Climate change and its health implications at Bongo District of Upper East Region of Ghana

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Abstract

Changes in climate features such as rainfall and temperature have impacts on health and the understanding of the climate changes has the ability to mitigate many of the climate-related diseases. Climate in the Upper East Region is changing and has been validated by appraising rainfall and temperature data for the region from 1954-2014, including the Bongo District and relationship of health data were compared with the climate data. There was relatively steady increase in temperature from 1954-1982 with sharp temperature variations between minimum and peak temperature ranges from 1983-2014. Rainfall amounts showed drastic variations for peak months instead of a same month showing maximum amount of rains irrespective of the year. Using the regression analysis to determine trends showed some diseases to relate to some climate features. The study found diarrhea, skin diseases, malaria, and upper respiratory diseases to increase and relate to climate. It also identified malnutrition to decrease, which may have indirect relationship with changing climate. Causes of some health issues in the district has been recognized to have links of the changing climate of which knowledge of it will help in public health sensitization to mitigate the occurrence and recurrence of the climate-related diseases.

Keywords: Climate change, Health, Malaria, Temperature anomaly, Diarrhea, Bongo

1. Introduction

The long-term good health of populations depends on the continued stability and functioning of the biosphere's ecological and physical systems controlled by the atmospheric envelope of the Earth (References). Thus, the atmospheric conditions of the earth over a short period is referred to as the weather whereas the enveloping gaseous layer conditions over a long period determine the climate. According to Heinlein (1973) 'climate is what you expect and weather is what you get'. From this popular quote it should not be worrisome if the expected weather conditions are changing. However, the changes in climate have become a worldwide scare that everyone is complaining about. The changes in climate come from natural and anthropogenic sources; this makes prediction of related impact very challenging without systematic study. The nature of rainfall and temperature conditions comes with related diseases because any imbalances in rainfall and temperature do impact on human development, particularly on health. Arhin et al. (2015) and Selinus et al. (2004) identified the impacts of natural environment on public health and recognized the impact of climate change on human development. The changes in climate therefore add up to the existing spectrum of environmental health hazards faced by humankind. It is therefore important to evaluate the impact of climate change on health in retrospect to the traditional environmental health concerns in order to design a practicable health baseline database. Before the advent of climate change, environmental health concerns have focused on toxicological or microbiological risks to health from local environmental exposures and pathways. It is worthy to note that global and local climate changes are affecting air quality, contaminating groundwater and surface waters and these are resulting in water borne diseases, vector borne diseases, skin cancers, drought, heat and cold waves that directly or indirectly impact on human health. From IPCC (2007), Checkley et al. (2000) and Lancet (2009) climate change may mean harmful diseases carried by mosquitoes could survive in some areas characterized by more rainfall whilst heat related deaths could occur in temperature environments. They further indicated a greater risk of infections carried by water and food coupled with longer and more frequent drought in some regions causing food insecurity. It is on these bases that the paper reviewed the changes in climate at Bongo area with respect to health so that comprehensive assessments of climate risks to health and health systems in the District can be monitored via environment and health surveillance integration.

2. Location, geology and physiographic settings

The study area is located in northern Ghana, about 20 km north of Bolgatanga, the Upper East regional capital (Fig. 1). From the national capital, it is 760 km via a bitumen road and 510 km from Ghana's second city Kumasi. The District is opened all year through accessible and motorable laterite roads.

