International Journal of Environmental Studies and Safety Research
ISSN: 2536-7277 (Print): 2536-7285 (Online)
Volume 4, Number 4, December 2019
http://www.casirmediapublishing.com

EFFECT OF TEMPERATURE ON HUMAN HEALTH AND COMFORT IN GWAGWALADA LGA, FCT ABUJA, NIGERIA

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ABSTRACT
This research assesses the effect of temperature on human health and comfort in Gwagwalada LGA, FCT Abuja, Nigeria. Both primary and secondary source of a data were used for the study. The nature of the secondary data of the study were time series data on climate variable (in this case being temperature) for a period of twenty years (2000-2019). 150 copies of structured questionnaire were administered to 150 and respondents in the study area. The data was processed and analyzed both quantitatively and qualitatively. The qualitative data was analyzed using both descriptive statistics with the help of Microsoft excel, and IBM SPSS statistical package version 26. The descriptive statistics that was used consists of central tendency and the time series trend analysis. The result of the finding revealed that there is an increasing trend in annual maximum temperature and average maximum temperature 62 percent. Majority of the respondents were aware of climate change. The finding also revealed that majority of the respondents agreed that climate change has an impact on human health and general comfort. The finding also shows that increase in temperature (heat) in the area makes residents weak and unable to carry limit performance, and sound sleep. The finding also indicates diseases such as diarrhoea and gastroenteritis, yellow fever, malaria and cholera to be associated with wave in the area. It is recommended that government as all level should play a vital role in order to reduce and tackle discusses associated with high temperature in the area.
Keywords: Effect, Temperature, Human, Health, Comfort

INTRODUCTION
In spite of the achievement of the medical sciences through modern technology, the health of the human population is still influenced to a great extent by weather and climate, (Akinbobola& Omotosho, 2004). Weather variability and health are two vital element of nature that affects daily living, (Whitney, 2009). Weather affects health in a number of ways. These effects may be direct as with heat stress, or indirect, as with infectious diseases such as malaria and Influenza, Chicken Pox etc. (Griffiths 1976; Centre for Human Rights and Rehabilitation [CHRR], 2008). Our increasing understanding of climate change is transforming how we view the boundaries and determinants of human health. While our personal health may seem to relate mostly to prudent behaviour, heredity, occupation, local environmental exposures, and health-care access, sustained population health requires the life-supporting "services" of the biosphere. Populations of all animal species depend on supplies of food and water, freedom from excess infectious disease, and the physical safety and comfort conferred by climatic stability. The world's climate system is fundamental to this life-support (World Health Organisation [WHO], 2003). Today, humankind's activities are altering the world's climate. We are increasing the atmospheric concentration of energy-trapping gases, thereby amplifying the natural "greenhouse effect" that makes the Earth habitable. These greenhouse gases (GHGs) comprise, principally, carbon dioxide (mostly from fossil fuel combustion and forest burning), plus other heat-trapping gases such as methane (from irrigated agriculture,

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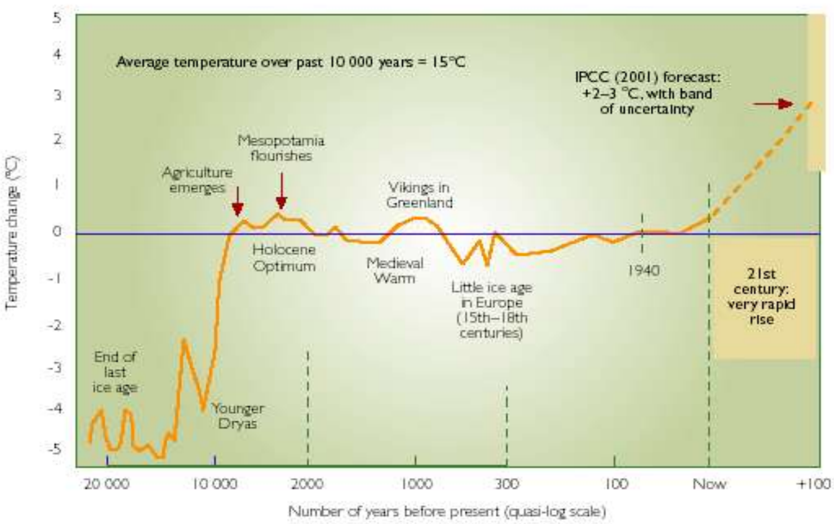
animal husbandry and oil extraction), nitrous oxide and various human-made halocarbons (WHO, 2003).

In its Third Assessment Report (2001), the UN's Intergovernmental Panel on Climate Change (IPCC) stated: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities" (Intergovernmental Panel on Climate Change [IPCC], 2001). During the twentieth century, world average surface temperature increased by approximately 0.6°C, and approximately two-thirds of that warming has occurred since 1975. Climatologists forecast further warming, along with changes in precipitation and climatic variability, during the coming century and beyond. Their forecasts are based on increasingly sophisticated global climate models, applied to plausible future scenarios of global greenhouse gas emissions that take into account alternative trajectories for demographic, economic and technological changes and evolving patterns of governance. The global scale of climate change differs fundamentally from the many other familiar environmental concerns that refer to localised toxicological or microbiological hazards. Indeed, climate change signifies that, today, we are altering Earth's biophysical and ecological systems at the planetary scale – as is also evidenced by stratospheric ozone depletion, accelerating biodiversity losses, stresses on terrestrial and marine food-producing systems, depletion of freshwater supplies, and the global dissemination of persistent organic pollutants.Human societies have had long experience of naturally-occurring climatic vicissitudes (Fig. 1.1). The ancient Egyptians, Mesopotamians, Mayans, and European populations (during the four centuries of the Little Ice Age) were all affected by nature's great climatic cycles. More acutely, disasters and disease outbreaks have occurred often in response to the extremes of regional climatic cycles such as the El Niño Southern Oscillation (ENSO) cycle (Fagan, 1999).

Figure 1.1. Variations in Earth's average surface temperature, over the past 20,000 years



Source: WHO, 2003.

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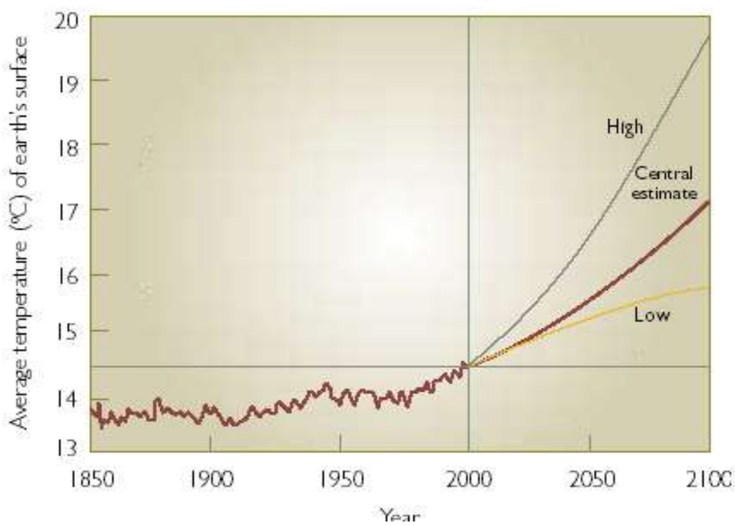
The IPCC (2001) has estimated that the global average temperature will rise by several degrees centigrade during this century. As is shown in Figure 1.2, there is unavoidable uncertainty in this estimate, since the intricacies of the climate system are not fully understood, and humankind's developmental future cannot be foretold with certainty.

Figure 1.2 Global temperature record, since instrumental recording began in 1860, and projection to 2100, according to the IPCC



Source: WHO, 2003.

