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Temporal Analysis of Heatwave Occurances in Kano Metropolis, Nigeria

Isı Dalgası Oluşumlarının Zamansal Analizi: Kano Metropolisi, Nijerya

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ABSTRACT:

Heatwaves have become one of the biggest ecological threats to the survival of people in thebiosphere. For the reason, in this study is aimed that is analyzed the temporal occurrences of heatwaves in the Kano between 2009 to 2018 so as and that it devised a protocol against for this menace. Daily maximum temperature is measured at the synoptic hours during the period of extreme heat (hot anddry). With the se temperature values were used to takeout the period of heatwaves using percentile thresholds of 95th. In 2016 it experienced high number of heatwaves occurrences with consecutive 26 days of 40.8°C. The heatwaves is occurred frequently in April and May. This situation, it implies that is identifying as the periods when the occurrence of heatwaves is intense in Kano in April and May.

KEYWORDS: *Heatwave, Kano Metropolis, Temporal Analysis, Temperature*

ÖZ:

Isı dalgaları, biyosferdeki insanların hayatta kalmasına yönelik en büyük ekolojik tehditlerden biri haline geldi. Bu nedenle, bu çalışmada Kano'da 2009-2018 yılları arasında meydana gelen sıcak hava dalgalarının zamansal oluşumlarının analiz edilmesi ve bu tehdide karşı bir protokol geliştirilmesi amaçlanmıştır. Günlük maksimum sıcaklıklar, aşırı sıcak (sıcak ve kuru) sinoptik saatlerde ölçülür. Elde edilen sıcaklık değerlerinden hareketle %95'lik eşik değerleri kullanılarak ısı dalgalarının periyotları belirlenmektedir. 2016 yılında, 26 gün boyunca 40,8 °C ısı dalgaları meydana geldi. Sıcak hava dalgaları sık sık Nisan ve Mayıs aylarında meydana gelmektedir. Bu durum, Nisan ve Mayıs aylarında Kano'da sıcak hava dalgalarının oluşumunun yoğun olduğu dönemler olarak tanımlanmasını ifade etmektedir.

Anahtar Kelimeler: *Isı dalgası, Kano Metropolisi, Zamansal analiz, Sıcaklık*

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INTRODUCTION:

Heatwaves are very common feature during the warm seasons. An intense heatwave impacts public health, utility infrastructure, and human activities. The severity and frequency of heatwaveevents are representation of large-scale climate patterns and may be related to overall changing climate conditions (Hayhoe etal., 2010). Urban areas are perhaps the most complex of the entire earth`s surface due to the versatile nature of their artificial characteristics as promoted by the various human activities taking place since the humankind`s appearance (Montavez et al., 2000; Ibrahim, 2011). The earth`s surface temperature has been on increase since after the commencement of industrial revolution in Europe. The phenomenon was directly linked to the ample emission of green house gases which emanated from the anthropogenic activities. The increase of carbon dioxide (CO_2), chloro-floro carbon (CFC) and methane (CH_4) in the atmosphere has triggered the occurance of global warming which emerged as a contemporary universal environmental challenge leading to so many heat disorders (IPCC, 2007).

The increase in population of the metropolitan Kano probably causes an increase in the amount of greenhouse gases such as carbondioxide (CO_2), methane (CH_4), cloroflorocarbon (CFCs), and nitrous oxide (NO_2) from the large number of automobiles and electronic generators that emit such green house gases with subsequent increase in the mean temperature of the area which may increases the spate of heat waves intensity. Increased in heatwaves intensity may also cause lowering of water tables leading to emergence of recurrent droughts in the area, frequent bush fires, desertification, decreased in soil fertility which leads to the loss of agricultural products and subsequently increase the risk of death and serious illness especially in younger and older age groups and the urban poor who constituted a large sector of the population (Zaitchik et al., 2006).This means that, metropolitan Kano is at risk, that is the research on the issue of heatwaveneed to be conducted in Kano metropolis as the most growing urban center in Nigeria.

