



ENVIRONMENTAL CHANGE AND LANDUSE SCENARIOS UNDER CHANGING CLIMATES: THE EXPERIENCE IN THE UPPER CROSS RIVER REGION, NIGERIA

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Abstract:

This paper seeks to show that due to changing climates, there are salient marginal Sahelian conditions (conditions of aridity) emerging on the Northern fringes of Cross River State, a state that is geographical positioned in the southern rainforest belt of Nigeria. The paper adopts a simple descriptive approach and shows the distinct characteristics of this zone, in terms of floristic composition and edaphic and geomorphic structures under changing conditions. Some relationships are established between environmental variables like health, water supply and crop-yield on one hand, and climatic variation, floral life-forms and soil conditions on the other. The changing land use patterns relative to environmental changes are also examined. The paper concludes with a look at current and future adaption strategies to these climate-induced conditions.

Keywords: Climate Change; Land Use; Marginal Areas; Adaptation; Mitigation.

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1. Introduction

Climate change is one of the most actively investigated scientific issues in the world today, because of its potentially far-reaching consequences (IPCC, 1996; and Danielson et al, 1998). As climate changes other components of the earth-atmosphere system might respond to influences exerted on them by the change. Among the likely responses are frequent and massive droughts, flooding and heavy storms, and increased sea and land temperatures. All these have far-reaching implications on man and his activities (Guinness and Nagle, 2006). There is thus the need for a scientific study of this change and its manifestations. A review of recent catchment-scale studies of the effects of climate change on land resources shows that none has been concluded on Nigeria. In all of Africa, as quoted by the Intergovernmental Panel on Climate Change, IPCC (2007), only in Ethiopia (Hailmariam, 1999); Nile Basin (Conway and Holme, 1996; and Strazepk, et al, 1996), and South Africa (Schulze, 19997; and Hulme, 1999) have such researches been recorded. This paper presents the changing but salient environmental conditions in the upper Cross River region, which are

attributable to climate change; and suggests possible ways of adapting to the emerging negative scenarios.

In general, the manifestations of climate change are never the same across the globe, since the different regions are differently impacted due to differences in geographical location. For instance, in some regions, the rising temperature has increased their rainfall levels, while it has reduced rainfall in some others, thereby making some areas wetter and others drier. As noted by Guinness and Nagle (2006), it is not clear how global warming will affect the dry lands of tropical Africa in the future. What is not in doubt however, is the profound impact on land cover, occasioned by prolonged droughts. This is already the scenario in the Sahel region of Africa, where droughts have increased the rate of desertification. The Sahel region has been described as the most perilous climatic zone in Africa. The area lies along the southern border of the great Sahara Desert. It is also referred to as the Sub-Saharan region. Countries that lie in the Sahel region of West Africa include Senegal, Mauritania, Mali, Burkina Faso, Niger, Chad and Nigeria. But areas of Nigeria that fall under the Sahel zone are the Northern-most fringes, covering the states of Sokoto, Kano, Katsina, Yobe and Borno. Today, many groups of scientists and many organizations such as the Food and Agricultural Organization of the United Nations, are investigating the phenomenon of desertification. Regions of potential desertification are being mapped and various proposals for halting and reversing the process are being studied.

Unfortunately, and as a result of the geographical location of Cross River State in the southern geopolitical zone of Nigeria, an impression is being created that the entire state falls within the forest zone of Nigeria. This broad categorization tends to give a false impression of homogeneity of environmental conditions, while hiding the seething process of degradation that is going on in the marginal areas of the northern axis of the state. There is a gradual but steady encroachment of Sahelian conditions into the zone. The tendency is that if such conditions are not identified and consciously managed, they may degenerate to conditions worse than those in the Sahel.