World temperature has increased by around 0.4°C since the 1970s, and now exceeds the upper limit of natural (historical) variability. Climatologists assess that most of that recent increase is due to human influence. Indeed, changes in world climate would influence the functioning of many ecosystems and their member species. Likewise, there would be impacts on human health. Some of these health impacts would be beneficial. For example, milder winters would reduce the seasonal winter-time peak in deaths that occurs in temperate countries, while in currently hot regions a further increase in temperatures might reduce the viability of disease-transmitting mosquito populations. Overall, however, scientists consider that most of the health impacts of climate change would be adverse (WHO, 2003)

Climatic changes over recent decades have probably already affected some health outcomes. Indeed, the World Health Organisation estimated, in its "World Health Report 2002", that climate change was estimated to be responsible in 2000 for approximately 2.4% of worldwide diarrhoea, and 6% of malaria in some middle-income countries (WHO, 2002). However, small changes, against a noisy background of ongoing changes in other causal factors, are hard to identify. Once spotted, causal attribution is strengthened if there are similar observations in different population settings. The first detectable changes in human health may well be alterations in the geographic range (latitude and altitude) and seasonality of certain infectious diseases – including vector-borne infections such as malaria and dengue fever, and food-borne infections (e.g.

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salmonellosis) which peak in the warmer months. Warmer average temperatures combined with increased climatic variability would alter the pattern of exposure to thermal extremes and resultant health impacts, in both wet and dry seasons. By contrast, the public health consequences of the disturbance of natural and managed food-producing ecosystems, rising sea-levels and population displacement for reasons of physical hazard, land loss, economic disruption and civil strife, may not become evident for up to several decades. Banser (2009) insists that the effects of changes in the weather on our health are undeniable. She justified this fact by describing how weather affects the mood and activities of a man like being depressed and weak on a cloudy day, and being very active on a sunny day. She said that a rheumatoid arthritistis patient will have more pains during rainy day, because of the effects of atmospheric pressure on their health.KallksterinandValimount(2008) also have the larger increases of mortality to hot weather extremes which brought about several illnesses. They said that humidity leads to excessive dehydration of nasal passage and the upper respiratory tract during winter and increases the chances of microbial and urinal infections.

A study carried out by Climate and Health Resource Room (CHRR, 2008) on climate and malaria in Africa showed that where malaria is not adequately controlled, its distribution and seasonality are closely related to seasonal characteristics of the weather, and when there are cases of anomalies such as rainfall anomalies, malaria which is seasonally endemic becomes epidemic in warm arid regions of Africa. They also carried out study on climate and meningitis in Africa and the study showed that epidemics of meningitis occur in Sahel region (e.g. in Nigeria: Borno, Adamawa, Yobe and some parts of Taraba States). In Africa during the dry season, they typically coincide with the period of very low humidity and dusty conditions that disappear with the onset of the rains. More so, Akinbola and Omotosho (2004), carried out a research on the relationship between meteorological variables and the occurrence of malaria, measles, chicken pox, meningitis and pneumonia in Ikeja, Akure and Kaduna, all in (Nigeria) and their results showed that there is a relationship between the diseases and the seasons. It shows that malaria and pneumonia are associated with the rainy season while meningitis, chicken pox are common during the hot period.Adetolalu (1984) also carried out a research that investigates how temperature relates with respiratory diseases in northern Nigeria and he discovered that the diseases thrive more when the temperature is very low. It is obvious from these studies that among several factors that could be responsible for the occurrence of common diseases in any environment, the weather of such a place could be a major factor since its effects could be felt either directly or indirectly. But the extent of its impact can vary from place to place. It thus on the premise of this background that this study was aimed at assessing the effect of temperature on human health and comfort in Gwagwalada Area Council of the Federal Capital Territory, Abuja.

MATERIALS AND METHODS

Research Design

The most suitable research design for a study is one that minimizes bias, maximizes the reliability of data collected and in line with the purpose of the study. As such, this study

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employed the descriptive cross-sectional survey design. The area of the study was conducted in Gwagwalada Area Council, Abuja. Gwagwalada Area Council is one of the six area councils in Abuja with a total population of 158,618 inhabitants. (National Population Census, 2006.) It is located on geographical coordinates 8°5'621"N and 7°04'443"E of the equator and Greenwich meridian respectively.

Location of the Study

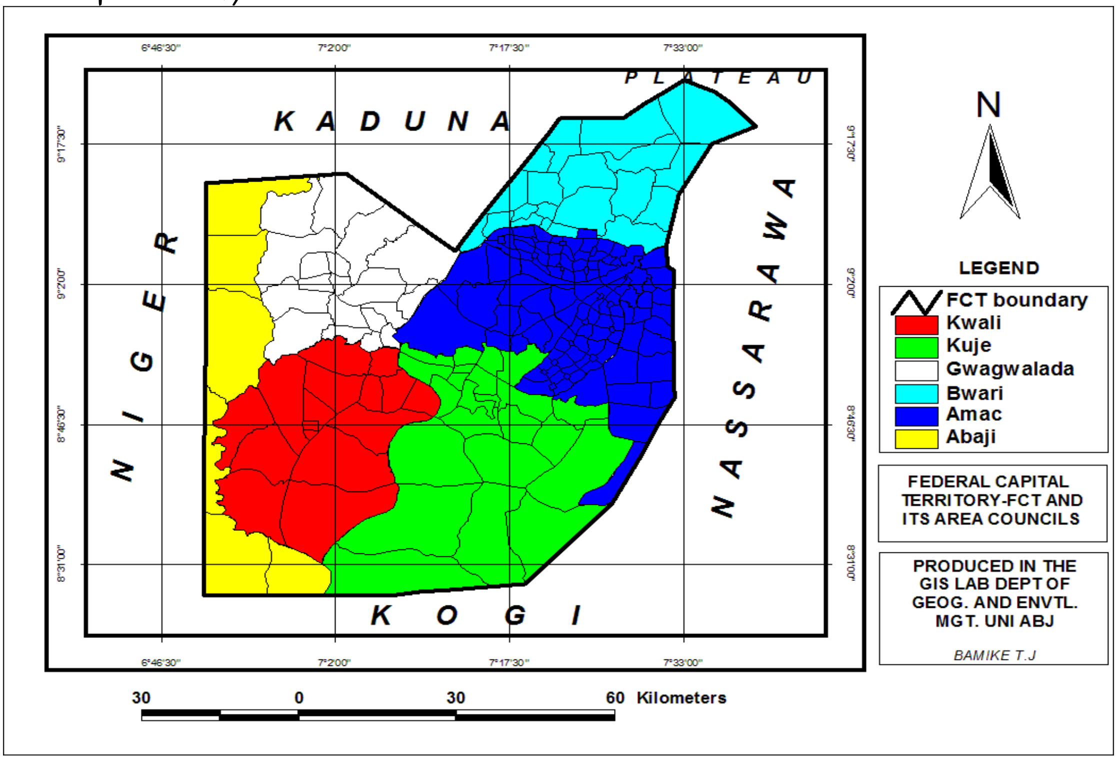

Fig.3.1 Map of the Study Area

The study area, Federal Capital Territory (FCT) lies between latitude 80° 25′ and 9° 25′ North of the equator and longitude 6° 45′ and 7° 45′ East of the Greenwich meridian. It is located in the middle belt of Nigeria. Its size is equivalent to 0.8% of Nigeria (Mabogunje, 1977) it is bordered by four states: Kaduna in the North, Nasarawa in the West, Kogi in the South and Niger in the East. It covers a land mass of 8,000 square kilometres (Km^2) (Abuja master plan, 2000). The FCT is almost predominantly underlain by high grade metamorphic and igneous rocks of pre-Cambrian age. Generally trending NNE-SSW, these rocks consist of gneiss, migmatites and granites.