However, despite all these tremendous effects of heatwaves to human being and its threat to the survival of man, little or no information exists on the occurrence of heatwaves in Kano metropolilis. Therefore, this study aim the analyzing the temporal occurance of heat waves in Kano metropolis, Northwestern Nigeria.

2. Materials and Methods

2.1. Study Area

Metropolitan Kano encompasses all the eight Local Governments of Dala, Fagge, Gwale, Municipal, Nassarawa, Tarauni, Kumbotso and Ungogo (Figure 1). It lies from Latitudes 11o52`N to 12o7`N and Longitudes 8o22.5`E to 8o47'E and is 500 metres above sea level. The total area covered is 499.95 km^2 (Ahmed, 2010).

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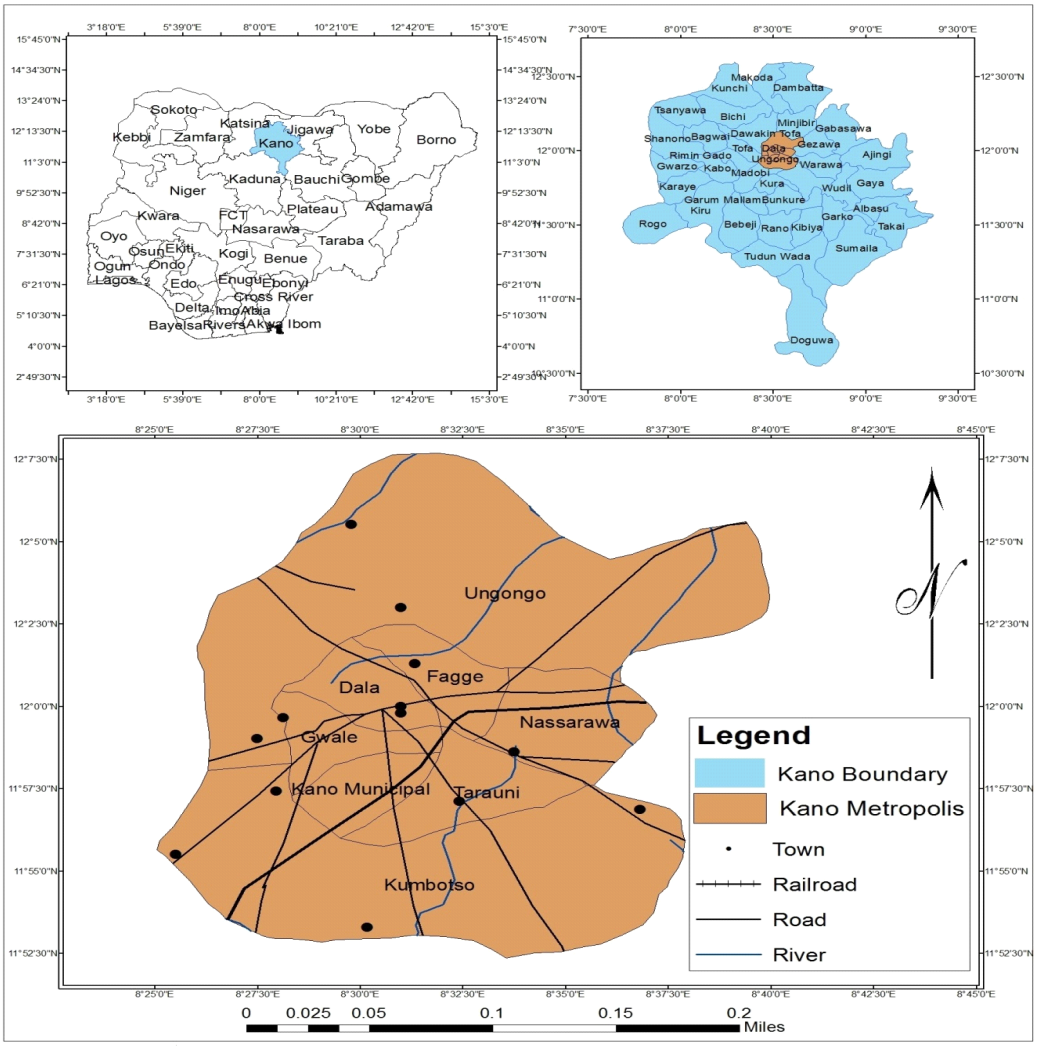

