Climate Change and Harsh Weather Conditions in Developing Countries: Implications on Water Resources, Public Health and Food Security

E.I. Okoyeh, B.C.E. Egboka, O.L. Anike, E.K. Enekwechi and I.C. Mjemah.

Abstract - The changes in weather and climate in Nigeria and other developing countries have precipitated ecological and health problems. Variations in rainfall pattern/amount have resulted in negative implications on water resources, agriculture and food security. Surface waters are affected by the prevailing climate change resulting in the drying/total loss. Excessive evaporation with attendant heavy rainfall causes water pollution/contamination, erosion and landslide. Low crop yields due to change in rainfall amount results in food insecurity and increase in poverty. The sudden severe climatic changes with attendant rapid southward desert encroachment encourage migration. Many ensuing diseases such as malaria, meningitis, diarrhea, bronchitis, asthma, eye problem, cholera and typhoid attributed to the recent climate change are commonplace. The resultant implications are more severe in the rural areas and disproportionately affect the rural poor especially women and children. Public health and food security implications of the recent climate changes are yet to receive the deserved attention. The ecological scourge of heat waves, desertification, windstorms, flood disasters, soil and gully erosion and pollution of water resources require multi-objective and integrated approach and management measures. Involvement of expertise from relevant fields in climatic change study for the containment of the resultant global implications is recommended.

Index terms – water resources, public health, food security, climatic change, ecological hazards

1 INTRODUCTION

The implications of climate change on fresh water, public health, agriculture and food security is on the increase and better appreciated on consideration of the huge losses associated with it. The variation in the onset and cessation of rainfall has raise concern and currently noticed in many parts of Nigeria (Fig.1). Excruciating impacts of heat wave/high temperature, which ranges between 270C to over 400C in recent times has been attributed to the release of green house gasses from fossil fuel into the atmosphere. The heat wave causes painful irritation of the eyes, nose and the whole body. Excessive dust storms at this period may impair visibility hence, making land and air transportation hazardous. Soil quality, crop yield and food supply are equally not spared due to changes in climate and weather conditions.

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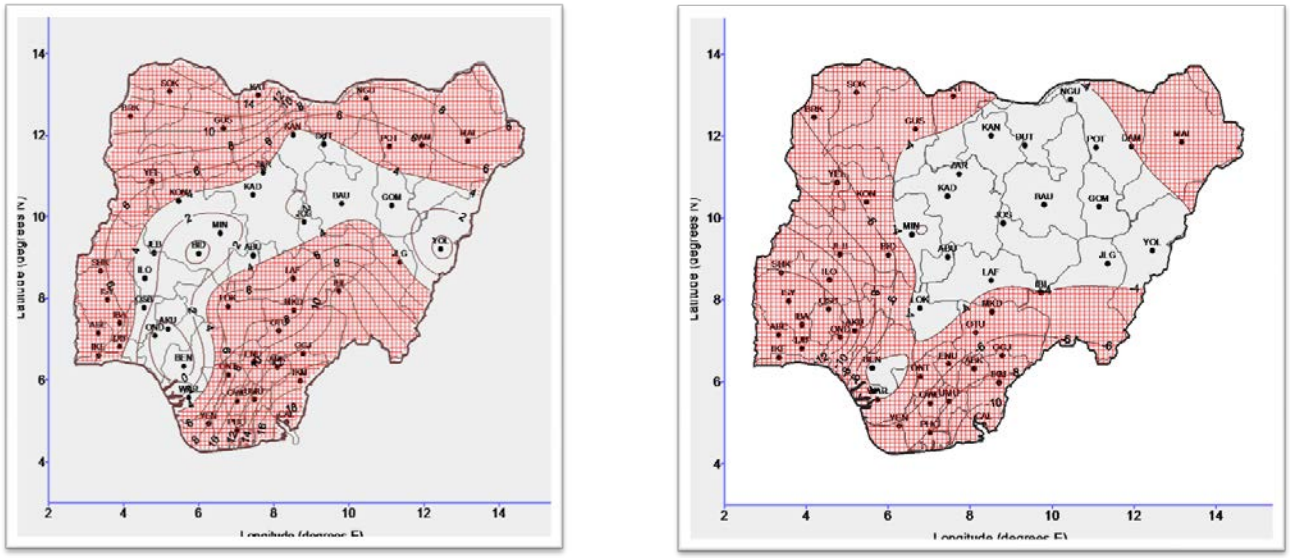
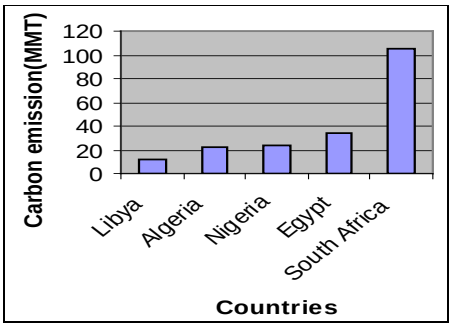