Population of the Study

The population for this study consists of residence of Gwagwalada Area Council, FCT Abuja, consisting of 158,618 people (National Population Commission Projected Population, 2016).

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Sample and Sampling Techniques

In determining the sample size of a given population, different methods abound. Thus, in determining the sample size of the respondents of the study, the Taro Yamane (1967) formula for calculating sample size was used.

$$n = \frac{N}{1 + N(e)^2}$$

Where; N= the size of the population, n = the sample size, e = Acceptable margin of error (10% was employed).

$$n = \frac{N}{1 + N(e)^2} = n\frac{158618}{1 + 158618(0.10)^2} = \frac{158618}{1 + 158618(0.01)}$$

$$n = \frac{158618}{1 + 15861.8} = \frac{158618}{15862.8} = n = 99.9 = 100$$

Thus, the sampled respondents of the study were 100 residents of the study area.

Sampling technique is a statistical method of selecting the sampling unit that would be representative of the population of the study. It can be classified into probability and non-probability sampling (Krishnaswami &Satyaprasad, 2011). The study adopted the probability sampling technique was used in sampling the respondents of the study. The rationale for the adoption of the probability sampling technique was because, probability sampling procedures has every item of the population given an equal chance of inclusion in the sample (Gay *et al.,* 2009). The probability sampling technique that was used was the simple random sampling technique, of which four villages were selected randomly in Gwagwalada Area Council. The study sites were Dobi, Ledi, Dagiri, and TungaMaje

Nature and Sources of Data

The study employed the use of both primary and secondary data. Primary data used was a cross sectional data from respondents of the study. The natures of the secondary data of the study were time series data on climate variables (in this case being temperature) for a period of twenty years (2000-2019), as well as existing literature relative to the objectives of the study. The Secondary were sourced from the Nigeria Meteorological Agency (NIMET) FCT office Abuja, journals, articles and books.

Method of Data Collection

The secondary data of the study was obtained from the Nigeria Meteorological Agency (NIMET) FCT office, and consultation of relevant literatures that were relative to the study. At the Nigeria Meteorological Agency (NIMET) FCT office. In order to crate good rapport between the officials of NIMET, the research assured them the purpose of the research was purely academic, and confidentiality will strictly be adhered to.

The survey questionnaires uses in the study were distributed directly and physically to the respondents of the study by the researcher. Before issuing the questionnaires to the participants of the study, the researcher introduced themselves to the respondents, explained the aim and objectives of the study, and solicited their voluntary participation in the study. The researcher then administered the questionnaires to the interested respondents, with instructions on how to address the questionnaires, after which the researcher waited for the participants of the study to finish answering the questionnaires, retrieve them back, and thank the participants of the study for their participation.

Method of Data Analysis

The data for this study was processed and analysed both quantitatively and qualitatively. The quantitative data was analysed using both descriptive statistics with the help of Microsoft Excel, and IBM SPSS Statistical package version 26. The descriptive statistics that was used consist of central tendency and the time series trend analysis.

RESULTS AND DISCUSSION

Trend of Temperature in the Study Area

The data presented in Table 4.1 depicts the various distribution of temperature in the study area for a time frame of twenty years. The annual maximum temperature of the study area, the average (mean) maximum temperature, the annual minimum temperature, the average minimum temperature, as well as the average temperature of the study area is depicted in the table. The trend chart depicted in Figure 4.1, 4.2, and 4.3 provides a vivid picture of the trend of temperature variability in the study area across the time frame under consideration.

Table 4.1: Temperature Distribution in the Study Area.

S/N	Year	Annual Max. Temperature	Average Max. Temperature	Annual Min. Temperature	Average Min. Temperature	Average Temperature
1	2000	393.4	32.8	261.8	21.8	27.3
2	2001	392.9	32.7	260.1	21.7	27.2
3	2002	392.3	32.7	259.0	21.6	27.15
4	2003	408.7	34.1	261.6	21.8	27.95
5	2004	413.3	34.4	272.3	22.7	28.55
6	2005	400.3	33.4	266.8	22.2	27.8
7	2006	396.2	33.0	266.0	22.2	27.6
8	2007	398.8	33.2	272.2	22.7	28.0
9	2008	408.9	34.1	264.8	22.1	28.1
10	2009	407.7	34.0	272.5	22.7	28.4
11	2010	410.7	34.2	256.6	21.4	27.8
12	2011	408.5	34.0	258.6	21.6	27.8
13	2012	411.4	34.3	263.1	21.9	28.1
14	2013	415.7	34.6	258.9	21.6	28.1
15	2014	413.1	34.4	255.5	21.3	27.9
16	2015	414.9	34.6	264.6	22.1	28.4
17	2016	416.5	34.7	264.8	22.1	28.4
18	2017	411.4	34.3	259.1	21.6	28.0
19	2018	413.7	34.5	258.7	21.6	28.1
20	2019	413.1	34.4	264.0	22.0	28.2
Total		**8141.5**	**678.4**	**5261**	**438.7**	**530.4**

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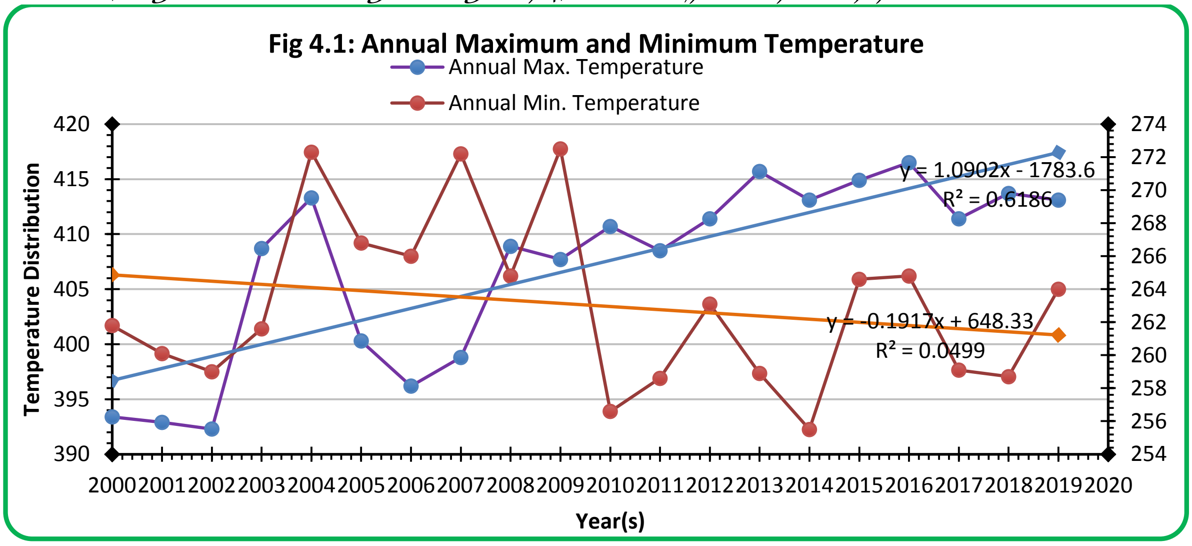
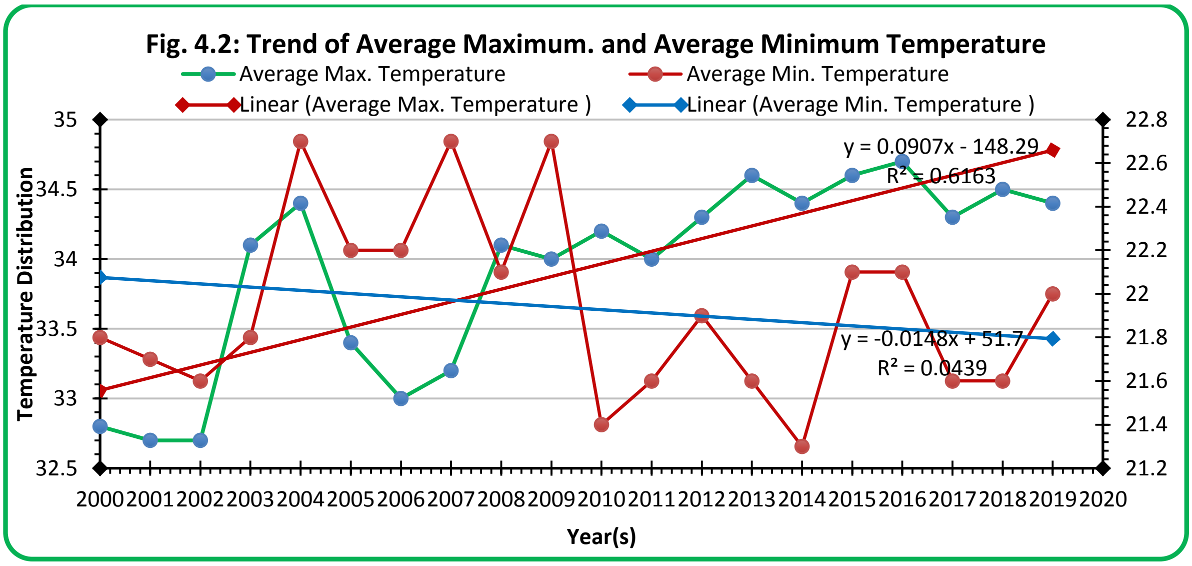
Source: Nigeria Meteorological Agency (NIMET), FCT, Abuja, 2020.