Like most natural hazards, the process of degradation creeps in gradually on the affected areas and subsequently creates the problems of recognition and perception. The problem is further sustained by the general human perception of natural hazards. Members of an endangered environment usually suffer from what Ebong (1993) has described as “Cognitive Dissonance”, that is a situation in which the individual and behavior is not in accord with the available information about the objective hazardous environment. In other words, people appear to wave aside any possibility of a catastrophe in so far as they are not immediately affected. According to Castree (2016), such attitude arises from the relative infrequency in the occurrence of the hazard, which will affect their ability to respond. Such seems to be the case in the perception of the environmental conditions in the Upper Cross River State, where desiccation and degradation are creeping in gradually.

On a global scale, according to a report released by Greenpeace USA in September 2013, climate change denial and the campaigns designed to block adaptation measures grew mainly out of the 1990s negotiations slated to develop a global agreement. This tactic was utilized by the lobby groups in the hopes of delaying action and blurring the lines between the valid scientific efforts to challenge climate change findings and those designed to merely undermine the credibility of the scientific community. This strategy feeds into the “uncertainty argument” and develops an

impression of debate through references to the uncertainty of scientific findings that exist in any research model.

However, concerned scientists have continued to push to establish the facts of climate change impacts and the likely ways of adaptation and mitigation. According to Olaniran (2011), three types of actions have been suggested to address the problem of climate change: these include mitigation, adaptation, and resilience. Mitigation involves efforts to prevent climate change. Mitigation activities can be divided into two parts: conservation and development and deployment of alternative energy sources. Each of these has two principal components which are technology and behavior change. Adaptation deals with responses to climate-related disasters that are not prevented by mitigation efforts while resilience is the characteristic needed in individuals, communities, nations and the world, to prepare for disasters to reduce the suffering and loss they bring and to rebound in positive ways. Effective structural planning could be an important tool and potent mitigation and adaptation strategy to address the problem that may arise from the effects of climate change and land degradation. The relationship of climate change and changing land uses is the focus of the current investigation.

Scientists such as Segura et al (2014) and Robert (2009) suggest geoengineering techniques, which can be employed to change the climate deliberately and thus control some of the effects of global warming. These include:

Hydrological geoengineering - typically seeking to preserve sea ice or adjust thermohaline circulation by using methods such as diverting rivers to keep warm water away from sea ice, or tethering icebergs to prevent them drifting into warmer waters and melting. This, according to Wikipedia, may be seen as an adaptation technique, although by preventing Arctic methane release it may also have mitigation aspects as well. Solar radiation management may also be seen as an adaptation to global warming. Techniques such as space sunshade, creating stratospheric sulfur aerosols and painting roofing and paving materials white all fall into this category.

Local land use and municipal planning represent important avenues for adaptation to global warming. These forms of planning are recognized as central to avoiding the impacts of climate related hazards such as floods and heat stress, planning for demographic and consumption transition, and plans for ecosystem conservation [Tompkins and Adger, 2004]. This type of planning is different from the National Adaptation Programs of Action (NAPAs) which are intended to be frameworks for prioritizing adaptation needs [Jump, 2005]. At the local scale, municipalities are at the coal face of adaptation where impacts are experienced in the forms of inundation, bushfires, heatwaves and rising sea levels [Jump, et al, 2009].

2. Materials and Methods

The study is based on several years of fieldwork with students of geography department of the Cross River State College of Education, Akamkpa, as well as with students of the Faculty of Environmental Sciences, Cross River University of technology, Calabar. Major environmental alterations over the years were noted and correlated with the global climatic trends. A descriptive approach is adopted here since most observations were from perceptual experiences.

The Study Area

The zone is found in the northern most part of Cross River State. It stretches from the foot-hills of Obanliku in the east through the hilly and low-land area of Obudu, to the western plains of Ogoja and Yala Local Government Areas. The zone also lies on the same latitude, of between 6° and 7°N and longitudes 8° 30' and 9°30' E.