Fig. 1. Late Onset and Early Cessation of rain now affect many parts of Ngeria. (source Anuforom, 2009)

Lowering of watertable in shallow aquifers with attendant effect on groundwater discharge has resulted in loss of surface waters exacerbating the impacts of climate change on water resources availability. Although adaptation is perceived as being very important to protect societies against the effects of climate change and variability, the statistics reveal a disproportionate impact in developing countries and less-favoured population [1]. Funding climate change related researches for the realization of effective adaptation measure is required and the implementations of environmental policies are recommended.

2 CLIMATE CHANGE AND HARSH WEATHER CONDITIONS IN NIGERIA

Climatic changes are wildly/globally attributed to the release into the atmosphere Green House Gases (GHG) from fossil fuels and from other similar anthropogenic activities. These gases such as carbon dioxide, methane, chlorofluorocarbon, nitrous oxides etc affect the heat intensity of the earth surface by forming a thick cover above it. The gasses allow for the penetration of the radiation from the sun into the earth surface and absorb the heat released from the earth surface thereby keeping it abnormally warm. Nigeria is bound to experience substantial impacts of climate change commonly referred to as global warming since her economy is largely dependent on fossil fuel [2]. Carbon emission through gas flaring and other energy sources affect the total environment of Nigeria (Fig. 2). The impact of climate change in Nigeria is also exacerbated by the high rate of deforestation for fuel wood (Fig. 3).



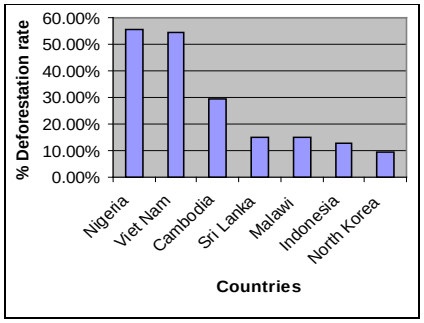


Fig. 2. Carbon emission in 2001 (Source EIA, 2003)

Fig. 3. Deforestation rate of primary forests, 2002-2005 (Adopted from Butler, 2005)

2.1 CLIMATE CHANGE AND FOOD SECURITY IN NIGERIA

Over 60% of Nigeria working population are employed in the agricultural sector, majority, especially in the rural areas been subsistence farmers. The seasonal annual rainfall distribution of over 2000mm in the southeast and less than 500mm in the northeast affects agricultural practices and food supplies. Shift in the long-term rainfall mean toward more arid conditions result in adverse implications on water resources availability and food supply. While some crops can be grown in a wide range of channels, many others require specific conditions as a result; cereals such as rice, maize, corn, millet, sorghum and tubers such as cassava, yam, cocoyam, and potatoes remain the major components of agricultural food produce in Nigeria. The seasonal distribution of rainfall and the recent prolonged dry season also impacts negatively on the activities of northern dwellers. The annual dry season is often preceded by longer periods of drought that adversely affect the dense population in the north especially the rural subsistence households.

2.2 WATER SUPPLIES AND PUBLIC HEALTH

Substantial impacts of climate change abound in both physical and ecological environments of Nigeria (Plate 1). Long absence of rainfall results in sharp droop in agricultural activities with consequent unemployment. Depletion of watertable in shallow aquifers, destruction of catchments, siltation of reservoirs and drying up of surface water supplies are commonplace. Inaccessibility and lack of adequate water supply for domestic purposes impairs hygiene with attendant public health implications. The spread of malaria is exacerbated due to the availability of enabling environment resulting from climate change that encourages the breeding of mosquitoes. Climate change with resultant increased average temperature in some areas has lead to heat related illness. Human ailments and debilitation in form of meningitis, blindness, cough, catarrh etc are on the increase. Global environmental changes are likely to further affect health potentials, as immune suppression is associated with ozone depletion. Food and water insecurity is also predicted with declining freshwater and food producing ecosystems [3].