Source: author's computation, 2020.



Source: author's computation, 2020.

The trend chart depicted in Figure 4.1 and Figure 4.2 presents the variability trend of annual maximum and annual minimum temperature, as well as the average maximum and average minimum temperature in the study area, for the time frame under consideration. From the trend chart, it can be observed that the trend line for annual maximum temperature in the study area is upward by nature, while the trend line for annual minimum temperature is downward sloping. More so, if critically looked at, the same behaviour of the trend line can be observed in the Figure 4.2, in the case the average maximum and average minimum temperature in the study area. The upward movement of the trend line indicates an increasing trend in annual maximum temperature, while the downward sloping trend line implies a decreasing trend in annual minimum temperature in the study area across the time frame under consideration, either on the annual average basis.

The cyclical nature of the nature of trend plot of the annual maximum, annual minimum temperature, as well as the average maximum and average minimum temperature depicts the various natures of fluctuations or variability of these measures of temperature in the study area, as a result of the climate change. From the trend chart depicted above, it can be observed that between the years 2000-2002, continues decline in both annual maximum, annual minimum temperature, as well as average maximum and average minimum temperature in the study area. However, a steady increase in temperature was experienced in the years 2003 and 2004. Although a significant decline in annual maximum and average maximum temperature was recorded in the years 2005 and 2006, the annual maximum and average maximum temperature recorded a steady and continues increasing trend in the study area, as indicated by the nature of movement of the trend line. It must be pointed out here however, that despite the increasing trend in annual maximum and average maximum temperature in the study area between the years 2007-2019, some sought of variability in the in these measure of temperature was recorded. On an aggregate, the value of R^2 as depicted in the trend equation represents the overall percentage of the increasing variation in annual maximum and average maximum temperature in the study area. Hence, the variation in annual maximum and average maximum trend of temperature in the study area between the years 2000-2019 was recorded at 62 percent ($R^2 = 0.6163$).

With respect the annul minimum temperature and average minimum temperature of the study area, it can be observed that the years 2003 and 2004 recorded a significant increase in the minimum temperature of the study area, both at the annual and average levels. However, a cyclical increase-decrease fluctuation was experienced between the years 2005-2009. More conspicuously from trend plot chart of the annual minimum and average minimum temperature is the sharp decline in the year 2010 and 2014. These years recorded the lease annual minimum and average minimum temperature in the study area, across the entire time frame under study. Although an increase in annual minimum and average minimum temperature was recorded in the years 2015 and 2016, it is important to point out here that the value of this increase was not significant, and at a constant figure in the case of average minimum temperature figure (see Table 4.1). More so the year 2017 and 2008 recorded a decline a both annual minimum and average minimum temperature in the study area. Although a slight increase was recorded in the year 2019, it important to note that this increase was not significant.The value of the R^2 depicted in the trend equation signified the percent of decreasing variability in annual minimum and average minimum temperature in the study area. From the trend equation, it can be observed that the degree of decreasing variation was 44 percent ($R^2 = 0.0439$).

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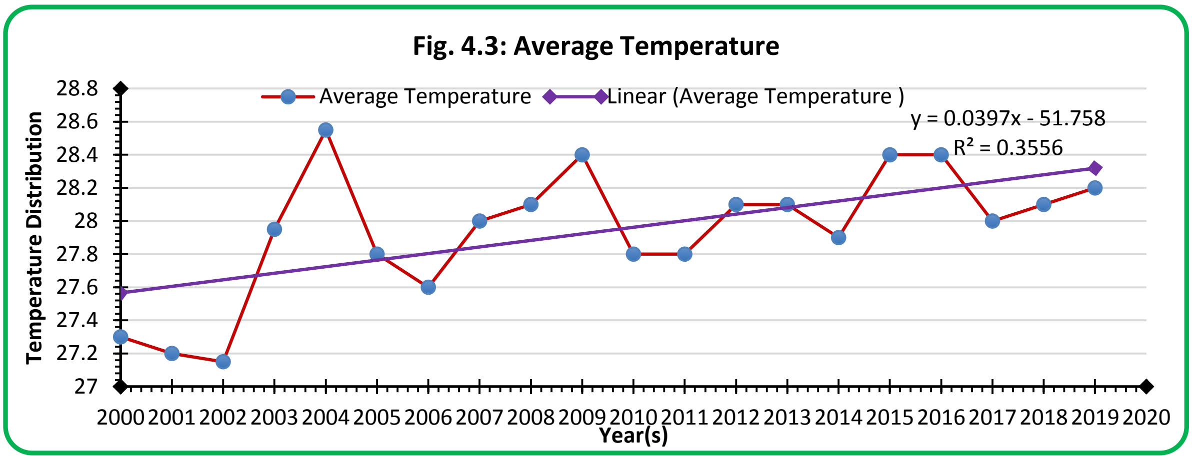

Source: author's computation, 2020.

The trend chart depicted in Figure 4.3 represents the average temperature in the study area for the period under consideration in the study. The upward movement of the trend line signifies an increasing trend in the average temperature in the area of study between the years 2000-2019. From the chart, it can be observed that the trend plot is downward sloping between the years 2000-2002. The implication here is that a decreasing average temperature was recorded between these years (see Table 4.1). However, a sharp increase in the average temperature of the study area was recorded in the years 2003 and 2004. It important to point out here that the year 2014 recorded the highest average temperature in the study area at 28.55°c, while the year 2007 recorded the lowest average temperature in the study area at 27.15°c.

The year 2007-2009 recorded an increase in the average temperature in the study area. However, a slight decline was experienced in the year 2010. The decline in average temperature in the year was experience in the year 2011 at a constant figure. However an increase in average temperature was recorded in the years 2012. Between the years 2012-2019, a cyclical increase-decrease in average temperature was experienced. However, this fluctuation was less significant, as indicated by the movement of the trend plot. The R^2 (0.3446) indicates a 35 percent increasing trend in average temperature in the study area.