Like other Guinea Savanna environments, this area lies in-between the rain forest and the Sudan environment. The climate is characterized by short rainy season and long dry season. Rainfall begins in May and lasts till October, during which serious farming activities take place. Very dry conditions set in from November. The harmattan wind blows in during this time with its very low relative humidity and crisp dry air. However, apart from the Obudu Cattle Ranch which has unique temperature conditions, annual temperature figures show a constant high, over and above the two southern zones. Average yearly temperature for Ogoja station is 27.5°C as against 26.7°C for the southern zone and 27.0°C for the central zone. Also, the highest temperatures do not occur during the peak of summer (i.e. in June) but occurs just before the onset of the rainy season, in April.

Geomorphic processes are as in other savanna belts. Large areas of the belt lie on a stable shield, where the bedrock is extremely complex in rock composition and structure. Exposures of plutonic igneous masses are numerous. But here instead of the process of planation which gives rise to Inselbergs in the higher savannas, we have rigid masses produced largely by more recent volcanic action. These masses are represented by the Obanliku - Obudu plateau and hills. Chemical weathering during the wet season is considered to be a very important process affecting igneous and metamorphic rocks rich in aluminum and silicate minerals. The intensity of erosion by running water is extremely high, because of the rather poor protection of the soil by vegetation. Sediment loads of streams - both suspended and bed-load - are very high during periods of peak flow. In contrast, stream discharges fall to low values down to zero during the long dry season, when braided channels of sand and silt are exposed to view. This is a major feature of the Aya and Abebe rivers, two of the major rivers in the zone.

Soil conditions are of dense accumulation of sesquioxides of aluminum and iron, which are residual products of weathering. Laterites and lateritic crusts are dominant. Lateritic crusts are usually exposed to the surface through erosion of top soil.

It is the position of this paper that this zone is a distinct ecological entity, which possesses distinct characteristics that are not in consonance with the rest of the state. In general, the vegetation belts in Nigerian grade from the forest belt in the south, to the Guinea, Sudan and Sahel savanna belts in the North. But because of the precarious nature of the Guinea savanna zone in Cross River, the original attributes of the zone are disappearing and giving way to Sahel conditions. This is shown in the analyses that follow.

