

# Appraising The Slow And Steady Threat Of Desertification On Adamawa North Senatorial Zone

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**Abstract**—The Adamawa North Senatorial zone was once relatively densely forested with various species of trees, shrubs, and grasses cohabitating varieties of animals, birds and insects. Rivers and streams and ponds in the zone were all season, but today, the physical features are opposite. The forests have disappeared, the rivers and the streams are now seasonal and the different species of animals (birds and insects) are gone. The main objective of this paper is to expose the menace of desertification with specific objectives of identifying the causes, examining the effects, evaluating the environmental changes and recommending mitigating measures to restore the lost environmental characteristics of the Adamawa north areas. Some secondary data of rainfall and temperatures were gotten and analysed statistically while primary data were gotten from the returned questionnaires which were administered equally and purposefully to people aged fifty years and above across the five local government areas. The result of the probit model indicated that rainfall and temperature have a negative impact on Desertification but not too statistically significant. The result of field responses from people who have seen the past and present revealed that important variables that dramatically affects desertification are deforestation, overgrazing, overpopulation and slash and burn cultivation among many other human activities. The paper ends by recommending competitive afforestation or tree planting exercise for a prize among all schools from primary to secondary as well as community based exercises, effective legislation and enforcement with regards to felling of trees, usage and replacement, regulations and education of herdsmen on modern patterns of raising animals.

**Keywords**— *Appraising, Slow and Steady, Threat, Desertification, Adamawa Northern Senatorial Zone*

## I. INTRODUCTION

People who have seen and travelled through the Adamawa North environment in the past and comparing them with the prevailing physical status of the environment, it is an indisputable fact that so many unbelievable negative changes or transformation have taken place. Some fifty or even forty years ago, the environments from Maiha to Madagali were fairly thickly forested by different varieties of trees, tall grasses, co-habiting varieties of animals, birds, and insects. Most of the rivers and streams in the region used were all season for fishing. Today, the story is the opposite, the trees have virtually disappeared, the rivers and streams no longer exist in the dry season; roofing grasses and zana mat is almost gone, the wild animals that used to terrorize and devour the domestic animals and human beings have equally disappeared

etc. This means that the environment which was ones a home to large number of fauna and flora has become a shadow of itself. The caption of the topic is deliberate because desertification is a slow and steady process which cannot be seen overtly and so people may not be aware that their land is degrading. There is therefore dire need to create to create awareness and to build up a sense of stewardship step in the challenge of reducing degradation. The main solution lies in the behavior of the farmer who is subject to economic and social pressures of the community/country in which he/she lives. Food security, environmental balance and land degradation are strongly inter-linked and each must be addressed in the context of the other to have measureable impact. This is the challenge of the 21st century for which we must be prepared [15].

Defined desertification to be the degradation of land in arid, semi-arid, sub-humid dry areas caused by climate changes and human activities which usually manifest in reduction in the land depletion in surface and ground water resources [23]. Similarly, [2] contend that land degradation occurs all over the world and this is referred to as desertification when it takes place on dry lands. It is one of the most serious problems facing the world today which puts at risk the livelihood of more than one billion people who are directly dependent on land for survival [17, 36].

The northern states of Nigeria is the dry land part of the country that are prone to desertification. More than half of the region is covered by ferruginous tropical soils which are highly weathered and markedly lateralized. A large proportion of the region is also characterized by sandy fixed undulating topography, low in-organic matter, nitrogen and phosphorus. Average rainfall in dry-land of Nigeria varies from 500mm in the north eastern part to 1000mm in the southern sub-area but unpredictability, unreliability characterize the pattern of rainfall [23] The region is therefore prone to recurrent and sometimes intense and persistent periods of drought, which may result in the depletion of soil and shallow ground water resources; capable of disrupting the low level of resilience of the natural ecosystems of the affected area. In spite of the teething problems of the region, the dry land zone is the most grazed among other human activities. Others include wood extraction for fuel and construction, bush burning, cultivation of marginal lands and faulty irrigation practices.