Awareness Levels and Perceptions on Climate Change in the Study Area

Table 4.2: Level of Awareness of Climate Change

Understanding of Climate Change	Frequency of Responses	Percentages
Do you have a good understanding of climate change?		
Yes	57	58.2%
No	41	41.8%
Total	98	100

Source: field survey, 2020.

The study attempts to establish the awareness levels and perception of the residents of the study area with respect to climate change. To this end, the respondents were asked whether they have a good understanding of climate change. The results of the responses of

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the respondents of the study with respect to this question are presented in Table 4.2. From the result depicted in the table, it can be observed that 58.2 percent of the respondents of the study have a good understanding of the concept of climate change, while 41.8 percent of the respondents do not have a good understanding of the concept of climate change. Given the percentage distribution of respondents of the study who were of the opinion that they have a good understanding of the concept of climate change, the need to assessed the perceptions of the dimension of climate change these group of respondents was important. Thus, the results presented in Table 4.3 depict the various perceptions of climate change by residents of the study area. From the results presented in Table 4.3, it can be observed that large majority of respondents (about 54 percent), agree to the statement that there has been 'an increase in temperature and number of sunny days, while 51 percent of the respondents agreed that amount of rainfall has also increased as result of climate change. More so, about 54 percent of the respondents were of the perception that there has been 'an increase in frequency of heavy rainfall. In the same vein, 58 percent of respondents were of the perception that rains are occurring earlier or later than the expected rainy season.

The results also revealed that 51 percent of the respondents were of the were of the perception that 'total number of rainy days' have not decreased; while 50 percent disagreed with the statement that 'duration of dry spell during rainy season has increased. Additionally, 44 percent of the respondents disagreed that number of sunshine hours during rainy season have decreased. 50 percent of the respondents agreed that 'intensity of heat during dry seasons has increased', while, 47 percent said told that 'bitterness of cold during harmattan has increased'. Similarly, 26 percent of the respondents were of the perception that here has been 'a decrease in ground water table' as a result of climate change. On the basis of observations related to Climate Change Dimensions it can be concluded that that majority of the respondents have felt that there has been a significant amount of change in various parameter of climate change.

Table 4.3: *Perceptions of the Dimensions of Climate Change in the Study Area*

S/N	Climate change dimensions	Respondent's Perception				
		Strongly agreed	Agreed	Undecided	Strongly disagreed	Disagree
i	Increase in amount of rainfall	30(30.6%)	20(20.4%)	15(15.3%)	18(18.4%)	15(15.3%)
ii	Increase in frequency of heavy rains	29(29.6%)	24(24.5%)	7(7.1%)	18(18.4%)	20(20.4%)
iii	Rains are occurring either earlier or later than the expected rainy season	30(30.6%)	27(27.6%)	21(21.4%)	15(15.3%)	5(5.1%)
iv	Total rainy days have decreased	19(19.4%)	18(18.4%)	11(11.2%)	34(34.7%)	16(16.3%)
v	Duration of dry spell during rainy season has increased	15(15.3%)	17(17.3%)	17(17.3%)	31(31.6%)	18(18.4%)
vi	Number of sunshine hours during rainy season have	17(17.3%)	14(14.3%)	24(24.5%)	25(25.5%)	18(18.4%)

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	decreased					
vii	Intensity of heat during dry season has increased	22(22.4%)	27(27.6%)	17(17.3%)	16(16.3%)	16(16.3%)
viii	Bitterness of cold during harmattan has increased	25(25.5%)	21(21.4%)	15(15.3%)	22(22.4%)	15(15.3%)

Source: field survey, 2020.

Table 4.4 reveals the thoughts of the participants of the study with respect to climate change. From the results, it can be observed that majority of the participants (54.1 percent) were either concerned or very concerned about climate change, while 28.6 percent were slightly concerned. 17.3 percent of the participants were unconcerned about climate change. With respect to the thoughts of the participants as to whether climate change has any impacts on human health and general comfortability, 61.2 percent of the participants of the study were of the perception that climate change has an impact on human health and general comfortability, while 38.8 percent had a contrary perception.

Table 4.4: Thoughts on Climate Change in the Study Area

Thoughts on Climate Change Items	Frequency of Responses	Percentages
How concerned are you about climate change?		
Very concerned	29	29.6%
Concerned	24	24.5%
Slightly concerned	28	28.6%
Unconcerned	17	17.3%
Total	**98**	**100**
Do you think climate change has any impacts on human health and general comfortability?		
Yes	60	61.2%
No	38	38.8%
Total	**98**	**100%**

Source: field survey, 2020.

Effects of Temperature on Human comfort in the Study Area

The study sought to assess the effects temperature on human heals in the study area. The result presented in Table 4.5 reveals the various responses and perceptions of participants of the study with respect to the effects of temperature on human comfort in the study area. From the results, it can be observed that 54.2 percent of the respondents of the study were of the perception that they do not find increasing temperature in the study area refreshing, neither does it keeps them active nor alert. From the results, it can be observed that 45.9 percent of the respondents of the study were of perception that they increasing temperature in the study area extremely uncomfortable because it makes them weak and unable to carry out their job at their various offices and at home.

Table 4.5: Temperature and Comfort

S/N	Temperature and human comfort	Respondent's Perception				
		SA	A	UD	SD	D
i	I find the heat in my area refreshing as it keeps me active and alert.	15.3%	10.2%	20.4%	33.7%	20.4%
ii	I find the heat extremely uncomfortable because it makes me weak and unable to carry out my job at the office and at home.	26.5%	19.4%	22.4%	22.4%	9.2%
iii	the increasing heat in my area makes impossible to have a sound sleep. Sometime we are forced to sleep outdoors.	21.4%	18.4%	15.3%	26.5%	18.4%
iv	The heat in my area causes reaches for my babies and makes them to cry a lot.	24.5%	30.6%	8.2%	26.5%	10.2%
v	The increasing heat in my area gives me body odour.	21.4%	27.6%	17.3%	20.4%	13.3%
vi	The increasing heat due to rising temperature brings about air pollution in my environment.	30.6%	25.3%	14.1%	14.1%	15.3%
vii	The heat makes it difficult for me to study as I tend to sweat a lot.	19.4%	23.5%	22.4%	21.4%	13.3%

Source: field survey, 2020.

The respondents of the study were asked whether the increasing heat in the study area as a result of the increasing trend temperature makes impossible to have a sound sleep, and forced to sleep outdoors. From the result depicted in Table 4.5, 39.8 percent of the respondents were of the perception that increasing heat in the study area makes it impossible to have a sound sleep, and sometimes forces them to sleep outdoors, while 44.9 percent of the respondents had a contrary perception to this question. The results also revealed that in increasing heat in my area as a result of increasing temperature in the study area causes reaches children in the study area makes them very uncomfortable, resulting in them crying a lot, as indicated by 55.1 percent majority responses. From the results of the study, 49 percent of the respondents of the study were of the perception that increasing temperature in the study area gives them body odour. In the same vein, 55.9 percent of the respondents of the study were of the perception that increasing heat due to rising temperature in the study area brings about air pollution in their environment. More so, while 42.9 percent of the respondents were of the notion that increasing heat as a result of increasing temperature in the study area makes it difficult for them to study, as it tends to sweat a lot. However, 34.7 percent of the respondents of the study were of a contrary response.

Effects of Temperature on Human Health

One of the objectives of the study was to identify the effects of temperature on human health. The following qualitative data were collected by the research with respect to this objective.