Quest for urbanization/development often without adequate planning excruciates the impacts of changing weather condition. Environmental hazards with attendant heavy toll on human welfare associated with the recent climate change have been experienced in different parts of Nigeria at different magnitudes. The coastal areas are under the sage of flood menace. The highly populated deltas of Nigeria that are under sea level are at risk of flooding as a result of anticipated sea level rise due to climate change. The 1999 flood incidence in Lagos, Abeokuta, Delta and Edo states of Nigeria respectively recorded many looses while 800,000 people were affected by flooding incidents in 14 countries of West Africa in 2007. In 2012, over 8 local Government areas of Anambra State Southeastern, Nigeria were affected by severe flood incident. The seasonal heavy rainfall also exacerbates erosion menace that deteriorates soil quality. Soils are loosened, surface water dried up and wind erosion is predominant. The unsuccessful effort to combat most environmental hazards such as flooding ensuing from climate change has been attributed to lack of understanding of the dynamics of the characteristics of the environmental varieties particularly weather and climate [4]. Unplanned physical expansion that encourages property development on natural pathways of runoff obstructing water flows exacerbates the implications of climate change in Nigeria.

Pic. 1. Climate change and soil degradation

2.3 QUESTIONNAIRE STUDY

The analysis of the questionnaire randomly distributed among the inhabitants of some communities in southeastern Nigeria indicates that the climate change is also appreciated in the rural areas. 100% of the respondent acknowledged the recent climate change with its associated water, health, and food security problems. Over 40% and 50% of the respondent respectively have neither idea of the major causes of the changes nor knowledge of how to tackle the ensuring problems (Fig. 4a & 4b)

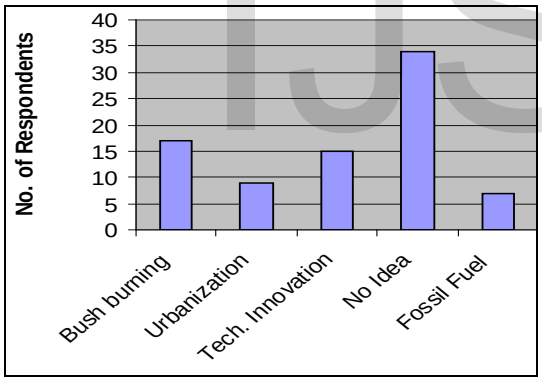


Fig.4a Causes of climate change

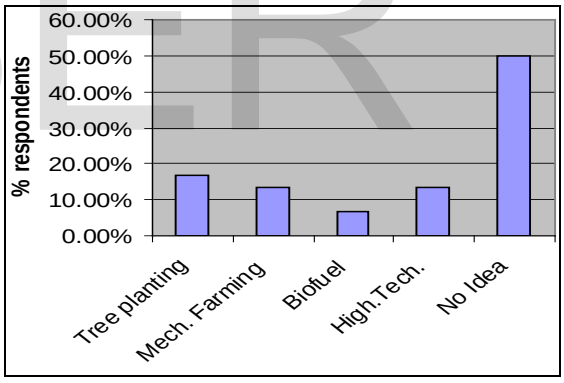


Fig.4b Suggested Remedial measures

The percentage of the respondent who attributed the change to carbon emissions from fossil fuel attended high institutions while over 16% of the respondent in the rural areas associated the change to deforestation for fuel wood. Table 1 and 2 show the educational status and age distribution of the respondents respectively while Fig. 5 represents the sex distribution across the respondent.

