report of the First National Environmental Summit: *Greening the Environment for Sustainable Development*, (pp. 96-112). Federal Ministry of Environment, Housing and Urban Development.
- Blaikie, P., Cannon, T., Davies, I. and Wisner, B. (2004). At Risk: Natural Hazards, People's Vulnerability and Disasters. 2nd edition, (pp. 464), London: Routledge.
- Bovill, E.W. (1921). The encroachment of the Sahara on the Sudan.-*Journal of the Royal African*
- Carpenter, S., Walker, B., Anderies, J.M., and Abel, N. (2001). From Metaphor to Measurement: Resilience of what to what? *Ecosystems*, 4(8):765-781.
- Coching, C. (1926). Climatic Pulsations During Historic Times in China-*Geographical Review* 16: 274-282.
- Dregne, H.E., Kassas, M. and Rozanov (1991). A new Assessment of the World Status of Desertification. *Desertification Control Bulletin*, 19: 6-18.
- Experiencing Serious Drought and/or Desertification, Particularly in Africa. UNCCD Secretariat, Bonn.
- FAO (1993). Definition and General Approach to the Problem. In: Sustainable Development of Dry lands and Combating Desertification. A Position Paper. FAO, Rome.
- FAO (2006). Global Forest Resources Assessment 2005. Progress towards Sustainable Forest Management. Food and Agricultural Organization Forestry Paper 147, pp. 320.
- FAO, UNESCO, and WMO (1977). World Map of Desertification, United Nations Conference on Desertification, Nairobi.
- Gadzama, N.M. (1991). Keynote Address: Sustainable Development in Nigeria's dry belt: In K.O. Ologe (ed.), Problems and Prospects. (pp. 5-18). *Sustainable Development in Nigeria's Dry Belt*. Ibadan, NEST.
- Gashua, M.A. (1991). An evaluation of Indigenous Techniques of Coping with Drought in Bede Local Government Area, Borno State. Unpublished M.sc., Thesis, Department of Geography, Ahmadu Bello University, Zaria, Nigeria.
- Glantz, M.H. and Orlovsky, N. (1983). Desertification: A review of the concept. *Desertification Control Bulletin*, 9: 15-22.
- Inkani, A.I. (2015). Households' Vulnerability and Adaptation to Water Scarcity in Rural Areas of Katsina State, Nigeria. Ph. D. Thesis submitted to the Department of Geography and Environmental Studies, University of Nairobi, Kenya.
- Jones, B. (1938). Dessication and the West African Colonies. *Geographical Journal*, 91: 401-423.
- Katsina State, Ministry of Environment (2000) Situation Report of the State. Presented at the Meeting of the Sub-Committee on Drought and Desertification. Held at EEC/KISG Conference Hall on February 1st, 2000.
- Katsina State, Ministry of Environment (2002). *Katsina State Position paper on Desertification Control*. Presented at the meeting organized by the Federal Ministry of Environment for the Front line states with desertification

problems. Held at Katsina on the 16th of May, 2002.

Kumpulainen, S. (2006). Vulnerability Concepts in Hazard and Risk Assessment. In *Natural and Technological Hazards and Risks Affecting the Spatial Development of European Regions*, edited by P. Schmidt-Thome, 65-74. Geological Survey of Finland Special Paper 42. Helsinki: Centre for Urban and Regional Studies/Helsinki University of Technology.

Lamprey, H. F. (1975). Report on the Desert Encroachment Reconnaissance in Northern Sudan, 21 October to 10 November, 1975. UNESCO/UNEP. (mimeo) pp. 16.

Millennium Ecosystem Assessment (2005). *Ecosystem and Human Wellbeing: Current State and Trends*. Findings of the condition and trends working group. <http://www.millenniumassessment.org/en/condition.aspx>.

Mohammed, D., Akpan, A.E. and Aliyu H.S. (2013). Role of Community Participation in Combating Desertification in the Arid Zone of Nigeria: An Overview. *Journal of Environmental Management and Safety*, 4(3): 49-58.

Mortimore, M. (1989). *Adapting to Drought: Farmers, Famines and Desertification in West Africa*. U.K: Cambridge University Press, Cambridge.

Nasiru, I.M. (2007). *A Comprehensive Approach to Addressing Drought and Desertification in Nigeria*. Unpublished Master's Thesis, Department of Urban Planning, Faculty of Built Environment, University Teknologi Malaysia.

National Agricultural Research Project (NARP) (1994). *National Agricultural Research Strategy*

Plan for Nigeria, Report on North West Zone, Federal Ministry of Agricultural and Natural Resources, Abuja.