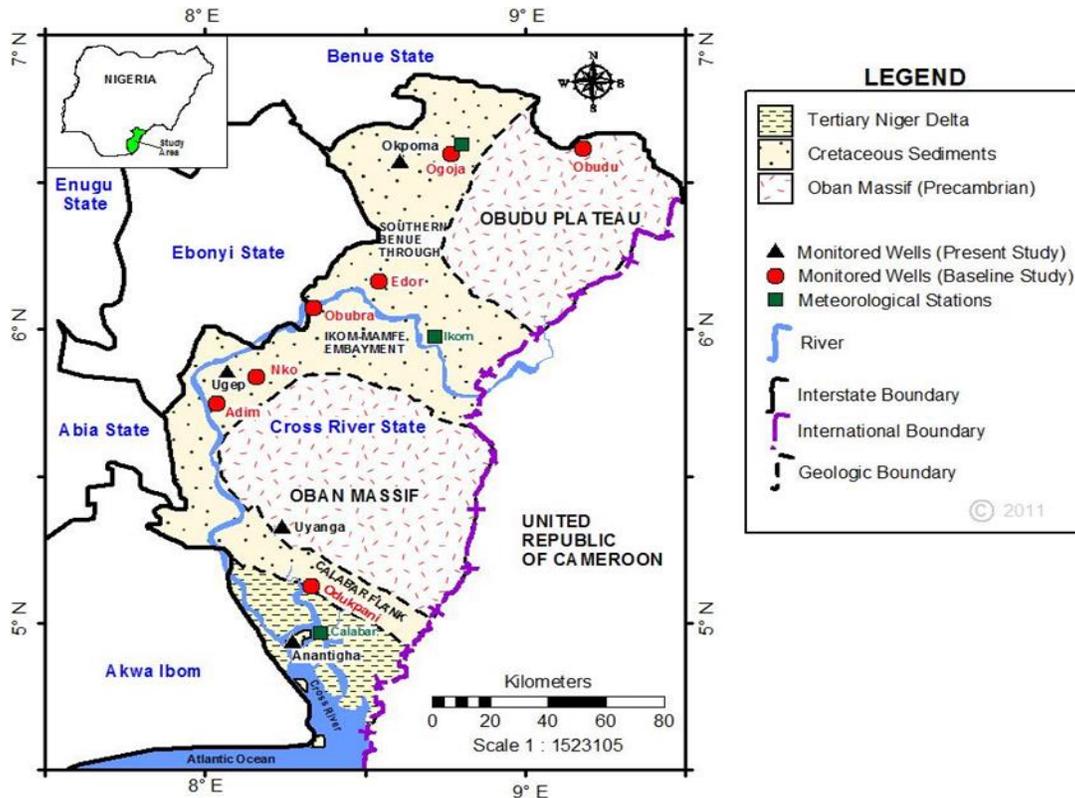


Figure 1: Map of Cross River State, Nigeria, showing physical setting. (Source: Esu et al, 1996, Geotechnical Characterization of Obudu dam site, Obudu, South-eastern Nigeria. International Journal of Engineering Geology)

3. Presentation of Results and Analysis

Emerging Sahelian Conditions and Evidence of Vulnerability to Climate Change

Vegetation is the most typical of all savanna characteristics in the area. It has a mixture of tree and grass species. The grasses grow tall reaching about 4m in some cases like the elephant grass. Trees are widely distributed with flattened crowns. Their trunks are thick and have rough barks. Along areas of high groundwater level, like stream channels, gallery forests occur with typical rain forest species present. The trees are either xerophytic or deciduous or both. Most of them are fire-resistant and are not affected by dry-season fires which usually sweep through the lower layer of grasses.

Most dominant tree species include the locust bean-tree, which is spared during land clearing on account of its high economic value; the silk cotton tree, which also survives because of its religious and cultural significance in many parts of the zone, and grows to very incredible heights, sometimes reaching up to more than 100m. The tree is a prominent feature of most village playgrounds in Ogoja and Yala areas of the zone. Date palms are also prominent around Ekpogrinya in Ogoja, and in Yache in Yala L.G.A., while the Baobab can be found in parts of Obudu. Typical forest species like "chlorophora Odorata", "perinellia spp", mahogany and iroko are also found on sacred grounds and in gallery forests. The oil palm tree is equally very common especially in the valleys of Obudu hills, where they may occur in colonies likened to the oil palm bush of the central zone. But around the Ogoja and Yala plains they appear in fewer clusters and stands, largely as a result of their being fell for wine tapping.

On the wetter parts of Obanliku - Obudu axis, large clumps of bush occur. Common grass and shrub species include the "independence grass" (*Adamsonia* spp), spear grass, elephant grass, and climbers like the "devil's beans". Spotty grass distribution is a common feature of the over-cultivated Ogoja plains. The hill-sides of other areas have very low grass vegetation, while all swamp areas in the zone have the same kinds of hygrophytes' species.

Current agricultural practices in the zone are sufficient to make us conclude that this vegetation is a derivative of the primeval forest of the south and central zones, but that human activities have helped to modify it and are still modifying it. Bush fallowing remains the major farming practice, instead of shifting cultivation. But the slash-and burn method of farm land clearing is practiced as in the rain-forest. A piece previously fallowed land is cleared and tilled, and tuber crops like yam, cocoa-yam and cassava are planted, sometimes they are inter-cropped with maize, melon and beans. Farming operations follow the rainfall regime, starting in April and ending in May/June. The growing period stretches from June to September /October, when harvest begins. After harvest the land enjoys a brief fallow period during the dry months.