TABLE 1. THE EDUCATIONAL STATUS OF THE RESPONDENTS

	No. of occurrence	Percentage occurrence (%)
No formal education	36	43.90
Primary school	25	30.49
Secondary school	12	14.63
Polytechnic	2	2.44
University	7	8.54
Total	**82**	**100**

TABLE 2. AGE DISTRIBUTION OF THE RESPONDENT

	Class Mark (x)	Frequency (f)	Fx
11-20	15.5	18	279
21-30	25.5	15	382.5
31-40	35.5	10	355
41-50	45.5	14	637
51-60	55.5	11	610.5
61-70	65.5	9	589.5
71-80	75.5	5	377.5
	Total	82	3231

The mean age distribution of the respondents is as given below:

$$\frac{\sum fx}{\sum f} = \frac{3231}{82} = 39.4$$

From the above result, the mean class age is 31-40 years

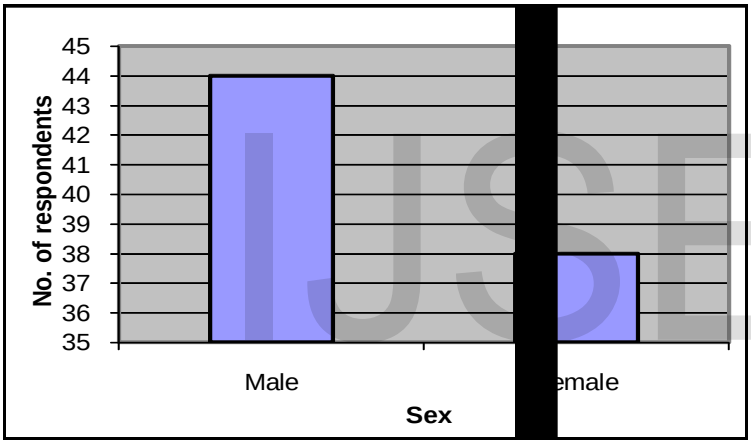


Fig. 5 Sex distribution of the respondents

The high values in Figs. 4a and 4b above are indications of the level of awareness of the recent global issue in the developing countries such as Nigeria.

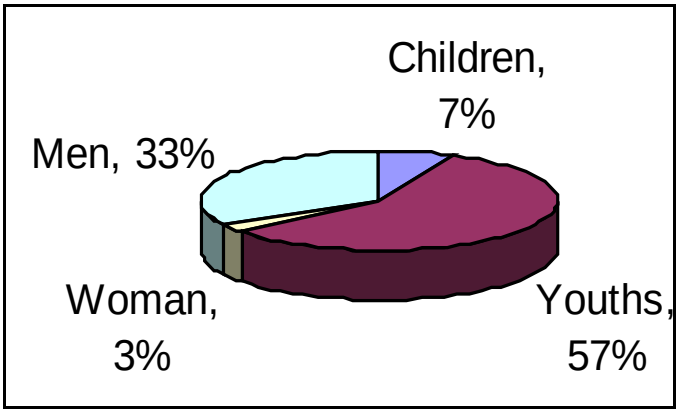


Fig. 6. The % of people least affected by climate changes by the respondents

The women and children are the most affected of the climate change in the area (Fig. 6) and the same is applicable in other developing countries. Generally the poorest populations and marginal groups are impacted the most; nevertheless, there can be a differential effect on men and women as a consequence of their social roles, inequalities in the access to and control of resources, and their low participation in decision-making [5]. Women understand better the causes and local consequences of changes in the climatic conditions [6] and are in a better position as a result of their domestic activities to note certain environmental hazards as such, their knowledge and experience should be considered when planning adaptation processes for vulnerable communities [5]. This is confirmed by the excruciating burden of domestic water supply on women and children that is exacerbated by the change under study.

3 CLIMATE CHANGE AND HARSH WEATHER CONDITIONS IN TANZANIA

3.1 CLIMATIC CONDITIONS

Tanzania's climate ranges from tropical to temperate in the highlands. Average annual precipitation over the entire nation is 1,042 mm. Average temperatures range between 17°C and 27°C, depending on location. Natural hazards include both flooding and drought. Within the country, altitude plays a large role in determining rainfall pattern, with higher elevations receiving more precipitation. Generally speaking, the total amount of rainfall is not very great. Only about half the country receives more than 762 mm annually [7]. The country has two distinct regimes, Bi-modal in northern Tanzania, with long rains between March – May and short rains between October – December, and a single rainfall between November – April in the south of the country (Fig.7).