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Mortality

Normal human body temperature is maintained by the hypothalamus and is 36.1–37.8°C. When the environmental temperature exceeds the regulatory capacity of the hypothalamus, this can exert substantial stress on body organs (Kim *et al.,* 2015).Several world studies have shown that extreme temperatures can increase mortality. These graphs generally have the shape of a U, V or J and show an increase in mortality beyond a specific threshold temperature (Kim *et al.,* 2015). In most of these studies, a minimum mortality temperature (TMM) or a comfort range, in which the least number of mortality per unit of time happens, has been reported. In Greater Beirut, the TMM was 27.5°C and 1°C rise in temperature yielded a 12.3% increase (95% CI: 5.7–19.4%) and 1°C drop in temperature caused 2.9% increase (95% CI: 2–3.7%) in mortality (El-Zeina *et al.,*2004). Although temperature itself can effect mortality through physiological routes; low income, lack of air conditioning, poor access to transport, poor education, unhygienic microenvironments and older age have been recognized as risk factors which increase vulnerability to heat and cold (El-Zeina *et al.,*2004). Studies have shown that heat waves increase mortality more in vulnerable populations, such as elderly people, especially women, mentally ill people, children, those in thermally stressful occupations or people with pre-existing illness (McMichael, *et. al.,* 2006).

It is very likely that climate change will lead to more frequent heat waves. Excess deaths were reported in England, Wales and France during the 2003 heat wave and caused a public health crisis. Much of the mortality from heat waves is due to cardiovascular, cerebrovascular and respiratory causes and happens more in the elderly (Haine, 2006).Some researchers have mentioned a phenomenon called "urban heat island effect," which refers to urban centres with temperatures being somewhat higher than the surrounding suburban and rural areas (Haine, 2006). Some inner urban environments have high thermal mass and low ventilation, which absorbs and retains heat and amplifies the rise in temperatures, especially overnight (McMichael *et al.,* 2006). The impact of extreme heat on human health may also be exacerbated by increases in humidity (Haine, 2006). Populations are likely to acclimatize to climate change through a range of behavioural, technological and physiological adaptations. However, infrastructural changes are likely to happen much slower, especially in developing countries (Haine, 2006). The temperature–mortality relation varies greatly by latitude and climatic zone. People in hotter cities are more commonly affected by low temperatures, and people in colder cities are more affected by high temperatures. Other factors such as housing that may provide poor protection against cold or heat can cause higher excess winter mortality than expected (McMichael *et al.,* 2006). However, cold also shows its deadly effect through infectious diseases such as influenza in elderly people or respiratory syncytial virus in infants (McMichael *et al.,* 2006).

McMichael *et al.*(2006) estimated the temperature threshold below which cold-related mortality begins to increase, to range from 15 to 29°C, and the threshold for heat-related deaths to range from 16 to 31°C in different world cities. These researchers found heat thresholds were generally higher in cities with warmer climates, but cold thresholds were

unrelated to climate (McMichael *et al.,* 2006). Other researchers have reported lower latitude cities to have higher threshold temperatures (Chung *et al.,* 2009).
In China, associations between daily maximum temperature and daily mortality from all-causes were observed in different cities, with increases in 3.2–5.5%, with each 1°C increase in the daily maximum temperature over the threshold. Also a stronger temperature-associated mortality was detected in females and adults over 30 years (Li *et al.,* 2004) Isaksen *et al.* (2016) in King County, Washington, showed that heat, expressed as humidex, is associated with increased mortality and that the risk increases with heat's intensity.

Cardiovascular Disease and Mortality

In China, strong associations between daily maximum temperature and daily mortality from cardiovascular causes were observed in different geographical cities, with increases in 4.6– 7.5% with each 1°C increase in the daily maximum temperature over the threshold (Li, *et al.,* 2014).In Beijing, people with hypertensive disease were susceptible to both extremely low and high temperatures, and in Shanghai, people with ischemic heart disease showed greater susceptibility to extremely cold days (Wang, *et al.,* 2015). Some studies have documented an association between mean temperature and humidity variations, and the number of visits to the emergency departments for atrial fibrillation (Franchini&Mannucci, 2015). In East Asia, heat waves had the strongest effects on cardiovascular deaths, which was (8.8, 95% CI: 5.5–12.2) (Chung *et al.,* 2009). In Washington State, statistically significant results were found for circulatory (9%) and cerebrovascular (40%) deaths and heat in all ages (Isaksen *et al.,* 2016) and stratifying by age, and statistically significant increases in mortality risk on hot days were found for the 65– 84 age group, in cerebrovascular (37%), and in the 85+ age group, in circulatory (18%), cardiovascular (17%), and cerebrovascular (53%) mortality (Isaksen *et al.,* 2016).

In China per capita years of education (as an indicator of economic status), percentage of population over 65 years and percentage of women had direct impact on cold-related cardio- vascular mortality in populations. Also number of hospital beds (as an indicator of the availability of medical resources), percentage of population engaged in industrial occupations, and percentage of women showed direct impact on heat-related cardiovascular mortality [39], which confirms that socioeconomic factors can alter the effect of climate variables on cardio- vascular mortality. Gender also shows a different impact at low and high temperatures. Men tend to have a higher risk at low temperatures, whereas women tend to have higher risk at high temperatures (Yang *et al.,* 2015).A study from Kerman, Iran, showed increases in daily mortality from cardiovascular diseases as temperature decreased. Also significant correlations were observed between cardiovascular mortality and temperature, and the maximum correlations for cardiovascular deaths were on lag 0–lag 3. For each 1°C decrease in temperature, cardiovascular deaths showed a 0.6% increase (Khanjani&Bahrampour, 2013), but no increase in cardiovascular mortality was detected with increased temperature, which is probably related to acclimatization. In Shiraz, Iran, the minimum number of cardiovascular deaths happened at 20°C. Drops in mean monthly temperature were significantly associated with increased 18- to 60-year-old cardiovascular deaths that happened one month later (Khanjani, *et al.,* 2014).

Respiratory Disease and Mortality

There is epidemiological evidence that shows influenza-related morbidity and mortality peaks 2–3 weeks after falls in AH. Also, in vitro experiments have shown improved survival of the influenza virus at lower AH levels (Metz & Finn, 2015). Extremes can be hazardous for health in many other indirect ways as well. Prolonged droughts fuel bush fires that release hazardous respiratory pollutants (Epstein, 2001). In Korea, above a threshold temperature of 29.5°C, a rise in temperature of 1°C resulted in an increase in death from respiratory conditions (RR 1.02; 95% CI: 1–1.04). There was also an increased risk of death from asthma (RR 1.05, 95% CI: 1.01–1.11) (Kim *et al.,* 2015).In Hong Kong, cold temperature and rainfall was associated with most influenza epidemics; but, relative humidity and absolute humidity did not show much contribution to epidemics (Chong *et al.,* 2015). This effect may be due to prolonged survival of viral particles under colder conditions or enhance crowding and indoor activities that would increase contact, aerosol and droplet transmission (Chong *et al.,* 2015).Some studies have shown that rainfall could be a predictor to forecast influenza infection for subtropical and tropical regions, but not in all temperate regions. One plausible mechanism is that rainfall could increase indoor activities, and therefore influence the number of contacts and the risk of exposure to infected individuals (Chong *et al.,* 2015).