About half a century ago, people of Adamawa north area extraction used to consider and regard the phenomenon of

desert to be the problem of northern Borno, Yobe, Niger and Chad. Today, the concept has become a reality, slow and steady the process of desertification has engulfed the region. The United Nations Environment Programme (UNEP) note that desertification has affected 36 000 000 km (14, 000 000 sq. miles) of land which cover some of the world's poorest countries. A 2007 report by the United Nations University maintains that the lives of 100 to 200 million people are affected by desertification. The report also notes that this phenomenon may cause the displacement of about 50 million people by 2017, making it one of the most severe environmental challenges facing humanity of our time.

Africa is the most affected continent by desertification and one of the most obvious natural borders on the land-mass is the southern edge of the Sahara desert where Adamawa North area covering Maiha, Mubi South, Mubi North, Michika, Madagali and part of northern Hong local government areas exists. The region has been subjected to periodic drought that devastated the people. This is evident in the form of sparse or variable rainfall, variations in climate and unsustainable land management practices in the dry-land environments (Desertification, 2012). A lot of damage has been done to the Nigeria's land through the process of deforestation and the overwhelming trend of desertification manifested in the encroachment of the desert on the land that was once fertile. Odjugo [27] conducted a study from 1901 to 2005 which revealed that there was a temperature increase in Nigeria of 1.10C against global mean temperature of 0.740C and the amount of rainfall in the country decreased by 81mm. the combination of extremely high deforestation rate increased temperature and decreased rainfall are all contributing to the desertification of the country.

The researcher who incidentally happens to have seen the region fifty five years and beyond is interested in knowing the causes of the devastation and how it caught the inhabitants unaware without taking mitigating measures to control the process. The land which used to be fertile and thickly forested and covered with variety of vegetation inhibiting animals of different kinds gradually transformed into the present landscape. This research work will attempt to answer questions like: what are the various causes of desertification in Adamawa north area? What are the effects of desertification in Adamawa north area? What environmental changes can be attributed to desertification in Adamawa north area? What are the impacts of government's environmental policies geared towards curtailing desertification in Adamawa north area?

The broad aim/objective of this paper is to expose the menace of desertification on environment in Adamawa north area while the specific objectives of the paper are to: identify the various causes of desertification in Adamawa north area, examine the effects of desertification on the environment in Adamawa north area, evaluate the environmental changes that attributed to desertification in Adamawa north area and to assess the government's environmental policies geared towards curtailing desertification in Adamawa north area.

## II. LITERATURE REVIEW

### A. *The Phenomenon of Desertification*

Desertification which is synonymous to land degradation has received widespread global debate as evidenced by the

literature [2, 17, 11, 15]. Two distinct schools of thought have emerged regarding the predictions, severity and impact of land degradation. One school believes that it is a serious global threat posing major challenges to humans in terms of impact on biomas productivity and environmental quality [12]. Ecologists, soil scientists and agronomists support this argument. The other school which comprised the economists believes that if land degradation is a severe issue, why did market forces not taken care of it. The supporters of this school believe that farmers have more vested interests in their land and will not let it degrade to the point that it is detrimental to their profits by Cresson, 1997.

There are numerous terms and definition of desertification that are sources of confusion, misunderstanding and misinterpretation depending on the disciplinary orientation. Some common terms used are: soil degradation, land degradation, and desertification. While there is a clear distinction between 'soil' and 'land', the term refers to an ecosystem comprising landscape, terrain, vegetation, water and climate. There is no clear distinction between the terms 'land degradation' and 'desertification'. Desertification refers to land degradation in arid, semi-arid and sub humid areas due to anthropic activities [2, 8]. Some researchers argue that this definition of desertification is too narrow because severe land degradation resulting from anthropic activities also occurs in the temperate humid regions and the humid tropics.