Analysis of recent climate trends reveals that climate change poses significant risks for Tanzania. While projected changes in precipitation are uncertain, there is a high likelihood of temperature increases as well as sea level rise. Climate change scenarios across multiple general circulation models show increases in country averaged mean temperatures of 1.3°C and 2.2°C projected by 2050 and 2100, which are broadly consistent [8]. The sectors potentially impacted by climate change include agriculture, forests, water resources, and human health.

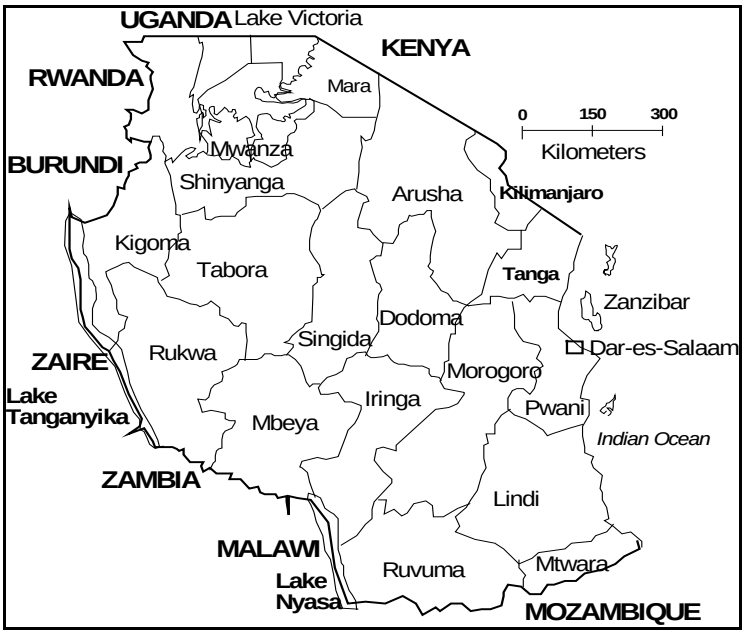


Fig. 7. Administrative map of Tanzania

According to the MAGICC/SCENGEN1 analysis annual precipitation over the whole country is projected to increase by 10% by 2100, although seasonal declines of 6% are projected for June, July and August, and increasers of 16.7% for December, January, February [8]. [7] found that northern and southeastern sectors of the country would experience an increase in rainfall ranging from between 5% and 45% under doubling of carbon dioxide. Whereas, the central, western, southwestern, southern, and eastern parts of the country might experience a decrease in rainfall of 10% to 15%, the southern highlands might similarly experience a decrease of 10%, which could alter the suitability of this area for maize cultivation (Fig. 8).

1 MAGICC/SCENGEN is a coupled gas-cycle/climate model (MAGICC) that drives a spatial climate-change scenario generator (SCENGEN). MAGICC is a Simple Climate Model that computes the mean global surface air temperature and sea-level rise for particular emissions scenarios for greenhouse gases and sulphur dioxide.

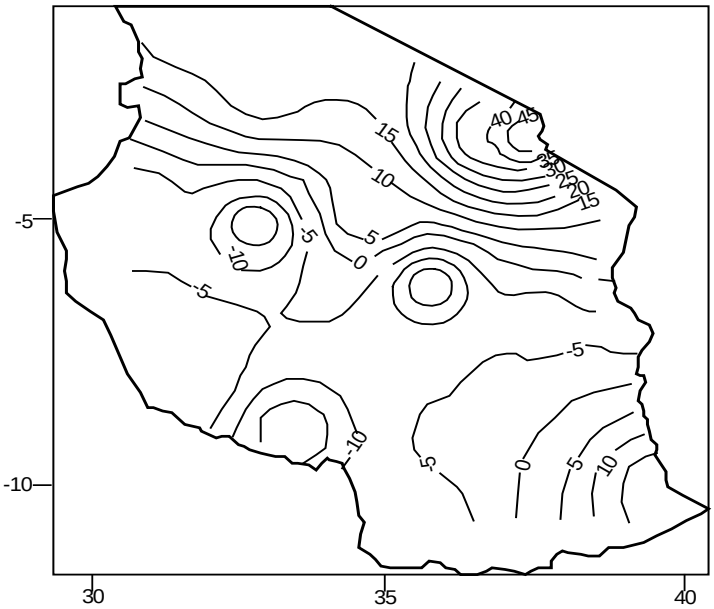


Fig. 8. Change in mean annual rainfall (in %) under 2 x CO2 (Source: Mwandosaya et al. 1998)