A study from Turkey reported that some meteorological parameters such as wind direction, air temperature and atmospheric pressure were related to the incidence of pulmonary embolism. But no relation was found between unprovoked pulmonary embolism(PE) cases' monthly distribution and pressure, humidity or temperature. However, there was a statistically significant positive correlation between provoked PE cases and air temperature (Anar*et al.,* 2015). The relation between PE and hot temperature may be related to dehydration or people traveling in cars for longer distances temperature (Anar*et al.,* 2015). In a study about temperature and infant mortality, white infants had an elevated risk for deaths from respiratory causes (Basu, *et al.,* 2015). Climate-related events including heat waves and extreme meteorological events can increase the frequency of acute cardiorespiratory events due to higher concentrations of ground level ozone, changes in particle pollution, altered spatial and temporal distribution of allergens (pollens, molds, and mites), and some infectious disease vectors. These events will not only aggravate the condition of those with current respiratory disease and asthma but also increase the incidence and prevalence of allergic respiratory conditions (D'Amato *et al.,* 2015). Weather can affect asthma directly, by acting on airways, or indirectly, by influencing airborne allergens and pollutant levels. Cold air temperature can aggravate asthmatic symptoms (D'Amato *et al.,* 2015). There is evidence that, during pollen season, thunderstorms can be associated with asthma outbreaks or acute respiratory disease outbreaks (D'Amato *et al.,* 2015). Some studies have reported higher barometric pressure, more hours of sunshine and lower humidity in winter to be associated with an increase in chronic obstructive pulmonary disease (COPD) exacerbations, implying that warm and dry high pressure systems were associated with COPD anomalies. Studies from Trinidad showed that in warm, wet climates incidence of asthma increased with higher relative humidity in the wet season. Conversely, a study from Japan demonstrated an association between low relative humidity and hospital admissions for paediatric asthma. The other indirect effects of humidity in respiratory disease include its role in promoting the increasing mold and mites (Davis *et al.,* 2016)

In many world countries, low humidity levels were found to precede the onset of increased winter time influenza-related mortality by several weeks. Low humidity probably impacts on virus stability and viability, host susceptibility and human behaviour (Davis *et al.,* 2016).A study from Australia about paediatric emergency department visits showed that high temperatures had a significant impact on paediatric diseases, including chronic lower respiratory diseases. Low temperatures were also significantly associated with respiratory diseases (Xu *et al.,* 2014). A study from Kerman, Iran, showed increases in daily mortality from respiratory diseases as temperature decreased. This relation reached a maximum after a 26-day lag. In this study, for each 1°C decrease in temperature, respiratory deaths showed an average of 2.5% increase (Khanjani&Bahrampour, 2013). In Shiraz, Iran, the minimum number of respiratory deaths happened in 25°C. Mean monthly temperature was inversely and significantly associated with total and female respiratory deaths on the same month and with total, male and female respiratory deaths that happened one month later (Khanjani&Bahrampour, 2013).

Premature Delivery

In the United States, ambient temperature was significantly associated with preterm birth, and regardless of their maternal demographic characteristics or baby gender, each 5.6°C (10°F) increase in weekly average apparent temperature (with lags up to one week), caused an 8.6% increase (95% confidence interval: 6.0, 11.3) in preterm delivery. Preterm delivery has many etiologies, but one possible explanation for its relation with heat is increased dehydration with heat exposure, which may decrease uterine blood flow and increase pituitary oxytocin to induce labour (Basu*et al.,* 2010). In Spain, when maximum apparent temperature exceeded the 90th percentile, the risk of preterm birth increased up to 20% after 2 days, and when minimum temperature rose to the 90th percentile, it increased by 5% after a week (Vicedo-Cabrera, *et al.,* 2014). Exposure to moderately high temperatures during late pregnancy might be associated with an increase in risk of preterm birth (Vicedo-Cabrera *et al.,* 2015). In Rome and Barcelona, increase in maximum apparent temperature (MAT), especially in the second half of the second trimester, increased the risk of preterm and particularly early preterm births (Schifano*et al.,* 2016).

Diabetes, Endocrine and Metabolic Diseases

Some researchers have suggested that climate change may be related to increase in type 2 diabetes (Shubair*et al.,* 2013).Studies have reported significant associations between increases in daily endocrine and metabolic diseases mortality with increase in the daily maximum temperature above the threshold. Mortalities for diabetes were also significantly associated with temperature. The increased mortality for every 1°C increase

International Journal of Environmental Studies and Safety Research
ISSN: 2536-7277 (Print): 2536-7285 (Online)
Volume 4, Number 4, December 2019
http://www.casirmediapublishing.com

in the daily maximum temperature over the threshold for endocrine and metabolic outcomes, and particularly diabetes, was 12.5–31.9% and 14.7–29.2% (Li *et al.,* 2014). Statistically significant increases in post-heat exposure diabetes-related mortality in the 45–64 age group in the United States suggests that underlying health status may contribute to these risks (Isaksen *et al.,* 2016). In a study about paediatric emergency department visits in Australia, high temperatures had a significant impact on endocrine and metabolic paediatric diseases, whereas low temperatures were also significantly associated with endocrine, nutritional and metabolic diseases (Xu *et al.,* 2014).Although congenital hypothyroidism was reported to have a seasonal pattern in some parts of the world, a recent study did not find a significant pattern (Khanjani*et al.,* 2016).

Human Disease Cause by Temperature in the Study Area

One of the objectives of the study was to identify the human diseases causes by temperature in the study area. To this end, human diseases caused by temperature were explored with an open-ended question. Participants were asked to 'Identify some of the diseases caused by temperature in the study rea?' Table 4.7 summarizes these results.

Table: 4.6: Perceptions of the Potential Main Risk Factors for Malaria

S/N	Risk Factors	Respondent's Perception				
		Strongly agreed	Agreed	Undecided	Strongly disagreed	Disagree
i.	Diarrhea and gastroenteritis	30(30.6%)	25(25.3%)	14(14.1%)	14(14.1%)	15(15.3%)
ii.	Dengue fever	15(15.3%)	17(17.3%)	25(25.5%)	23(23.5%)	18(18.4%)
iii	Yellow fever	24(24.5%)	30(30.6%)	8(8.2%)	26(26.5%)	10(10.2%)
iv	Malaria	27(27.6%)	31(31.6%)	14(14.3%)	13(13.3%)	13(13.3%)
v	Leishmaniasis	20(20.4%)	16(16.3%)	16(16.3%)	25(25.5%)	21(21.4%)
vi	Cholera	21(21.4%)	18(18.4%)	15(15.3%)	26(26.5%)	18(18.4%)

Source: field survey, 2019.

From the summary of results presented in Table 4.6, the major disease caused by temperature in the study area was malaria, as indicated by 59.2 percent of the respondents of the study. Closely followed by malaria infection in the study area was Diarrhea and gastroenteritis, as pointed out by 56 percent responses.55 percent of participants identified Yellow fever, while 40 percent of participants pointed out Cholera. 38 percent identified Dengue fever.

Diarrhea and Gastroenteritis

Changes in temperature may affect the incidence of diarrheal diseases (Haines *et al.,* 2006). In tropical and subtropical regions with crowding and poverty, heavy rainfall and flooding may trigger outbreaks of diarrhea(McMichael *et al.,* 2006) by contaminating fresh water resources. In Brisbane, Australia, there was a statistically significant positive relationship between diurnal temperature range (DTR) and diarrhea among children younger than five years. This effect was the greatest at one-day lag, with a 3% (95% CI: 2–5%) increase in emergency department admissions per 1°C increment of diurnal temperature range. The relative risk increased rapidly when DTRs were over 10°C (Xu *et al.,* 2014). Diarrheal diseases in Peru and Fiji have also accompanied short-term increases in temperature (McMichael *et al.,* 2006). Ambient humidity has been reportedly associated with infectious enteritis. Studies in Japan, Taiwan and Peru showed negative relationships between relative humidity and infectious gastroenteritis (Davis *et al.,* 2016). Also similar relationships have been uncovered for rotavirus, another agent causing enteritis in Australia (Davis *et al.,* 2016).