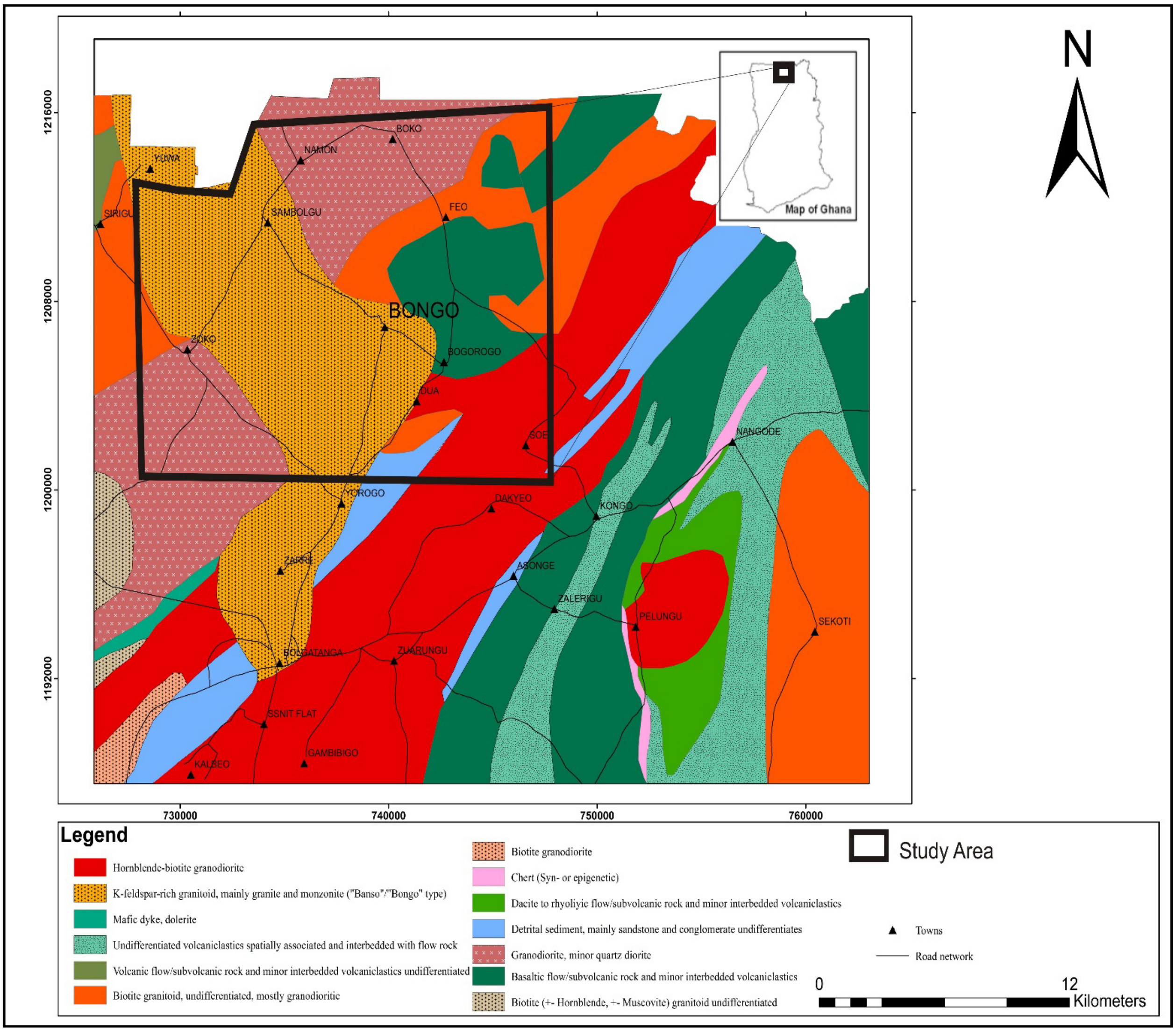

Figure 1 Regional Geology of Bongo District and its Surroundings

It forms part of Bole-Navrongo-Nangodi Birimian Greenstone Belt of Ghana (Fig. 1). The rocks underlying this District and is associated with Birimian Belt and trends generally southwest-northeast but there are some that strikes N-S locally (Kesse, 1985). Underlying the District are metamorphosed lavas and pyroclastics suite of rocks intruded at places by Migmatite bodies and granodiorites (Leube et al, 1990). According to Milési et al., (1989) three types of granitoids in terms of mineralogical compositions; belonging to the belt and basin granites are found in the District. These are mica–rich intrusive varieties which tend to border the volcanic belt and consist of:

(1) Coarse grained porphyrogranites generally consisting of hornblende, biotite-bearing granitoids and Granodiorites with associated quartz veins and dolerite dykes and

(2) Coarse to medium grained microcline–rich granites, foliated and locally referred to as Bongo granites.

These igneous intrusive occur within the metasedimentary package and cover most parts of the District. There are also a third group of rocks containing hornblende-rich varieties that are closely associated with the metavolcanic rocks and known as the ‘Dixcove’ or ‘Belt’ type granitites.

2. 1 Physiographic Settings

2.1.1 Climate and rainfall

Class of climate in Bongo District is Savannah with annual rainfall of about 600-1200 mm (Webber, 1996). The area exhibits single rainy season. The monthly totals increase slowly from March and peak in August after which there is a sudden decrease after October (Kranjac-Bersaljevic et al., 1998). The average monthly rainfall is 986 mm per month. Temperatures are constantly high and averages at 28.6oC. Nonetheless monthly averages range from 26.4oC at the peak of the rainy season in August to an extreme value of 32.1oC in April (Dickson and Benneh, 1995). As it is common for the tropics, diurnal temperature changes exceed monthly variations (Dickson and Benneh, 1995). The total evaporation of 2050 mm exceeds the annual rainfall more than two folds.

3. Methodology

Average climate data for rainfall and temperature from 1954 to 2014 was taken from the office of the Ghana Meteorological Agency, Ghana, for climate change assessment in the Upper East Region where Bongo District is part. Missing data were estimated by linear interpolation of the data of the same months of the adjacent years on either side of the missing value (WMO, 1983). Monthly temperature and rainfall averages for the climate data were compared with the percentages of the annual outpatient visits for some prevalent diseases and climate-related direct and indirect diseases at the Bongo District Hospital from 1985-2014. Necessitating these were reports about increasing temperatures and decreasing rainfall (Field et al, 2012) that may result in reduction in water for drinking and agricultural works (Laube et al, 2012) worsening climate related diseases.

Evaluating the validity of the global climate change in the study area and elucidating the suspicion that changes in climate impacts on human health, the climate data from 1954-2014 were reappraised to establish the status of climate change whilst relationships between climate data and reported health cases at Bongo Health Centre from 2008 to 2014 were assessed using regression analysis method for any linkages. Since response variables were more than one and there was the need to explore their relationship, correlation analysis of climate data and some health issues were used complimentarily to the simple linear regression in order to get the relationship between the three variables and the dummy variables (months).

4. Results and discussions

Results for climate features rainfall and temperature recorded between the years of 1954 - 2014 is presented in Fig. 2. From the Fig. 2 A there is relatively little or gradual change in day temperatures even though the temperature plot demonstrates variations in peak and minimum temperature records over the years. The temperature difference from 1954 to 1982 seems to show steadily upward change with an extreme, haphazard, chaotic contrasting climate change records occurring particularly from 1983 to 2014. The sharp and variable annual minimum and peak contrast between day and night temperatures from 1983 to 2014 will introduce unexpected heat and cold waves that will affect agricultural productions of certain crops and bring indirect and direct climate-related diseases. As quoted by Heinlein (1973) ‘climate is what you expect and weather is what you get’. However with respect to Fig. 2 the unequal and inconsistent daily hot and cold temperatures will present climate-related diseases in addition to environmental health problems which need attention to really understand their impacts on human developments. Fig. 2 B on the contrary showed great variability in measured amount of rainfalls from 1954 to 2014 and depicts decrease in rainfall amounts that may lead to serious indirect health implications.