Fig. 1. Kano Metropolis

Ten (10) years daily maximum temperature data (2009 – 2018) for Kano Metropolis was used for this study.The mean monthly temperatures data were obtained from the data archive of the Nigeria Meteorological Agency (NIMET) and Daily maximum temperatures were obtained from International Institute for Tropical Agriculture data base (IITA). All the data were analyzed to compute the 95th percentile values in order to define a threshold for maximum temperature. Values greater than the 95th percentile were extracted and counted for each day per annum and repeated for each year over the 10 years period. The values were then standardized to account for missing data. Plots to show the 10 years variability of the extremes for each of the parameter were generated. The data is set to between the range; ≥ 95th percentilevalues for the maximum temperature.

The data obtained were splited into four seasons in order to determine the period of heatwave occurrences in the study area. Percentiles were used in favour of maximum temperature values as stated by Pezza et al. (2012). Using daily maximum temperature the 95th percentile of temperature was found. A heatwaveevent occurred if it satisfied these criteria: maximum temperature ≥ 95th percentile of the maximum temperature for the month in which the heatwavebegins for a minimum of three (3) consecutive days.

2.2. Data Analyses

The SPSS computer software package was used to analyzed descriptive and inferential statistics. To compare the significance of the trends, Analysis of Variance (ANOVA) was performed and the resulting *P*value, which serves as a criterion to separate the class boundary using Least Significant Difference. The trend for each index was considered significant when found ≤0.05 and less significant above this interval.

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3. Result and Discussion

3.1. Mean Monthly Maximum Temperature and Heatwave Occurances from 2009-2018

Table 1 reveals spectacular out comes and the most highest decade with thirteen days of heatwaveoccurances which were found most especially in April 2016 and 2018. This is followed by April and May of 2009 and 2011 with ten (10) days heatwaveoccurances. The least number of days to which heatwaveoccur during this decade are March of 2014 and 2016 then April of 2014 and May of 2012 and 2014 with five (5) days of heatwaveoccurances. Whereby no heat waves is experieced in the remaining months. Similarly more heatwaveoccurances were experienced in the months of April followed by May and then March. The occurrence of a maximum of 10-13 consecutive days of heat waves in Kano between 2009-2018 is in conformity with the finding of Abbasnia et al. (2016) who reported 10-16 days of consecutive days of heat waves in Iran. More so, examining the seasonal frequency of heat waves during the study period indicated that the short-term heat waves were more frequent than long-term heat waves.

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Table 1: Mean monthly maximum temperature and heatwave occurances from 2009-2018 in Kano (Threshold at 95th fercentile)

Decade Mean Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2009-2018	29.7	34.1	37.6	40.8	38.6	35.2	31.9	30.3	32.2	34.8	34.1	30.3	No. Of Heat wave
2009	Nil	Nil	Nil	10days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	10
2010	Nil	Nil	Nil	9 days	9days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	18
2011	Nil	Nil	Nil	10days	10days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	20
2012	Nil	Nil	Nil	7 days	5 days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	12
2013	Nil	Nil	Nil	8 days	6 days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	14
2014	Nil	Nil	5days	5 days	5 days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	15
2015	Nil	Nil	7days	6 days	6 days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	19
2016	Nil	Nil	5days	13days	8 days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	26
2017	Nil	Nil	Nil	9 days	6 days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	15
2018	Nil	Nil	Nil	13days	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	13
No. of Heatwave days													162 days