Nelson, D.R., Adger, W.N. and Brown, K. (2007). Adaptation to Environmental Change: Contributions of a Resilience Framework. *Annual Review of Environment and Resources*, 32: 395-419.

Nigerian Environmental Study/Action Team, (NEST) (1991). *Nigeria's Threatened Environment: A National Profile*. Nigerian Environmental Study/Action Team (NEST). A NEST Publication. Ibadan, Nigeria.

Odjugo, P.A.O. (2010). General Overview of Climate Change Impacts in Nigeria. *Journal of Human Ecology*, 29(1): 47-55.

Okoye, C.O. and Ezeonyejiaku, D.C. (2010). Desertification in the Drylands of Nigeria: Causes, Consequences and Solutions. *Journal of the Faculty of Environmental Sciences*, Nnamdi Azikiwe University (UNIZIK), Awka, Nigeria. 1(1): 49-51.

Oladipo E.O. (1993). A Comprehensive Approach to Drought and Desertification in Northern Nigeria. *Natural Hazards*, 8(3): 235-261.

Osbahr, H., Twyman, C., Adger, N.W., Thomas, D.S.G., in review. Successful Adaptation: Social Networks, Resilience and Climate Change. *Ecology and Society*.

Reynolds, J. F. and Stafford Smith M. (2002). Do Humans Create Deserts? In: J. F. Reynolds and M. Stafford Smith (Eds.) *Global Desertification: Do Humans Cause Deserts?* (pp. 1-22). Berlin, Dahlem University Press.

- Rozanov, B. (1990). Global Assessment of Desertification: Status and Methodologies. Paper Contributed to the Örenäs Meeting on Desertification, Lund/Örenäs December 1990, pp. 12.
- Smit, B., Burton, I., Klein, R.J.T. and Wandel, J. (2000). An Anatomy of Adaptation to Climate Change and Variability. *Climatic Change*, 45, 223-451.
- Society*, 20: 175-185, 259-269.
- Stebbing, E.P (1938). The Advance of the Sahara.- *Geographical Journal* 91: 356-359.
- Stebbing, E.P. (1935). The encroaching Sahara: The Threat to the West African Colonies. *Geographical Journal* 85: 506-519.
- Stringer, L.C, Dyer J.C., Reed M.S., Dougill A.J., Twyman C., and Mkwambisi D. (2009). Adaptation to Climate Change, Drought and Desertification: Local Insight to Enhance Policy in Southern Africa. *Environmental Science and Policy* (2009), doi: 10.1016/j.envsci.2009.04.002. Retrieved on 18th April, 2016.
- Stringer, L.C, Dyer J.C., Reed M.S., Dougill A.J., Twyman C., and Mkwambisi D. (2009). Adaptation to Climate Change, Drought and Desertification: Local Insight to Enhance Policy in Southern Africa. *Environmental Science and Policy* (2009), doi: 10.1016/j.envsci.2009.04.002. Retrieved on 18th April, 2016.
- UN (United Nations) (1994). UN Earth Summit. Convention on Desertification. *UN Conference in Environment and Development*, Rio de Janeiro, Brazil, June 3-14, 1992. DPI/SD/1576. United Nations, New York.
- UNCCD (1994). The United Nations Convention to Combat Desertification in Those Countries
- UNCED (1992). *Report of the United Nations Conference on Environment and Development*, Chapter 12: Managing fragile ecosystems: Combating desertification and drought- (Rio de Janeiro, 3-14 June 1992), General A/CONF.151/26 (Vol. II), Chapter 12: available at (<http://www.unccd.ch/>) Retrieved on March 11, 2013.
- UNCOD (1977). World Map of Desertification. Document of the UN Conference on Desertification, A/CONF 74/2.
- UNEP (1991). Status of Desertification and Implementation of the United Nations Action Plan to Combat Desertification-*Report of the Executive Director* UNEP/GCSS.III/3, pp 88.
- Williams, M.A.J. and Balling, R.C. (1996). Interactions of Desertification and Climate. Arnold, London.
- Yahaya, O.Y. (2018). Vulnerability and Adaptation of Rural Farm Households to Desertification in Katsina State, Nigeria. Ph. D. Thesis submitted to the Department of Geography and Environmental Management, University of Ilorin, Ilorin, Nigeria.
- Yahaya, O.Y. and Ishiak, Y. (2014). Assessment of Rural Household's Perception and Adaptation Strategies to Desertification in Kaita Local Government Area, Katsina State, Nigeria. *FUDMA Journal of Arts, Management and Social Sciences (FUJAMSS)*. A Bi-Annual Publication of Federal University Dutsinma, Katsina State. Volume 1, No. 2, pp 149- 162.