The major distinction between desert and desertification is that desert is a desolate stretch of barren or arid landmass of widespread cover with little or no vegetation cover but mainly covered with sand, gravels or pebbles or mixture of these with practically no form of surface water, having minimal or no significant annual rainfall while desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from factors including climatic variations and human activities.

Deserts are of two types which are naturally occurring and man-made. The naturally occurring deserts like the Sahara desert were formed by natural processes interacting over thousands of years. The ecosystems of such paleodeserts are balanced and stable. The fauna and flora inhabiting these deserts have over the years adapted themselves so well to live in this hostile environments. Some human communities have also learnt to live in and with these deserts. The oasis found in such deserts have enabled cities and colonies to flourish around them. The deserts which are not bounded and limited by boundaries like sea or mountains are not reported to have spread rapidly and engulf fertile land and human habitations.

The man-made deserts are large or small land masses which were once known to be fertile and arable but which have degraded since their ecosystem has been subjected to the stress of human activities beyond its limits. The Indus valley was once a fertile region which invited invaders from the north who came into the country through the Himalayan passes. These hordes looted and burnt in their wake, leaving behind a scorched land which gradually turned into the present day desert. The process of such extreme degradation is known as desertification. Another incident of desertification was encountered in the 1930s, when part of the Great Plains in the United States turned into the 'dust bowl' as a result of drought and poor farming practices [19].

Some of the researchers like [23] did not distinguish deserts into natural and man-made. He defined desertification as the degradation of land in arid, semi-arid, sub-humid dry areas caused by climate changes and human activities with resultant effect of reduction in the nature of land, depletion in surface and ground water resources.

#### B. *Effects of Desertification*

The visible sign of this phenomenon called desertification is the gradual shift in vegetation from grasses, bushes and occasional trees, to grass and bushes and in the final stage, expansive areas of desert-like land. Studies revealed that Nigeria loses over 350 000 hectares annually or advancing desert, the dunes are threatening life-supporting oasis, burying water points, and in some cases engulfing major roads in the affected areas. Trees planted by government as shelter belts to check the advancing dunes are withering due to lack of attention. Studies by [23] reveals that an estimate of between 50% and 75% of Adamawa, Bauchi, Borno, Gombe, Jigawa, Kano, Kaduna, Katsina, Kebbi, Sokoto, Yobe and Zamfara states in Nigeria are affected by desertification and particularly vulnerable to wind erosion.

Luke [21] revealed in his studies that there is loss of biodiversity and gene pool reserves. Reforestation done with alien species does not help since the requirement for special plants such as the undergrowth and epiphytes will have lost their partners in the ecosystem. Without vegetation cover, the top soil is washed away by rain and blown away by wind. The soil washed away by rain usually ends in silting streams and rivers and thereby causing floods. Loss of arable land results in the depletion of food crops, and consequently the livelihood of forest people is threatened. Other consequences of desertification include loss of trees affecting the undergrowth like shade-loving herbs and epiphytes, loss of soil fauna such as earthworms which helps to turn the soil, loss of wildlife due to lack of or inadequate food in their regular living space, shortage of water drying up the exposed soil, induced intensification of wildfires and stirring winds, migration of large number of people from the affected areas to cities seeking for work and food, loss of medicinal herbs and plants and dusts from the desert an dry-lands are blown into cities around the world, these fine small particles of dust when inhaled causes health problems.

Deserts enrichment can threaten the livelihood of communities and survival of a nation. The drought that happened in 1973 as a result of desertification has claimed more than 100,000 human lives and 12 000 000 livestock. Studies have also revealed that desertification and land degradation are the major causes of poverty, hunger, social ills and loss of biodiversity in northern states of Nigeria. That northern states have an average poverty incidence of 70% compared to 34% for the southern states. Desertification often leads to conflicts amongst communities competing for farmlands, clashes and eventual loss of lives and properties. The problem also leads to migration from the rural areas to the urban centres. Research findings have indicated that deserts occupies between 35% and 40% of the land mass of the frontline states of Borno, Yobe, Jigawa, Kano, Katsina, Zamfaram Sokoto and Kebbi states. The African Institute for Applied Economics (AIAE) had estimated that in 2005, Nigeria had lost about N180 billion annually to deforestation hinged on the destructive trend to crop land expansion and the

falling down of trees for fuel. That real wood fuel prices had doubled in in the last two decades in the country due to woodland destruction resulting in an estimated loss of between N45 to N60 billion annually.