By the next cropping season, the same plot is cleared and planted with groundnuts, maize and Guinea corn in the Obudu area, ground beans and cassava in the Bekwarra area, and mostly cassava and maize in the Yala area. After that harvest, the plot is again allowed to fallow for about two to four years. Hardly is one plot cultivated continuously for up to three years. However, over the years, because of the increased pressure on the land due basically to increase in population, there has been a drastic reduction in length of fallow periods and there is further parcelation of farmlands.

For this reason, the vegetation has little time to regenerate. Worse of all is the method of land clearing. Trees are felled or trimmed to be used as yam stakes or just to remove shades, especially where groundnuts and rice are cultivated. Big trees are destroyed by ring-barking or firing at the base, while small ones which are supposed to provide the basis for the ultimate regeneration of the vegetation cover are cut off and used for staking.

Another serious-threat to vegetation is the dry season bush fires. On annual basis wild harmattan bush-fires consume most of the grass in the area, leaving charred skeletons of hardy shrubs standing like ghosts on the ash-covered earth. It is a common dry season night-time feature to see glowing flames at the hill-tops of Obudu and Obanliku. In some parts of the world, wild fires are said to be part of the natural process of checking the encroachment of forest species, and are caused by thunderstorms (Darvill, 2009). But in this zone the fires are set by humans, either as a way of clearing farm lands, or as a means of hunting games.

Equally serious a threat is lumbering. Remnants of forest species are felled for timber and other purposes. On the true border line areas like Mbube in Ogoja, Okorshe and Kutiang in Obudu, and Busi in Obanliku lumber wood are still exploited. In other areas felling is usually done for procuring fuel wood. This practice is the worst threat since no species is spared. Over the entire zone felling of palm trees for extraction of palm wine is a common practice. This may account for the considerable depletion of these trees in Bekwarra and Yache areas, where the limited numbers are further lost through continual felling. In the eastern axis, a combination of wetter conditions

and more scientific (albeit traditional) methods of tapping wine have helped to ensure higher concentrations of the species.

Also significant is the danger posed by wind storms. Wind storms which normally occur occasionally in the area especially at the onset of the rains, have become more frequent. The storms are often attributed to the "line-squalls" which usually indicate the change-over of seasons in the I.T.C.Z. zone of Nigeria (Ojo 1997). The winds rake great havoc on the larger tree species by either out-rightly uprooting them or breaking up their branches such that they begin to die gradually. These storm disasters themselves are as a result of loss of closed-up vegetation itself, and so the phenomenon is a self-perpetuating one.

Climate Change Implications on Other Components of the Environment

The fore-going features have profound influence on the total environment, given the emerging climate change scenarios. The combined effects of impoverished soils, absence of irrigation and a rugged terrain have made agriculture highly dependent on rainfall. A recent study in Obudu for example, showed that there a positive correlation between rainfall and crop yield. It follows that in time, and given the threat of global climate change, this area will suffer grave environmental stress. In many parts of the zone rigid masses of lateritic crusts or calcretes appear on the soil surface as a result of exposure due to erosion. Such surfaces hardly support plant growth. If careful and conscious effort is not made to manage the soil conditions, any little alteration in hydro-meteorological conditions of the area will bring about famine.

As accelerated soil erosion also leads to the silting of stream channels, shortage of portable drinking water is another serious problem. Worst still, the deep- seated weathering in the zone has made the drilling of bore-holes a difficult task. Ground water occurs in very deep and unreliable aquifers making extraction not only difficult but expensive. As a result, most of wells and bore-holes in the areas like Betukwel and Igwo in Obudu and Okpoma and Yache in Yala, dry up almost immediately dry conditions set in. Only in highland parts of the zone, where water is stored in the interstices of huge rock masses is the flow of springs guaranteed all year round. But the areas are mostly uninhabited.

In Yala, especially in Okpoma, Ekprinyi and Ijiegwu areas, water shortages are attributed to the depletion of natural vegetation of the area. In Alifokpa of the same area, a bore-well of up to 50 feet may not yield water in the rainy season. Surface water shortages are not only as a result of geomorphic processes but also because of the dearth of sufficient vegetation cover to protect both ground water and watersheds.