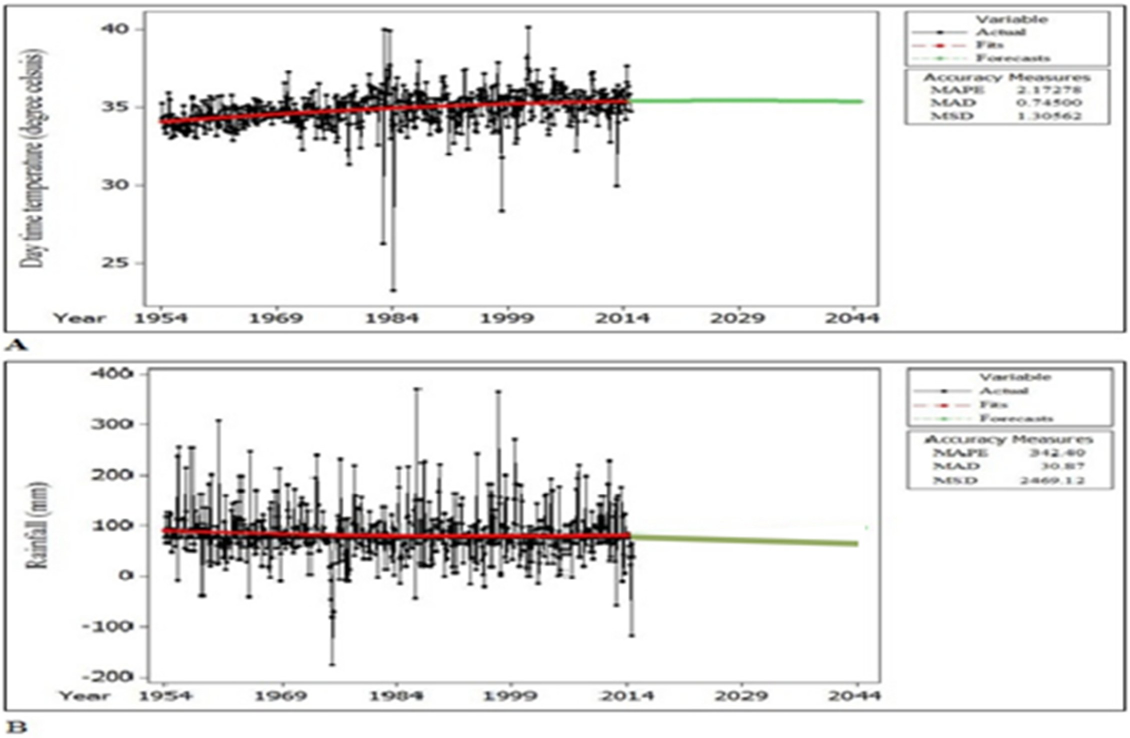

Figure 2 A is trend analysis of Daytime temperature and its long term forecast and B. is trend analysis of Rainfall and its long term forecast

The climate patterns shown in Fig. 2 may influence environmental determinants of health. It is plausible that without effective responses to the rainfall variability coupled with seemingly constant increase in average temperatures will compromise:

1. Water quality and quantity contributing to doubling of people living in water-stressed basins and populations drinking contaminated waters.
2. Food security resulting in yields from rain-fed agriculture being reduced or results in famine and
3. Control of infectious disease becoming increasing difficult as favourable habitats will be created by the changing and misunderstood climate to cause climate-related health issues that will impact on human developments.

From the outlined points 1-3 above, it implies climate change connects to several health outcomes of which some are beneficial and others have adverse impacts in humans. The appraised climate and health data at the study area presented in Fig. 3 shows a relationship between rainfall and diarrhoea. High temperatures were recorded from 2008 to 2014 (Fig. 2 A) suggesting lowering of the water table. This will affect drinking waters in streams, wells and boreholes that served as source of drinking water for the people. Water quality is disregarded because of the water-stressed aquifers, which makes the people to collect and harvest any rain water irrespective of its physical and chemical quality explaining the direct relationship between rainfall and diarrhoea (Fig. 3).

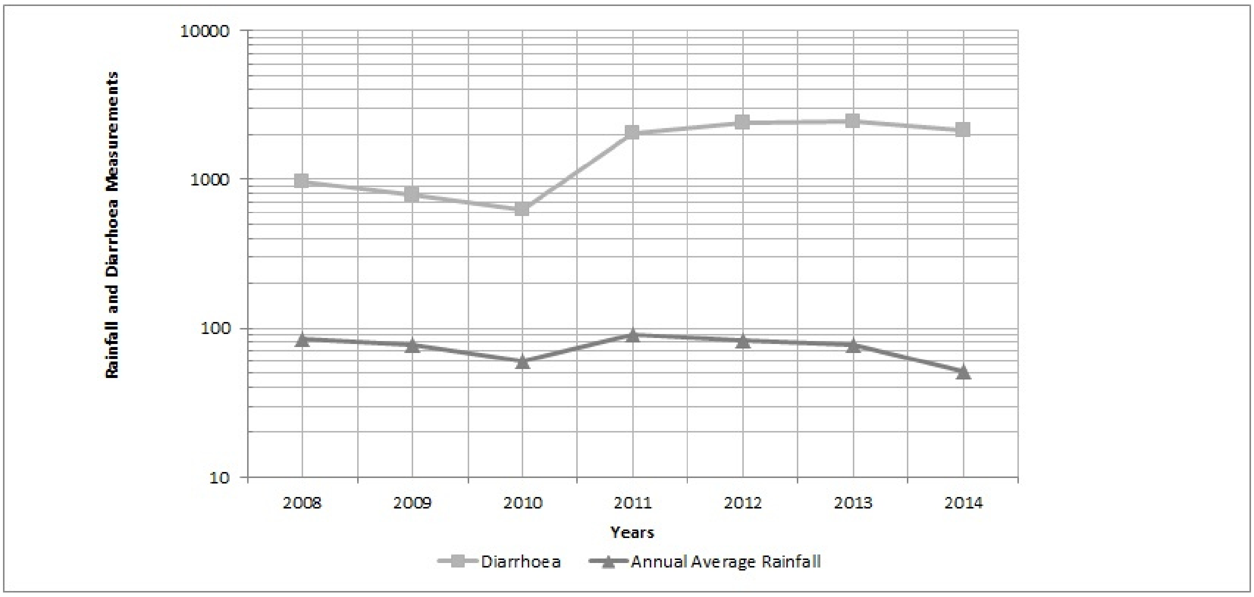

Figure 3 Relationship between rainfall and Diarrhea diseases in Bongo District from 2008-2014

Checkley et al (2000) suggests a relationship between Diarrhea, temperature and rainfall. The rainfall and temperature patterns from 2008 to 2014 with the available health data are presented in Figs. 4 and 5.