Speaking at the tree planting campaign organized at St Joseph's compound, Monguno, Borno state, Rev. Fr. Cosmos Kwalla, told newsmen that people who lived in the 70s downward are shocked about the nature and geography of northern states. That the land was fertile and thickly covered with varieties of vegetation, animals, birds and insects of different kinds. The growth in population saw the expansion of habitations, farmland as well as for domestic use such as for firewood, fences and furniture. To worsen the whole thing is the advent of climate change and with time, this factor transformed the landscape into what is now part of the biggest deserts in the world-Sahara desert. For a long time, the Federal and State government have been fighting each such desert geometric encroachment southwards by planting trees to serve as windbreakers against the sandstorms and their roots to improve the nature of the soil. Unfortunately, many of the tree planting campaigns have not yielded the desired results because within the short period of time, the trees were devoured by animals or withered for lack of proper care [33].

#### C. *Empirical/Symptoms of Desertification*

According to [14, 30], the process of desertification manifests in many ways that could be used to assess the magnitude of degradation as well as vulnerability of an ecosystem to desertification. By indicator or symptom is meant something that provides observable information about the condition being investigated and these indicators could be physical biological, and social such as the ground water level, water and wind erosion, presence of crust, distribution and frequency of key plant species, land use pattern amongst others.

#### D. *Aridification*

Aridification is the process of a region becoming increasingly dry, along term change and often measured as a reduction of average soil moisture content [13, 26]. It can be caused by natural or anthropogenic means such as climate change, reduced precipitation, and increased evaporation, lowering of water tables or changes in ground water. Aridification was applied in the assessment of vulnerability of land to desert conditions in Sokoto area [25]. The study assessed the moisture control section of an average representative soil (1951-1960 and 1977-1986). The result gave a reasonable indication that soil in the area was becoming drier in the moisture contents.

#### E. *Organic Matter in Soil*

The amount of organic matter in soils is an indicator of change in soil and land scape characteristics. The loss of organic matter causes degradation of soil structure, loss of water and nutrient to plant and micro-organisms because when organic carbon content falls below 2%, a soil is easily eroded [18, 20, 35]. The result of soil surveys carried out in 1969 and 1992 on four (4) soil types in Sokoto, the organic matter content measurement showed a clear decrease from 2.0% OC to 1.0% OC; 1.5% OC to 0.7% OC; 1.7% OC to 1.4% OC and 1.2% OC to 0.6% OC [25].

#### F. Surface Albedo

The change in albedo of dry land is an indicator of change in their conditions and quality, diversity of vegetation erosion deposition, surface soil moisture and anthropogenic-induced changes. Darkening of an arid land surface indicates an increase in land quality while brightening indicates a decline in quality primarily due to changes in vegetation [9]. Overgrazing, cultivation and anthropogenic pressure on arid and semi-arid regions had a strong impact on surface albedo in Israel, U.S.S.R. and Afghanistan and in the Sahel region.

#### G. Changes in Perennial plant cover

Research studies have revealed that a change in perennial plant cover particularly during dry season is an important indicator of desertification [30]. That the removal of forest cover had set in the process of desertification. In a study by Mohammed [25] in Sokoto area, they found out there had been changes in the vegetation cover of the area when two different Landsat images of MSS (1996 and 1986) were used. Green vegetation area in 1976 alone was 13.2% of the total surface while in 1986 alone, the green vegetation area had reduced to 4.0% of the total surface area considered.