3.2 THE CAUSES OF CHANGE IN WEATHER CONDITIONS

The general trend shows that there is an increase of temperature, and furthermore the patterns of seasonal temperature increase are consistent (Fig. 9). Like in Nigeria the causes of climatic changes are attributed to the release into the atmosphere Green House Gases (GHG) from fossil fuels and from anthropogenic activities. The most gases contributing to the global warming include: carbon dioxide, methane, chlorofluorocarbon, nitrous oxides etc.

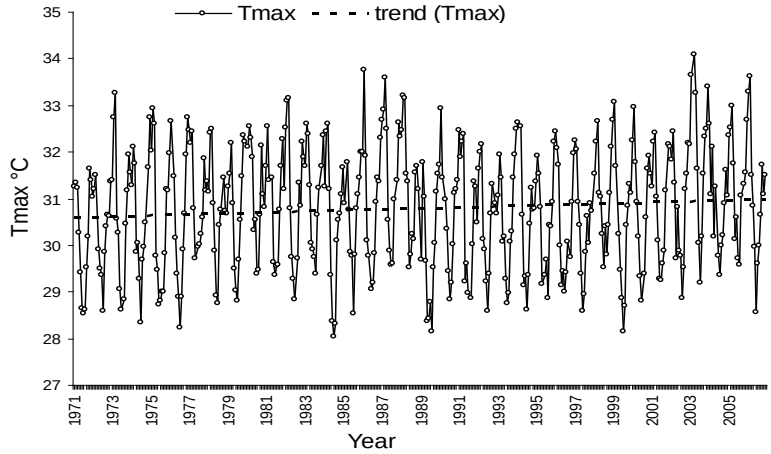


Fig. 9. Mean monthly maximum temperature (Tmax) variation for 36 years (i.e., from year 1971-2006) (Source: Mjemah at al., 2011)

Specifically, greater warming is projected for the cooler months (June-August) compared to the warmer months (December-February) [9]. Changes in the mean temperature and rainfall, and the increased variability of rainfall, are together likely to prolong the length of dry seasons annually and

to increase the severity of periodic droughts. This will be pronounced in the interior part of the country which will be experiencing reduced rainfall. The coastal areas will be less exposed to droughts. However, there the increased mean rainfall, coupled with cyclical variation in it, is likely to result in more frequent and severe flooding. The predicted sea level rise of 0.10-0.90 metres is going to aggravate flooding in the coastal region [10].

3.3 CLIMATE CHANGE AND AGRICULTURE/FOOD SECURITY

Agriculture is clearly the most important sector of the Tanzanian economy. It comprised 45.1% of GDP in 2000 [11]. Upwards of 80% of the population of the country relies directly on agriculture of one sort or another for their livelihood. The climate change has affected agriculture sector in Tanzania. The temperature increases due to global warming has shorten the growing season and, together with reduced rainfall, reduce water availability. Warmer climate can also increase crop losses caused by weeds, diseases and pests. Parry et al. (1999) and [13] reported that Tanzania may suffer a loss of over 10 percent of its grain production by the year 2080 [12]. The cultivation of maize – the most important source of carbohydrates providing about a third of the daily calorie intake – is going to be particularly hardly hit. Maize is a staple crop grown by half of Tanzanian farmers for domestic consumption. If CO2 concentrations will double and temperature increase by 2-4 degrees, the maize yield is likely to decrease on average by 33 percent by the year 2075. In the central Tabora-Dodoma region yields may be reduced by as much as 80 percent and the surrounding areas will also experience larger than average yield reductions [7].

3.4 CLIMATE CHANGE, WATER RESOURCES AND PUBLIC HEALTH IN TAZANIA

The general trend shows that there is a decrease in groundwater recharge rate. As precipitation shows a rather slightly increasing trend with 1.2 mm/year in the coastal region of Tanzania (Fig. 10), it may be assumed that the impact of increasing temperatures (Fig. 9) on decreasing groundwater recharge rates (Fig. 11) is more important. Variations of precipitation on timescales of decades may be significant. The precipitation records from 1971 on (Figure 9) shows an alternation of dryer (1970-1975, 1985-1990, 2000-2005) and wetter (mid 1990s, 1975-1980) periods. Changes in the strength of these cyclic fluctuations can cause systematic trends in the recharge component of the aquifer water balance [14].