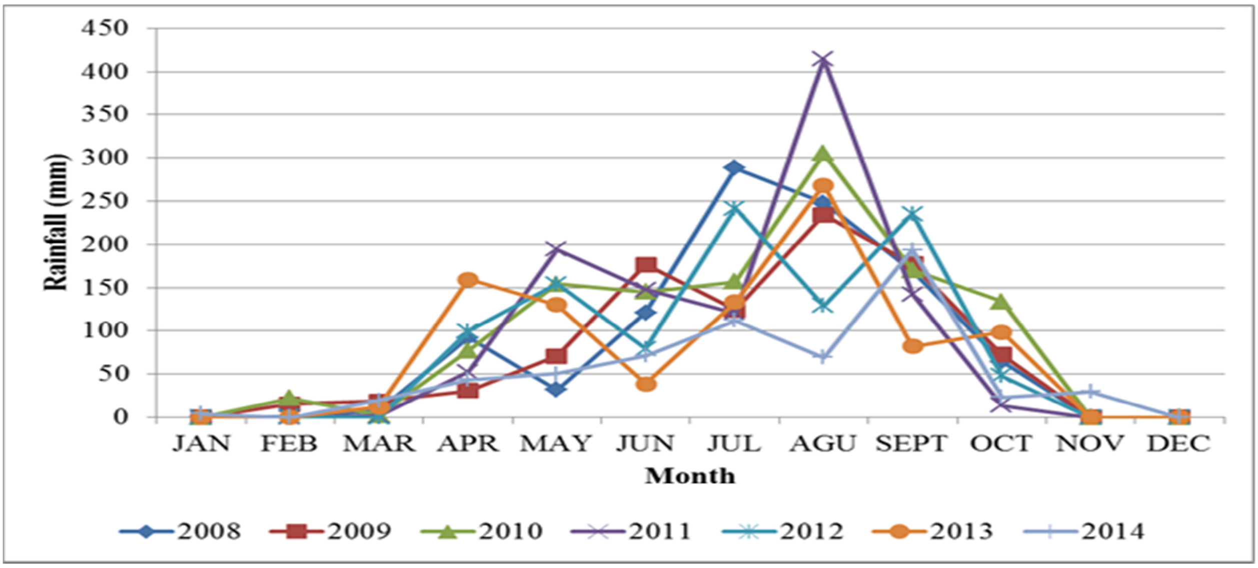

Figure 4 Rainfall amounts and patterns from 2008-2014 in Bongo District

Rainfall amounts and peak rain values vary on monthly and annual basis. Whilst in some years, example in 2011, the peak rainfalls were measured in May for the minor season whilst in the major season the peaks were in August and September. In 2008 there was low rainfall with peak rains occurring in July. There are so many variabilities in rainfall patterns (Fig.4) in terms of monthly peaks and amounts. These can affect many climate-related diseases and agricultural production. For instance, rainfall effects during climate change and vulnerabilities can be complex because heavy rainfall and flooding may trigger outbreaks of diarrhoea in areas where crowding and poverty are present. Also very high rainfall perhaps those in August 2010 and 2011 can reduce mosquito populations by flushing larvae from their habitat in pooled water environments. Good models of the rainfall data can help mitigate diseases such as diarrhoea, malaria, and other related-climate diseases.

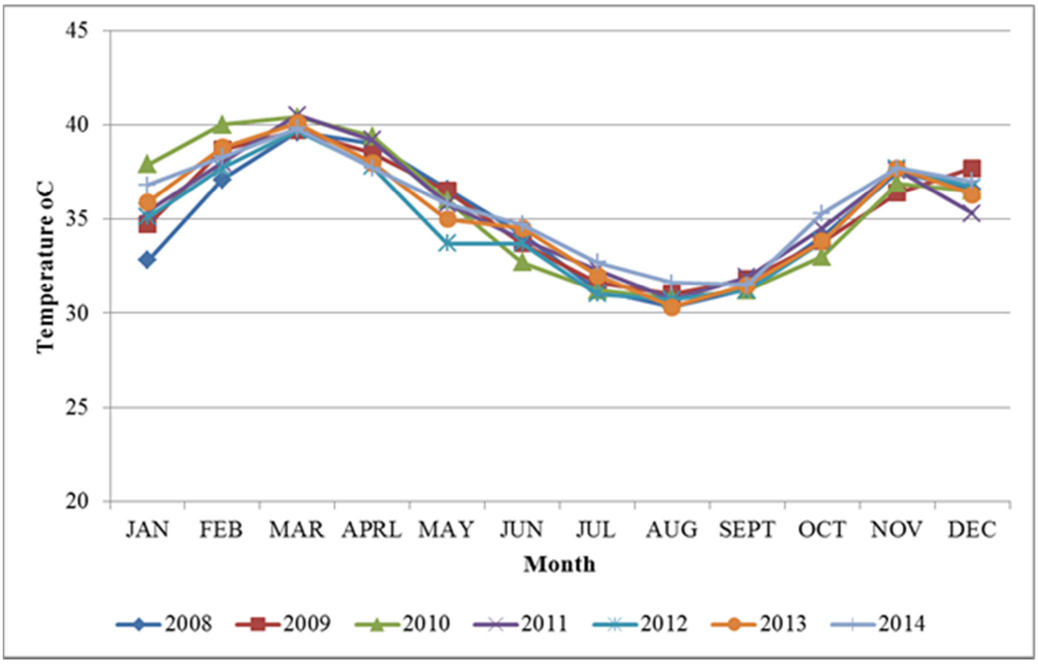

Figure 5 Temperature amounts and patterns from 2008-2014 in Bongo District

The temperature patterns from Fig. 5 shows bimodal pattern. The heat period occurs between January to April with peak temperatures of 40oC occurring generally in March. The second hot period starts from October to December and peaks in November. Many infectious agents, vector organisms, non-human reservoir species, and rate of pathogen replication are sensitive to climatic conditions. Diarrhoea, a climate–related disease as shown in Fig. 6 depicts an increasing trend in the study area.