#### H. Yields of crops

According to [5, 30], crop yield is often considered to be one of the most important indicators of desertification. The Sudan government in 1976. DECARP reported that "food production has declined and continues to decline because of deterioration associated to desertification. Studies by Oyetade [29] on desertification in Northern Nigeria revealed in the 1990s that some farmers could produce 40 bags of sorghum and 20 bags of groundnuts each year but in recent times, the yield has gone down as desertification takes over the land even though farmers work twice as hard as before, their yield is barely half of what they used to get in the past.

#### I. Population of Domestic Animals

Population in this case refers to numbers, frequency and distribution of large and small stocks. Large stocks are cattle, camels, donkeys and horses while small stocks are sheep and goats. Blajan [3] in his studies revealed that overgrazing of pastures in the Sahel was responsible for rapid degradation of the soil. Beauchamp [4] similarly revealed in his studies that in some arid and semi-arid regions, the domestic livestock animals and soils must be considered together as part of an agro-ecosystem which includes plants and increases in animal livestock with human population growth that usually promote desertification in these regions.

#### J. Land Use Pattern-firewood

Firewood in this case refers to the use of land and its vegetation for firewood and charcoal production. These are used for fuel by a third of the world's population [36]; customarily collected in the vicinity of residential areas by women. The change in fuel usage is often translated to the need to walk further and further from the residential area into lands not previously used for firewood collection or as changes in the rate of firewood collection. Changes also come when new areas are converted into residential use or by growth from village to town or town to city as with Dodoma in Tanzania [30] with the attendant new or increased firewood demand.

#### K. Population Structure and Numbers

Many research studies in Africa, Asia and Latin America have indicated that the rapidly increasing population densities in some dry-lands had upsetted the former balance upon which subsistence agriculture depended including large fallow periods to regain fertility. According to Milas [24], arable land for the whole world as a whole was projected to decrease from its 1975 level of 0.3Iha/person to 0.15ha/person by the year 2000. That means that as population increases, the remaining cropland would experience further encroachment on rangelands and forests with increase in ecological and population pressure resulting into poverty and desertification. Teen [32] in his studies also revealed that the original state of dry-land used for animal herding would remain sustainable as long as relatively few people are herding across large areas. But when the population and land pressure increases with too many animals overgrazing, destroying vegetation, and downward spiral desertification would start. Furthermore, when people add farming without using fertilizers, the soils are further impoverished.

#### L. Gaps in Literature

Desertification is the encroachment of the desert on land that was once fertile or the process by which natural or human causes reduce the biological productivity dry-lands (arid and semi-arid lands). The concept does not refer to the physical expansion of existing desert only by also the various processes that threaten all dry-land ecosystems. There have been several research studies on desertification with more emphasis on the frontline states environment to Sahara Desert with little or no attention to the middle belt environment. This phenomenon may not be unconnected with the absence of adverse effects of desertification. It is the gap that his study would like to fill with the aim of publicizing the phenomenon to the people of the environment and the government so that remediation measures could be taken in earnest, because the symptoms of this catastrophic environmental transformation have started rearing its ugly heads, it must be checked before it gets too late.

### III. STUDY AREA

The Adamawa north area is generally called Mubi region which has five local government area of Maiha, Mubi South, Mubi North, Michika and Madagali. Mubi region, bordered by Cameroun republic in the east, Borno state in the north, Hong local government area in the west and south. Mubi region is geologically situated within the north east basement complex zone of Nigeria. The relief is 400m to 500m above sea level which comprise of hill and mountain ranges on the east bordering Cameroun republic adjoined by undulating high plain ranges on the numerous valley lowlands and dissecting the lowland zones of the high plains lie stream channels that form the natural drainage system and river Yadseram as the main drainage channel of the region.