Source: I I TA **Field work, 2019.**

Figure 2 below shows the Mean maximum temperature recorded across season between 2009-2018 in Kano metropolis. Based on the result of the analysis, the peak or maximum mean temperature with high intensity of heat was recorded in April (during hot and dry season) with average temperature of 39.88 ^{o}C followed by November (during warm and dry season) with an average temperature of 34.09 ^{o}C and the least mean temperature (29.66 ^{o}C) was recorded in January (during cool and dry season). This means that for the third decade (2009-2018) severe heat was experienced during April (hot and dry season) in Kano Metropolis with average temperature of 39.88 ^{o}C which supersede that of the first and second decade.

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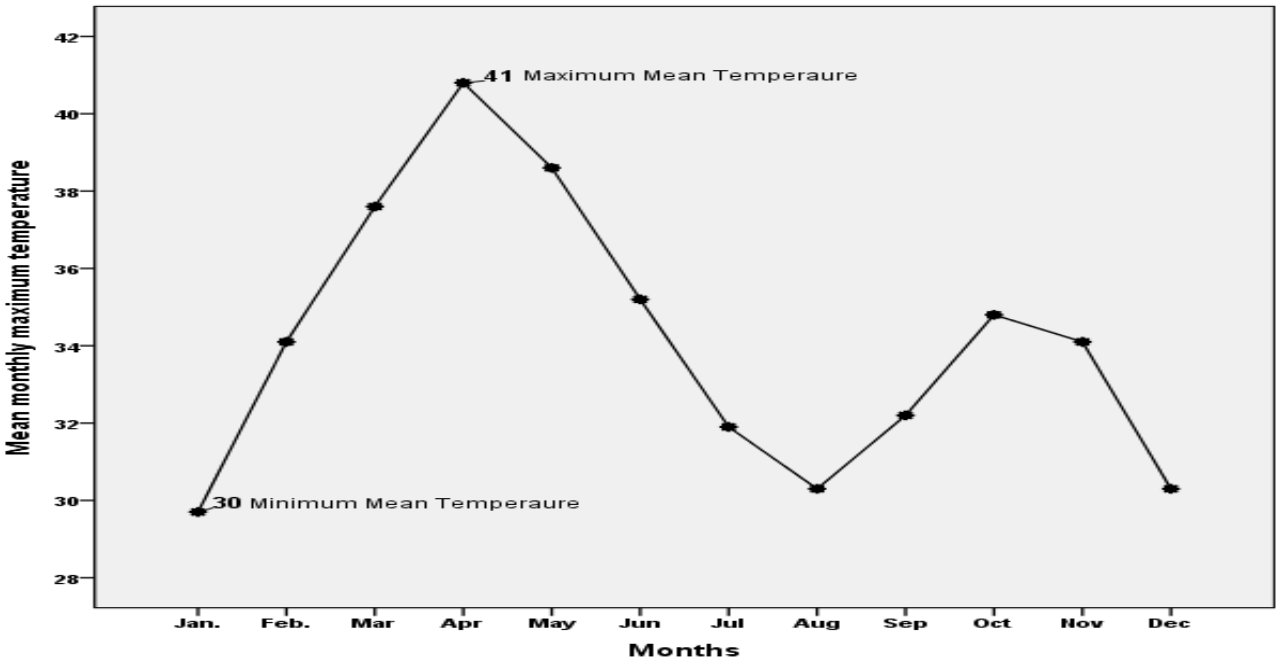

Fig. 2. Seasonal Mean Maximum Temperature By Decades In Kano Metropolis From 2009-2018