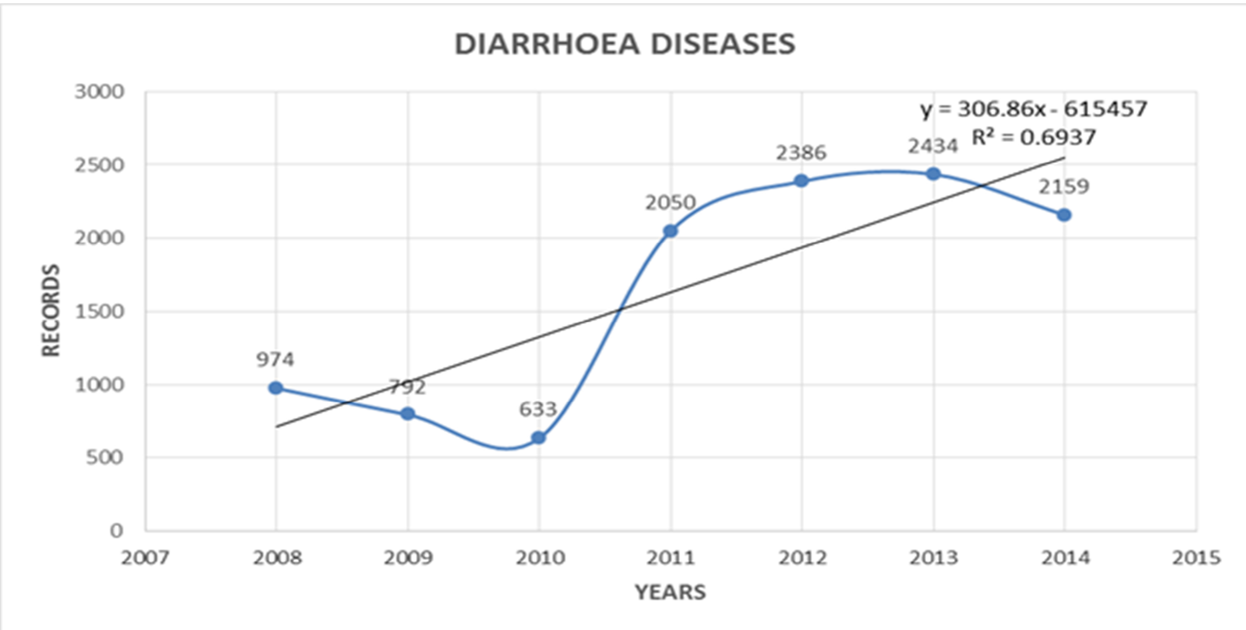

Figure 6 Diarrhoea increasing in occurrence from 2010 to 2015 in Bongo area

The relationship between diarrhoea and average rainfall is presented in Fig. 3. Average temperature shows little variations over the 30 year-period hence might not impact on diarrhoea occurrence in the area. It is imperative that the increases in diarrhoea are attributes of rainfall, coupled with environmental sanitation. The monthly peak temperatures appear bimodal and span over eight month-period. The extensive dry periods as indicated in Fig. 5

will affect the groundwater regime by affecting the recharge as well as the yield and may compel inhabitants to drink contaminated water as the quality of the drinking water cannot be certified to be potable. This probably explains in part the increasing diarrhoea in the area. Similarly climate affects the natural distribution of malaria. From Fig. 7, there is an increasing trend in malaria from 2009 to 2014. This research only looked at the climatic factors on health and not the non-climatic factors.

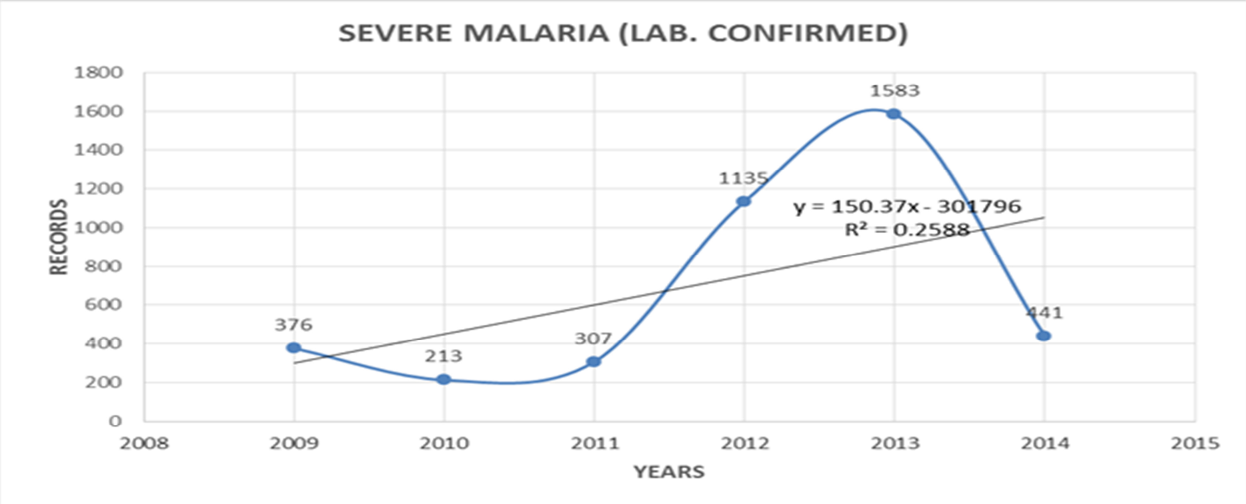

Figure 7 Trend of malaria in Bongo District from 2008 to 2014.

The trend in skin diseases (Fig. 8) increases also for the periods from 2008 to 2014. It is only malnutrition (Fig. 9) that declined over the years under consideration.