The region has a tropical wet dry season with a slight cool period between the months of November to February. The monthly temperature ranges from 25°C in cold months and 31°C in hot months. The local effects of the altitude in temperature is responsible for the fair lower temperature of the area compared with the central part of Adamwa and Yola in particular. The Mubi region was once under the United Nations Territory, commonly referred to as Northern Trust Territory which was politically annexed to Nigeria as a separate entity as

Sardauna province in 1960 following the United Nations plebiscite. The major ethnic groups that inhabits the regions include Margi, Gude, Nzanyi, Higgi, Kilba, Fulani and pockets of other ethnic groups that originates from other parts of Nigeria like Hausa, Igbo, Yoruba, including people of neighbouring countries of Cameroun, Chad and Niger. The population of the region as at 2006 National Population Census was 687,353. The main occupation of the inhabitants are peasant farming, livestock farming, seasonal fishing and hunting. There are no manufacturing or mining industries of big commercial outlays and only few or inadequate basic infrastructural facilities like schools, good roads, electricity, health service and non-existence of water supply. Though the inhabitants are industrious, that naturally abhors idleness and begging, the poverty level, mortality level, disease and unemployment rates are still very high due to long term neglect and bad governance.

IV. MAJOR FINDINGS OF THE STUDY

In carrying out this study, questionnaires were prepared and administered on purposefully targeted group of respondents aged 50 and above, with the belief that the group have seen the past, and present environmental changes that has occurred over the years. The response from the field work are hereby analysed using various tools of statistical analysis. A total of fifty questionnaires were distributed, however, only forty-five were recovered. Therefore, the analysis is based on the number of questionnaires returned.

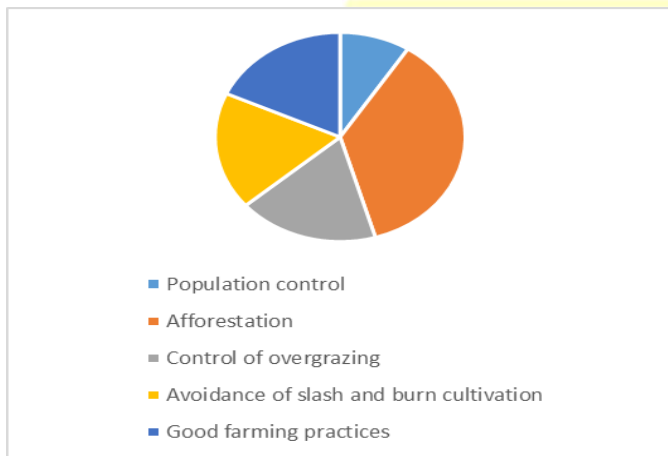


Fig. 1. Factors that contribute more to the incidence of desertification in Adamawa North areas.

The result of the responses indicates that deforestation has a very good role in the incidence of desertification, slash and burn cultivation also has its own role, but the combined effects of all factors that contributes to desertification has more than 50% of the pie chart as shown in figure 2. It therefore means that other factors like overgrazing, over-cultivation and climate change are inclusive in the causes of desertification in Adamawa North areas.

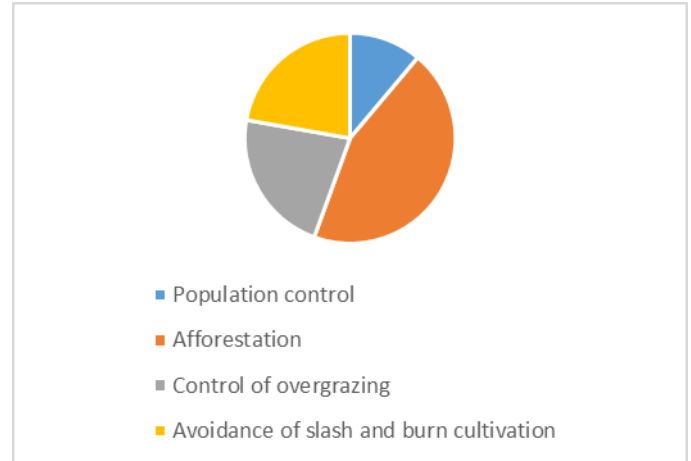


Fig. 2. Common effects of desertification on the land in Adamawa North areas.