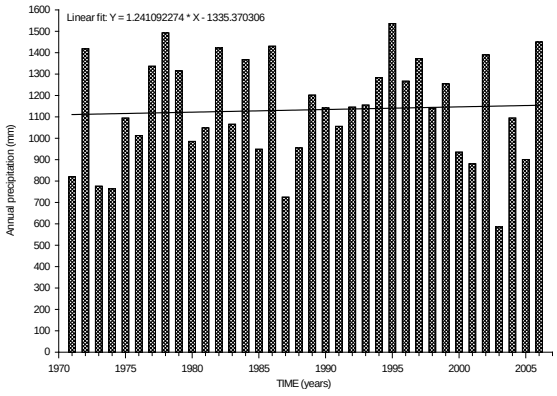


Fig. 10. Total yearly precipitation (in mm) in the period 1971-2006 (Source: Mjemah at al., 2011)

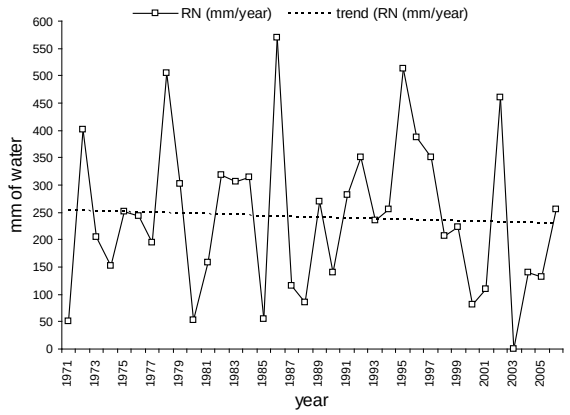


Fig. 11. Annual groundwater recharge rate variation for 36 years (1971-2006) (Source: Mjemah at al., 2011)

Climate plays an important role in the geographical distribution and seasonal abundance of vector species that are responsible for the transmission of a number of human diseases. Changes in temperature, precipitation, humidity, and wind patterns can directly affect vector species' reproduction, development, and longevity. The distribution of vector borne diseases in the human population is also limited by temperature in many regions where the climate is too cold for parasite survival [15]. Warming is increasing the incidence of insect-borne diseases such as malaria, schistosomiasis and trypanosomiasis in Tanzania. Disease outbreaks are known to be often influenced by local weather, but how changes in disease trends might be affected by long-term global warming is more difficult to establish Patz, 2002). The increased frequency of droughts and flooding is in turn likely to increase the frequency and magnitude of epidemics of water-borne diseases such as typhoid and cholera, as well as to influence the incidence of mosquito-borne diseases. Of the various vector borne diseases malaria in particular is a major public health concern in Tanzania. It accounts for 16.7% of all reported deaths in Tanzania and is one of the leading causes of morbidity in all regions, ranging from 24.4% in Rukwa regions to 48.9% in Dar es Salaam [16].

There are also intimate connections between nutritional status and health. In general, malnutrition and food shortages will increase morbidity and mortality related to infectious diseases. Finally, warming will aggravate the impacts of air pollution on respiratory illnesses which already kill as many Africans as malaria and more than diarrhoeal diseases. [10].

4 Conclusion

Due to the massive deforestation that has occurred in parts of southeastern Nigeria where the equatorial rainforest formally predominate the heat waves are directly felt on humans, animals, plants and water resources. The impact is worse in the north where open rangelands are found. The ground and sands are usually very hot making it difficult to walk or sit on. The homes are hot both day and night and difficult to sleep in. Loss of soil quality/fertility, poor crop yield, drying up of surface water and depletion of groundwater abound with adverse effect on human health, water and food security. There is need for mass education of the rural poor to equip them for the impact climate change for sustainable development and for the achievement of the millennium development goals. There is an urgent need for the implementation of environmental policies in order to reduce human vulnerability to the impacts of advancing climate change.

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