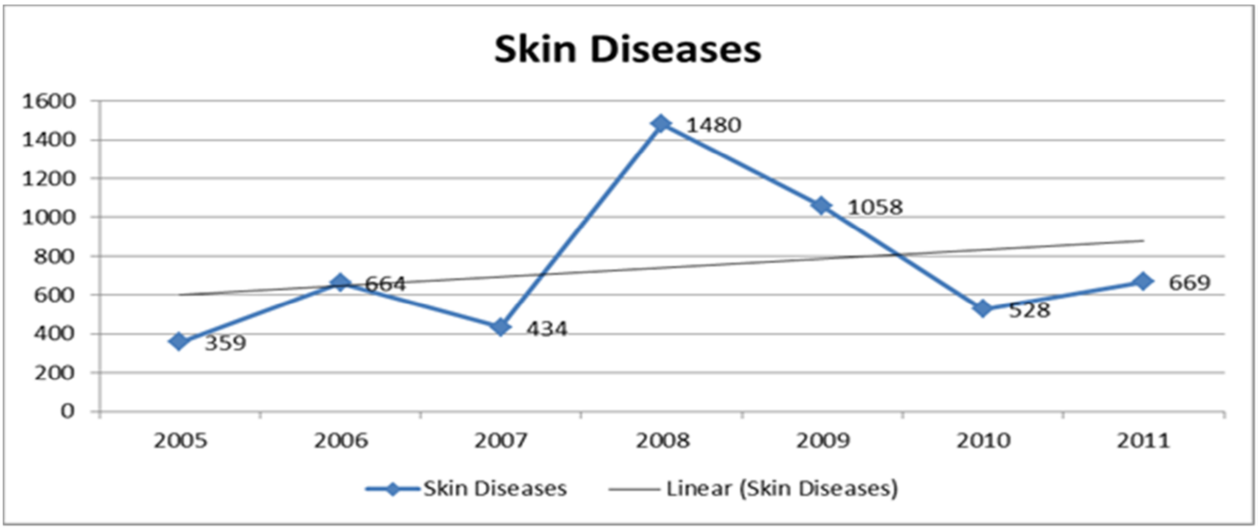

Figure 8 Skin disease patterns for the period ranging from 2008 to 2014

Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.6, No.2, 2016

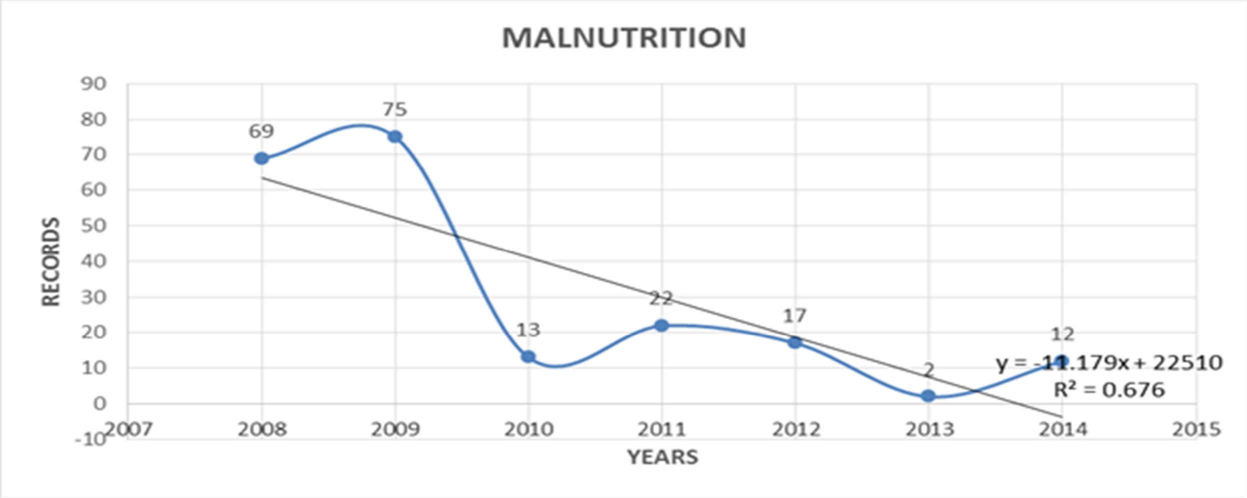

Figure 9 Malnutrition patterns for the period ranging from 2008 to 2014

Climate change impacts on health for five selected climate-related-diseases: malnutrition, malaria, skin diseases, upper respiratory tract disease and diarrhoea are shown in Figs. 10-14 respectively.