Based on the responses of the respondents, shortage of adequate water is one of the commonest effects of desertification on land in Adamawa North areas. This is evident in the fact that rivers that used to retain water all year round have dried up. Consequently, this has led to loss of fauna and wildlife in Adamawa North areas. Forty or fifty years ago, animals like lions, monkeys, elephants, antelopes, zebras and many other wildlife species were commonly found and were serious threats to domestic animals as well as human beings, however, today, the story is different.



Fig. 3. Effects of desertification to Man in the environment.

The analysis of the responses show that desertification has brought about increase in temperature, decrease in rainfall which by all practical evidences resulted to low yield of crops. Farmers have confirmed that a piece of land that used to produce 5-10 bags of maize now hardly produce 3-6 bags of the same crop. Another effect of desertification to man is that the abundance of varieties of trees and other shrubs and grasses that have medicinal value for varieties of diseases have either disappeared or are marginally available. In addition, the environments which used to be very beautiful and densely forested co-habiting varieties of birds, insects and other animals is now a shadow of its past.

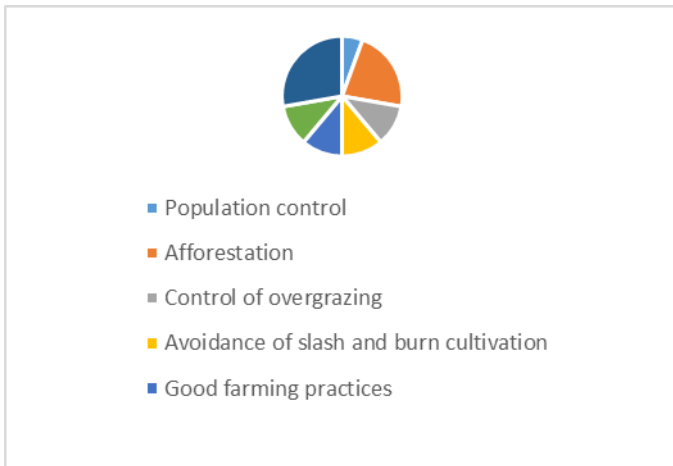


Fig. 4. Visible signs of Desertification in Adamawa North areas.

The visible physical features of deserts that used to be peculiar to Sahel regions of Borno, Yobe Katsina, Kano, Jigawa, Gombe, Sokoto, Bauchi and Kebbi are gradually rearing their ugly heads in Adamawa North areas. The ground water level is now low, and the surface water dries up faster than usual, biodiversity is very low since the disappearance of the forests. Sand storms are now very common and windy particularly in the dry season. There is now a delayed raining season as against the past which starts in April. It appears therefore from the analysis all these symptoms of deserts are now common features of the environment particularly in the northernmost part of the region.

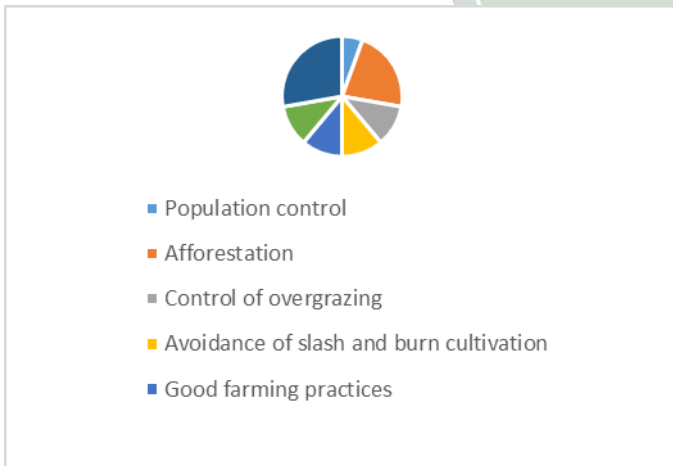


Fig. 5. Means of Controlling Desertification in Adamawa North areas.