It has been submitted that climate change could modify the ecological zones where disease-carrying vectors breed. The worst environmental hazards in this zone arising from the aforementioned conditions are the frequent outbreaks of epidemics. High temperatures tend to favour the breeding of disease-causing organisms in the zone. The dry and dusty Harmattan wind also brings air-borne diseases to the area.

Above all, most of the diseases are water-borne, and the acute water shortage in the dry season also gives rise to various ailments. In 1986, there was serious yellow fever epidemic in Okuku and Yache areas of Yala (The Nigerian Chronicle, Nov. 8, 1986). The epidemic was so severe that in

some instances a whole family was annihilated. In that incident a teacher at the Mary Knoll College, Okuku and his friend lost their lives the same day!

The occurrence of Guinea-worm epidemic is a common feature of the same area, including parts of Ogoja. Huge sums of government money are being spent on guinea-worm eradication in this northern zone. It seems however, that the guinea-worm area is confined to the western part of the zone, where streams hardly flow in high currents.

Also, in 1983 there was an outbreak of Bilharziasis in some parts of Obudu. The bilharzia parasite is said to penetrate the skin while one wades through infected water or from the drinking of contaminated water. In 1994 in the same area there was another epidemic outbreak, this time, of typhoid fever that led to so many deaths (Nigerian Chronicle February 12, 1994). Here the epidemic was reported to have arisen from the pumping of untreated and infected water from the Abeb River by the Cross River State Water Board responsible for municipal water supply in the area.

In 1995 there was massive vaccination of residents of the state as a result of the large-scale outbreak of Cerebrospinal meningitis epidemic in the same northern part of the state. The epidemic broke out in January of that year and continued to kill and maim until about March, when it was checked by Federal Government intervention. An estimate of about 300 people died in Obudu alone ("Tell", March 9, 1995). Unfortunately, information about that outbreak was carefully censored by government for certain diplomatic reasons at the time, and in the end, more than the figure above may have died. According to Udo (op cit), this disease occurs almost every year in the Sahel area of West Africa during dry season. To corroborate Udo's view, in 1996 several thousands of deaths were reported in Kano, Katsina, Maiduguri and other parts of northern Nigeria resulting from the outbreak of that disease.

Interestingly, the southern limit of this northern Guinea savanna zone also forms the limit of areas affected by these epidemics. For instance, in each of the cases above, none was reported in areas like Boki L.G.A., the immediate southern neighbor with rain forest conditions.

Also, diseases like Goiter (swelling of the thyroid glands) which occurs as a result of iodine deficiency in the body, also occurs in restricted parts of the zone. It is prevalent in Bendi area of Obanliku, where the soils and water are said to be lacking in iodine content as a result of upland conditions. According to one environmental health doctor in the state, this disease is a geographical one that affects inland areas, where the soils and water do not contain iodine to be taken up by plants and later consumed by humans. The disease is now checked by the consumption of iodine in iodate table salts.

It must be noted that these debilitating conditions do not present themselves so readily for recognition in the zone, rather they manifest more prominently only once in a long while. This paper therefore should not be seen as painting a gloomy picture of an environment, like some authors have done of the humid tropical environment, but rather as a presentation of conditions that are going on without being viewed in the correct perspective, with respect to the total environment. It should be seen that they are all indicators of a marginal area that deserves special attention.

4. Adaptation and Recommendations

The United Nations Disaster Risk Reduction Office (UNISDR) recognizes climate change adaptation as part of the disaster risk reduction domain as it intends to reduce the risks that vulnerable populations might encounter due to climate change. Before making any recommendations, it may be pertinent to look at how the inhabitants of this endangered zone have adapted themselves even though unknowingly, to the prevailing conditions; and government's efforts so far. In Bekwara and Obudu areas for example, as a result of rainfall uncertainty, swamp rice cultivation has become a common farming activity. New varieties of cassava, (especially the 'Takon' variety) and groundnuts are now being planted in swamps after rice has been harvested during the dry season. This cassava species requires less than a year to mature. The method is adopted in the absence of irrigation, and also since there are no large river flood plains for the practice of 'fadama' farming.