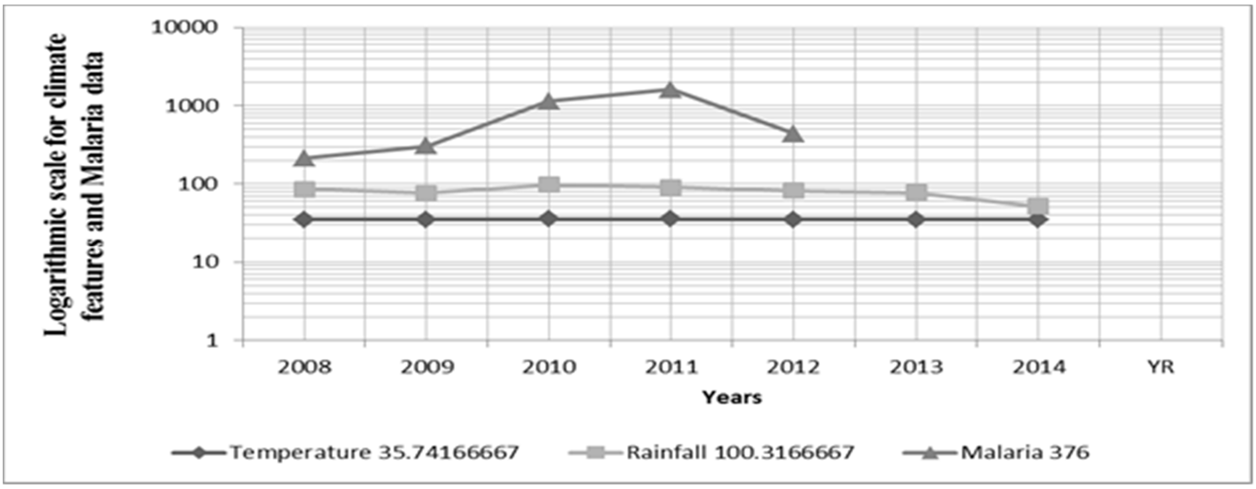

Figure 10 Relationship between malnutrition and climate information

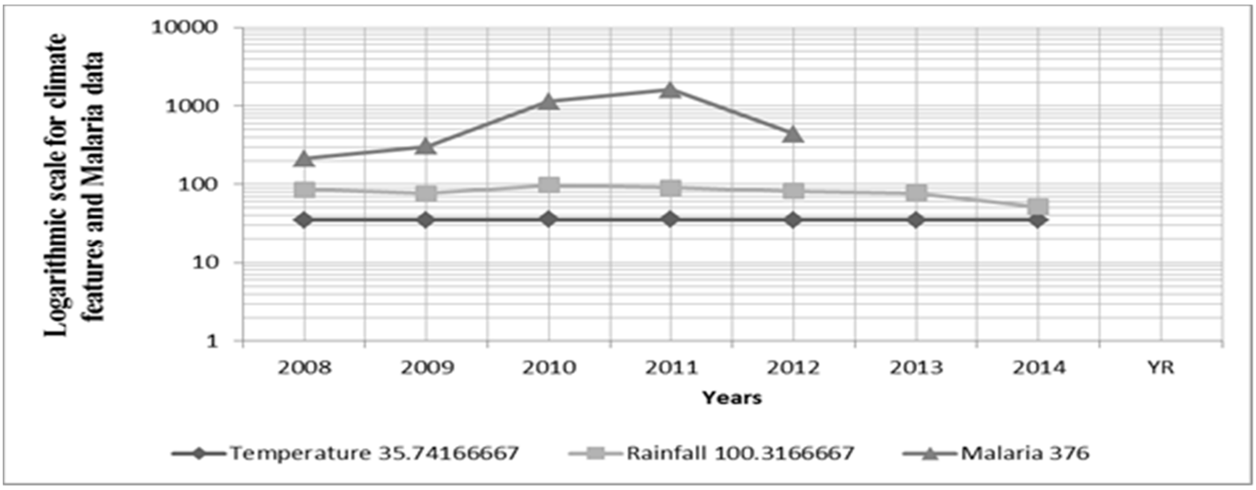

Figure 11 Relationship between Malaria and climate information

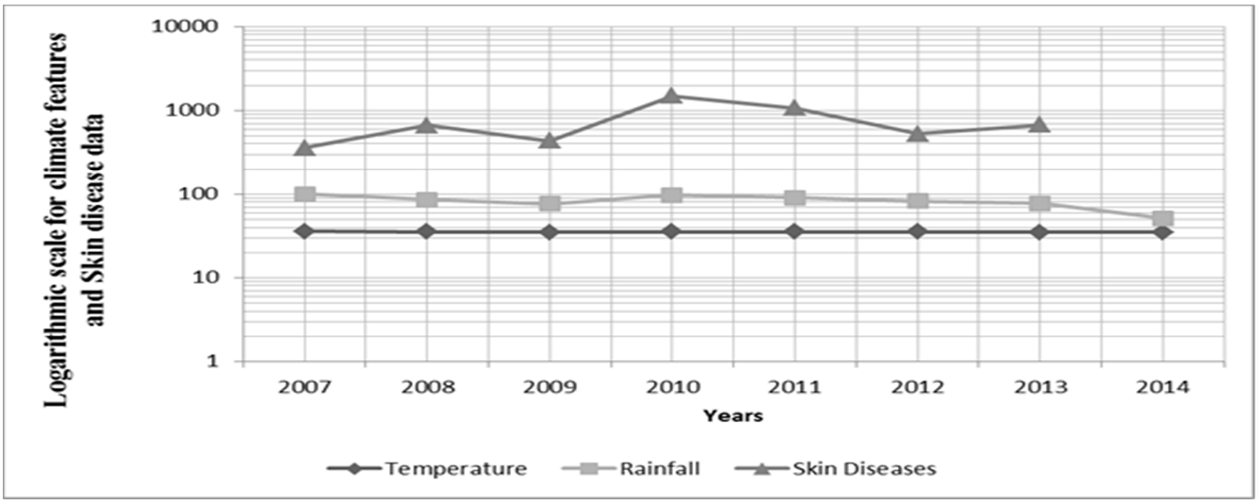

Figure 12 Relationship between Skin Disease and climate information

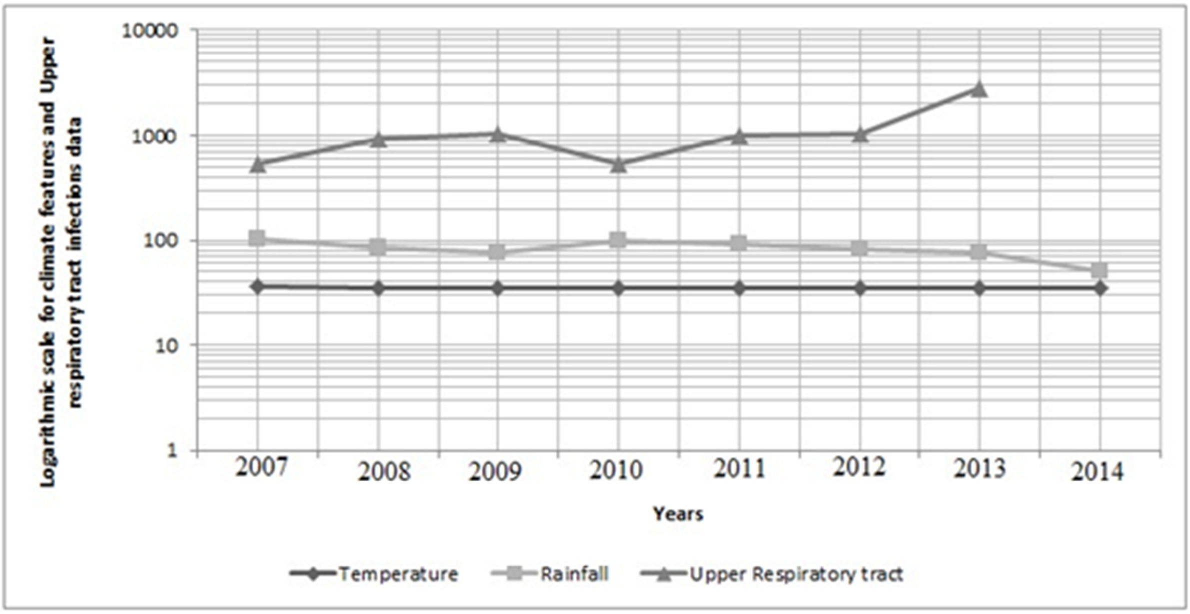

Figure 13 Relationship between Upper respiratory Disease and climate information

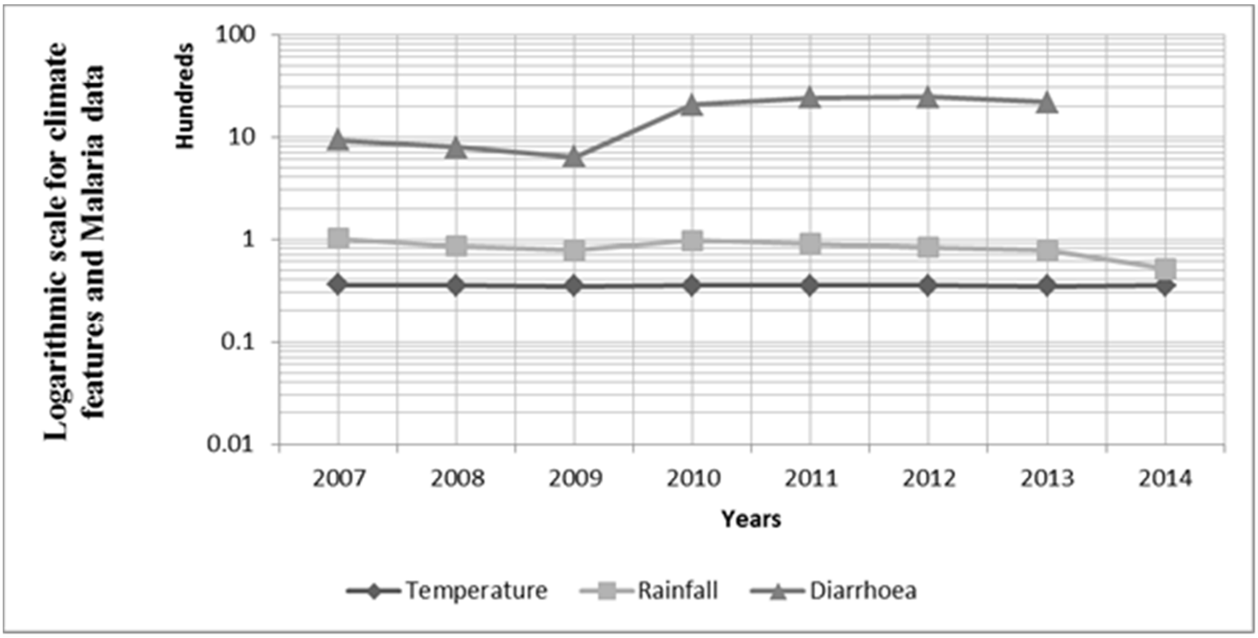

Figure 14 Relationship between Diarrhoea and climate information

According to WHO (2012), between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year, from malnutrition, malaria, Diarrhea and heat stress. Figure 14 shows a positive correlation between increased rainfall and Diarrhea. Heavy rainfall and flooding may trigger outbreaks of Diarrhea in areas with crowding and poverty. Increased rainfall also correlated positively with confirmed malaria cases. This might have been due to the availability of surface water allowing mosquito larvae to breed in abundance. The relationship between respiratory tract infections and rainfall (Fig. 13) shows that when rainfall lessened between 2007 and 2010, respiratory tract infections rose, probably due to airborne spores that would have otherwise been swept away by running water or locked in place by grass. These materials become dry due to the intense heat experienced in the dry season and are easily dispersed by wind. These airborne spores (dust, sand particles, bacteria and virus) may cause diseases like influenza, pneumonia, bronchitis and patients with Asthma suffer increased attacks. Increase in rainfall thus reduces the dispersal of these airborne spores and subsequently results in drops in disease rates. Malnutrition however shows a (negative correlation) decrease over the years with increased rains (Fig. 10) especially in the years of 2009 through to 2013. This trend may be attributed to the production of more food crops and livestock. Similarly the water stressed basins during the long dry seasons in the area results in the inhabitants collecting unsafe waters after rains as drinking water. Also in order to satisfy thirsty conditions in the midst of the heat waves at this period the people drink polluted waters harvested after the rains. This contributes to the worsening diarrhoea situations in the district. The increasing trend of