The result for the mean seasonal temperature between 2009 to 2018 in Kano metropolis is presented in Table 2. The result revealed that hot and dry season has the highest mean seasonal temperature of 40.8 ^{o}C. This is followed by warm and dry season with 34.1 ^{o}C and wet and warm with 30.3 ^{o}C. While the least mean seasonal temperature was found in cool and dry season with 29.7oC. However, the annual mean seasonal temperature was highest in 2018, 2017 and 2012 with 41.3 ^{o}C 40.3 ^{o}C and 40.4 ^{o}C in the hot and dry season. The least annual mean seasonal temperature is found in 2011 and 2018 with 27.8 ^{o}C in the cool and dry season. In the hot and dry season the temperature do fluctuate from 2009 to 2018 respectively. These increasing trends of extreme seasonal temperature conform to the previous report by Gbode et al. (2015) who reported similar finding of warming trend in Kano with increased number of cool nights, more warm days and a strong increase in the number ofwarm spells. This finding is in line with that of Abbasniaet al. (2016) who reported 10-16 consecutive days of heat waves in Iran during hot and dry periods.

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Table 2: Seasonal Mean Maximum Temperature By Decades From 2009-2018

Years	April (Hot and Dry) T °C Max.	August (Wet and Warm) T °C Max.	Nov.(Warm &Dry) T °C Max.	Jan.(Cool&Dry) T °C Max.
2009	39.9	30.9	32.9	31.8
2010	40.0	30.9	34.8	31.9
2011	39.2	30.1	33.3	27.8
2012	40.4	29.7	34.9	29.5
2013	38.8	29.6	35.4	30.6
2014	38.8	30.1	34.1	29.5
2015	40.0	31.2	32.9	28.1
2016	40.1	29.7	34.9	28.5
2017	40.3	31.0	33.4	31.1
2018	41.3	30.1	34.3	27.8
T °C mean	40.8	30.3	34.1	29.7

Source: NIMET.

The Figure 3 depict the distribution of Mean Maximum temperature across years (2009-2018). Based on the chart we observe that there is an upward and downward trend across the years, for the first three years, the mean maximum temperature (34.40 °C) was recorded in 2010, for the next three years the mean maximum temperature (33.63 °C) was recorded in 2012 and for the last four years the mean maximum temperature (33.95 °C) which was recorded in 2017 thus, the mean maximum temperature was recorded in 2010 of the second decade with mean temperature of (34.40 °C).

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Figure 3. Seasonal Mean Maximum Temperature by Decade from 2009-2018

The result from the analysis of variance revealed that there is no significant difference between years. Since the calculated P-value is (0.496) which is greater than p-value at 5% confidence level. However, significant difference exists between seasons hence calculated P-value is (0.000) which is less than the 5% confidence level.

The Duncan's separation indicated the season recorded the maximum mean temperature for the third decade. The highest mean maximum temperature (39.88 ^{o}C) which is greater than that of the first and second decade was recorded in April (during hot and dry season) followed by 34.09 ^{o}C which was recorded in November (during warm and dry season) of the third decade and the least mean maximum temperature (29.66 ^{o}C) was found in January (during cool and dry season).

To mitigate the occurrence of heatwaves orientation exercise via the print and electrononic media by governmental and non-governmental organizations to create awareness to the general public upon the inherent dangers associated with heat waves occurrence ought to be put in place. This assertion conforms to the report by the National Disaster Management Authority Government of India (2016) who reported use of print and electrononic media as the major strategy in combating the occurrence of heatwave.

CONCLUSION:

The increase in population of the metropolitan Kano probably causes an increase in the amount of greenhouse gases such as carbondioxide (CO_2), methane (CH_4), cloroflorocarbon (CFCs), and nitrous oxide (NO_2) from the large number of automobiles and electronic generators that emit such green house gases with subsequent increase in the mean temperature of the area which may increases the spate of heat waves intensity.

It was concluded from the research conducted that heatwavedo occur in Kano metropolis between April and May with its highest peak of 21 consecutive days in 2016 with the highest temperature of 40.8 ^{o}C. Therefore, it was recommended that the public need to be aware upon the devastating impact of heat waves via both print and non-print media and organizing sensitization campaign so as to prevent its future occurence.

ETICAL STANDARDS:

Conflict of Interest: There is no conflict of interest between the authors or other persons

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