Current increase in the use of chemical fertilizers helps in increasing output in the short run. But over time, there will be adverse effects. Some tree species are also protected by local legislation. In some villages like Bedia, Ibong, and Okorshie in Obudu LGA, it is forbidden to kill saplings of some species like the mahogany. The practice of maintaining traditional worship centres under some large tree varieties like the Silk-cotton and Oil-bean trees has indirectly helped and may continue to help in preserving. However, the new Evangelical movement has become a serious threat to this practice and to the tree species. Allegations of the trees being objects of witchcraft have led to indiscriminate felling of the trees.

Perhaps the most dramatic attempt to improve environmental conditions in this belt is the initiation of the Obudu Dam project. Though the project has suffered some bureaucratic delays, when fully completed, the dam is expected to provide water for both domestic use and irrigation for at least half of the zone, including parts of the neighbouring Benue State. The Cross River Basin Development Authority, the agency in charge of the dam project, is also experimenting with irrigation schemes at the Ishibori – Bekwara swamp field.

These adaptation measures notwithstanding, it is the opinion of this paper that full-scale programmes of ecological improvement should be initiated. This zone should be seen as a marginal area, just like the desert fringes in the north of Nigeria. All programmes of environmental rehabilitation going on in the Sahel areas should be implemented here. The tree-planting campaign of the government must be carried a step further. This is where the role of environmental education is very imperative. Creation of awareness of conditions in one's immediate environment is very significant in helping to shape his perception and behaviour towards that environment. This is perhaps why Faniran and Ojo (1980) see the indiscriminate destruction of forest by man as resulting from a kind of 'psychological hangover...of the pioneer who, faced with a hostile forest, has fought it with every tool at his disposal'.

At this stage it may also be necessary to re-awaken some of the positive cultural norms which promote preservation of vegetation resources. The method by which traditional forest reserves have been preserved should be explored by those involved in safe-guarding the environment.

And finally, it is hereby suggested that a Green Belt be formed along the northern limit of this zone, through government's acquisition of the strip stretching from the northern parts of Obanliku, Obudu, Bekwara, Ogoja and Yala, and its management as a reserve. Such a creation will serve two purposes: First it will form a veil checking the harsh influence of the *harmattan* wind blowing in from the north. Secondly, much of this strip of land has been an area of constant border skirmishes between the Tivs of Benue state and the different ethnic groups in the zone. This kind of scheme had been experimented in Oyo state at Olokenyi, 48 kilometers west of Ibadan at the transition between the rain forest and derived savanna for this second season. Today, that effort has given rise to the Olokemeji forest reserve.

5. Summary and Conclusion

In this paper we have tried to show that contrary to the apparent perception of Cross River State as a uniform ecological zone, the state possesses diverse physical conditions, and that in effect, the northern part of the state is seriously threaten with conditions that are similar to the Sahel environment under changing climatic conditions. The paper began with a look at the concept of climate change, as well as what marginal conditions in the Sahel region look like. The paper then characterizes the existing conditions in the study area, which are thought to have been worsened by climate change. These conditions included the geomorphic, edaphic, climatic and biotic components of the environment. On-going adaptation techniques by the indigenous population were also examined. Finally, the paper shows that the northern part of Cross River State is a delicate is a delicate ecological zone that must be managed properly; otherwise environmental conditions there may deteriorate to levels worse than those in the desert fringes. It has been concluded from the analysis that indeed the zone is a "marginal" area that deserves careful management in order to maintain a state-wide ecological balance for both present and future development.

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