Based on the responses, all the various factors mentioned are equally important in the control of desertification, however, afforestation is the most effective means of controlling desertification so far. It is being advocated even in places where the situation is worse. Other important variables that can be used include control of population which will decrease pressure on the forests as well as fuel, control of overgrazing which gives a lot of pressure on the forests as well as land leading to their degradation. Avoidance of slash and burn cultivation as well as good farming practices are also important in controlling desertification. Alternative source of fuel, using solar system or safe cooker will surely reduce the rate of deforestation, because there will be little need for felling trees.

V. EMPIRICAL ANALYSIS OF DESERTIFICATION

The empirical analysis of desertification was employed using a probit model for the analysis. This was necessitated by the fact that the dependent variable, desertification, is a dummy variable taking values of 0 or 1 for absence or presence of desertification over a certain number of years (1992-2012). The model used for the analysis is given as follows:  $Y = f(rf, tmp)$

It can also be expanded as;  $Y = \alpha + \beta_1rf + \beta_2tmp + U_i$

Where,

Y = is dummy for desertification

$\alpha$  = is the intercept

$\beta_1$  = is the slope parameter for rainfall

$\beta_2$  = is the slope parameter for temperature

$U_i$  = is the random error term (disturbance term)

The research adopted the probit model as an appropriate technique for the estimation of the relationship between desertification, which is a dummy (taking on values of 1 or 0; for observations of desertification or otherwise) and rainfall and temperature. In other words, the regressand (dependent variable) is a binary or dichotomous variable. In models where the regressand is a dummy variable, Ordinary Least Squares (OLS) technique is unsuitable, rather the probit/logit models is more appropriate for such models.

Below is the regression result obtained for the analysis of the secondary data used in the analysis of empirical relationship between desertification and rainfall and temperate for Adamawa North areas.

$$P = 14.1249 \quad -0.000134rf \quad -0.5169tmp$$

$$S.E (12.60527) \quad (0.000825) \quad (0.476905)$$

$$McFadden R^2 = 0.290472$$

From the estimates obtained, it is obvious that there is a negative relationship between the probit and the variables in the model (rainfall and temperature). In the probit model, intercept (14.1249) is the estimate of the probit when the slopes (rainfall and temperature) are held constant at 0. The slope  $\beta_1$  of rainfall (-0.000134) represents the change in rainfall. Therefore, if rainfall should increase by 1mm, the probit will go down by 0.000134, holding other variables constant. The slope  $\beta_2$  of temperature also indicates the change in the probit if there should be a change in temperature by 1°C, the probit will go down by 0.5169. However, the McFadden  $R^2$  is quite low 29%, its relevance in the probit/logit models are usually not too significant. Testing the joint significance of the model here is necessary. The likelihood ratio (LR) is the equivalent of the F-test in a probit model for testing the overall significance of the model. The null and alternate hypothesis are given by;

$$H_0: \beta_1 = \beta_2 = 0$$

$$H_1: \beta_1 \neq \beta_2 \neq 0$$

In the probit models, X2 distribution table is used as a basis for decision making regarding the overall significance of a model. At 5% level of significance, the (LR) statistic is significant, which implies that the overall model is significant. The probability of the (LR) statistic is 0.36.

## VI. POLICY RECOMMENDATIONS

From the results obtained, the following are recommended for implementation in Adamawa North areas.

- For effective afforestation, competitive afforestation or tree planting exercise for a reward should be introduced among all schools from primary to secondary as well as community based exercise with supervisory or evaluative commission from the state. This exercise will minimize or eliminate annual tree planting exercise by state government that ends up in futility because of lack of care.
- There should be a practical and effective legislation with regards to felling of trees, usage and replacement of trees without discrimination in all parts of the state.
- Over grazing resulting from influx of cattle and other animals from other countries, Nigeria inclusive should be regulated, and education should be provided on modern ways of raising animals and be enforced.
- The various environmental agencies, which have been confirmed to be ineffective by responses from the field, should be made to be very effective and people oriented, so as to ensure compliance with environmental laws in Adamawa State.

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