malaria in the area may also be due to climate change and land use. The Plasmodium parasite that causes the malaria reproduces faster inside vector mosquitoes when it's warmer, increasing the infection likelihood when the mosquito bites someone. Patz and Olson (2006) indicate that malaria is an extremely climate-sensitive tropical disease, making the assessment of potential change in risk due to past and projected warming trends one of the most important climate change health questions to resolve. From Pascual et al (2006); land use changes such as deforestation favour mosquito breeding and deforestation is a major issue in the District. If an estimated 700,000 to 2.7 million people die of malaria each year, and 75% of those are African children (www. cdc.gov malaria), then the increasing trend of malaria in the study area call for detailed investigations to stop the relentless expansion of malaria in the area. Additionally, published literature has also suggested that higher temperature associated with climate change could contribute to the development of skin carcinoma (Anderson, 2011). Causes and symptoms of climate-related skin diseases need awareness and further study particularly for the study area where most part of the year is dry and hot.

5. Conclusions

The effects of the variability in weather in the Bongo area have been established in this work. Variable rainfall patterns affect the supply of freshwater which increases the risk of diarrhoea and skin diseases. Increased rainfall also causes floods which contaminate freshwater supplies and increase the incidence of waterborne diseases. Dry weather conditions also affect the health of the people in Bongo. Infections can result from the inhalation of airborne spores and other particles that have been dislodged from dried top soils. However, the study shows a reduction in malnutrition which could be as a results of public health education.

Acknowledgement

The authors wish to thank the District Chief Executive Officer Hon. Alexis Ayamdor of Bongo District for helping in gathering the climate and health data. The second acknowledgement also goes to Ghana Government for paying our Book and Research Allowances (BRA) without which the fieldwork would have been very difficult. Also, to all that contributed directly or indirectly in this study, we thank you so much.

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