Dengue Fever

Studies suggest that there is a direct relationship between global warming and dengue fever. Dengue fever is characterized by severe headaches and bone pain, and mortality occurs in case of hemorrhagic fever and shock syndrome. It is carried by Aedes aegypti and is restricted by the 10°C winter isotherm (Epstein, 2001). Climate change has helped dengue fever to spread into northern Australia and Argentina (Epstein, 2001). As many of these changes in the pattern of diseases happened after long-term warming. Extreme weather and especially intense precipitation events after hurricanes have led to outbreaks of dengue fever in Honduras in 1998 and Venezuela in 1999 (Epstein, 2001). Changes in temperature and rainfall may also affect the distribution of disease vectors in dengue fever (Haines *et al.,* 2006). Researchers think that in the Asia-Pacific region, El Niño and La Niña events seem to affect the occurrence of dengue fever outbreaks (McMichael *et al.,* 2006).

Yellow Fever

Yellow fever is a climate-related viral disease that has a high rate of mortality and is carried by Aedes aegypti. Yellow fever is restricted by the 10°C winter isotherm and freezing kills Aedes eggs, larvae and adults (Epstein,2001).

Malaria

Among different infectious diseases, the incidence of malaria, in particular, is generally thought to increase because of climate change and global warming (Bosello*et al.,* 2006). Other vector-borne diseases may increase or decrease, but they currently make much less victims than malaria (Bosello*et al.,* 2006). Diseases, such as malaria, which are transmitted by mosquito vectors, are sensitive to meteorological conditions. Excessive heat and cold kills mosquitoes. Malaria mosquitoes persist in a range between 17 and 33°C (Beck-Johnson *et al.,* 2013). In this range, warmer temperatures increase mosquito reproduction and biting activity and the rate at which pathogens mature within them. For example, at 20°C, falciparum protozoa take 26 days to incubate, but at 25°C, they develop in 13 days. Also, Anopheles mosquitoes live only several weeks and warmer temperatures permit parasites to mature earlier, and the mosquitoes have more time to transfer the infection (Epstein,2001). Temperature thresholds also limit the geographic range of mosquitoes. Transmission of falciparum malaria occurs in geographical areas where temperatures exceed 16°C (Epstein, 2001).

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ISSN: 2536-7277 (Print): 2536-7285 (Online)
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http://www.casirmediapublishing.com

Studies from Kerman, Iran, showed that the most effective meteorological factor on the incidence of malaria was temperature. As the mean, maximum and minimum of monthly temperature increased, the incidence rate rose significantly and models showed that a 1°C increase in maximum temperature in a given month was related to a 15 and 19% increase in malaria incidence on the same and subsequent month, respectively. Other studies from other world countries have also shown the effect of rising temperature in the incidence of malaria (Mohammadkhani*et al.,* 2016).

Dynamic models project that global warming will increase the transmission capacity of mosquitoes some 100-fold in temperate zones, and that the areas capable of sustaining transmission will grow and include more world populations (Epstein, 2001). The reports show that malaria has returned to South Korea, parts of southern Europe and the former Soviet Union. Malaria has also recolonized in the Indian Ocean, coastal province of South Africa, many of these changes in the pattern of diseases are indicative of long-term warming and climate changes. Similarly, climate warming and the resulting change in the length of seasons in the East African highlands have led to an increased incidence of malaria (Franchini&Mannucci, 2015). Over the past century, intense precipitation (>5 cm over 24 h) has become more frequent, and warming of land surface has apparently intensified the monsoons that are strongly associated with mosquito and waterborne diseases in India and Bangladesh (Epstein, 2001). Several studies showed a positive association between increases in malaria and relative humidity, which is often positively correlated with precipitation (Davis *et al.,* 2016).

In GAO Et Al's. (2014) study, in Anhui Province, China, rainfall ($r_s = 0.48$) had the highest relation with malaria incidence. Malaria is a re-emerging disease in this province, and rainfall is known as an important meteorological factor in the re-emerging of this disease in the region. In this study, beside the effect of the same month's rainfall on malaria transmission, rainfall in the earlier months also influenced malaria incidence (Mohammadkhani*et al.,* 2016). Intense precipitation has also been reported to cause malaria outbreaks in Honduras (1998), Venezuela (1999) and Mozambique (2000) after hurricanes, torrential rains and cyclones in South America and southern Africa (Epstein, 2001). Climate change can allow diseases to invade immunologically naive populations with unprepared medical and health-care facilities (McMichael *et al.,* 2006). However, very high rainfall can reduce mosquito populations by flushing larvae from their habitat in water swamps. Researchers have also documented the association of malaria outbreaks with the El Niño Southern Oscillation (ENSO) cycle (McMichael *et al.,* 2006).

Leishmaniasis

Studies have indicated that climate variability may influence changes in the vector geographical distribution as well as the density of the rodent reservoirs of leishmaniasis. In South America, climate variability based on ENSO revealed a significant effect on leishmaniasis. Also significant relationships were found between Mediterranean visceral leishmaniasis and climatic factors in some studies (Davis, *et al.,* 2016). A study from Tunisia found that for relative humidity above 57.8% and lagged by 2 months, for each

1-unit increase in relative humidity, the disease incidence significantly increases by 5%. This study also showed seasonality during the same epidemiologic year and intervals between zoonotic cutaneous leishmaniasis (ZCL) epidemics ranging from 4 to 7 years. Mathematical models showed that ZCL incidence rises by 1.8% (95% CI: 0.0–3.6%) when there was 1-mm increase in the rainfall lagged by 12–14 months, and by 5.0% (95% CI: 0.8–9.4%) when there was a 1% increase in humidity from July to September in the same epidemiologic year. The researchers think that higher rainfall is expected to result in the increased density of plants that are food for Psammomysobesus (the reservoir rodent). Consequently, following an increase in the population of this rodent, the pool of Leishmania major transmissible from the rodents to blood-feeding female sand flies increases and can lead to a higher probability of transmission to humans over the next season (Toumi*et al.,* 2012).

Cholera
Studies have shown that cholera bacteria proliferate more rapidly at higher temperatures and in water (McMichael *et al.,* 2006). Intense precipitation has been reported to cause outbreaks of cholera after hurricanes in Honduras in 1998, and after torrential rains and a cyclone in Mozambique in 2000 (Epstein, 2001). It is possible that increases in the rate of coastal outbreaks of cholera are also related to the warming of coastal waters and El Niño events (McMichael, 2013). A study from Iran showed that the incidence of cholera was significantly related to higher temperature and humidity and lower precipitation. Cholera epidemics are most likely to occur in hot seasons and in countries with more than one hot season, several cholera epidemics are likely each year. The significant relationship reported between the incidence of cholera and the lack of precipitation in Iran may be due to the fact that drought leads to the use of unsafe water (Pezeshki*et al.,* 2012).

CONCLUSION
The potential effects of climate changes on population health cannot be overemphasized. Change in world climate wouldinfluence the functioning of manyecosystems and their member species. Likewise, there would beimpacts on human health. Some ofthese health impacts would bebeneficial. For example, milderwinters would reduce the seasonalwinter-time peak in deaths thatoccurs in temperate countries,while in currently hot regions afurther increase in temperaturesmight reduce the viability ofdisease-transmitting mosquitopopulations. Overall, however,scientists consider that most of thehealth impacts of climate changewould be adverse. Our increasing understanding of climate change is transforming how we view the boundaries and determinants of human health. While our personal health may seem to relate mostly to prudent behaviour, heredity, occupation, local environmental exposures, and health-care access, sustained population health requires the life-supporting "services" of the biosphere. Populations of all animal species depend on supplies of food and water, freedom from excess infectious disease, and the physical safety and comfort conferred by climatic stability. The world's climate system is fundamental to this life-support.

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