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Geo-informatics assessment of urban heat impact within clustered building zones: A quantitative evidence for the enactment and enforcement of environmental friendly building laws in Calabar metropolis

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Abstract
Heat Island forms as cities replace vegetation with pavement for roads, Buildings and infrastructures that absorb and re-radiate the heat, thus increasing surface and ambient air temperatures of Calabar Metropolis. It also impacts negatively on human health and the environment. Higher temperature causes an increase use of air conditioners which results in additional power plant emissions of heat trapping greenhouse gasses. The study investigates the impact of urban heat island and captures its implication in this work as basis for the need for a more pragmatic legal framework to curb the excessive human activities which culminate into world global warming and incidents of urban heat Island, especially, in city and urban centres. To achieve this, sampling data were collected in synoptic hours in six (6) locations in the metropolis and two points in the rural area. The data were subjected to statistical and GIS analysis to determine the heat index in the study area. The results showed that Mobil, Orok Orok, SPC Junctions and Watt Market were points with highest temperature. Statistically, the study also revealed that there is a significant variation in heat index between urban and rural areas. It was thus recommended that along with the technological options formulated for curbing the issue of urban heat island, a new legal framework and the amendment of the existing Building Laws should be designed and enforced to endorse eco-friendly urban practices for sustainable development.

Keywords: building law, zoning code, urban heat island, global warming, architectural designs, landscape design

1. Introduction

Air temperature is gradually rising in all cities of the world. Several factors become the cause of it, such as diminishing of green area, low wind velocity due to high Building Density and change of street surface coating materials [1]. As Buildings, Roads and other infrastructures replace open land and vegetation; surfaces that were once permeable and moist become impermeable and dry [2]. The reason is not far-fetched. The need for more building to provide more accommodation for the increasing number of persons who move to the city centres, has led to the alteration on land cover which in effect has tremendously affected thermal energy flow leading to elevated surface and air temperature.

Urban areas tend to have higher air temperatures than their rural surroundings as a result of gradual surface modification that include replacing the natural vegetation with Buildings and Roads. The term "Urban heat island" describes this phenomenon. Studies have shown that urban heat island is a fall out of Global warming for which many of the existing legal frameworks were designed to address. According to EPA 2017, Portland modified its zoning code to include "eco-roof development bonus" for developers to install green roofs called eco-roofs [3]. While in Seattle, the city adopted the minimum landscaping requirements in 2007, known as the Seattle factor [4] and the city of Pennsylvania, in the state of Pennsylvania, in its weatherization program under the Energy Coordinating Agency (ECA) applied cool roof coating as part of its package of energy efficiency treatments. Applying this program in the study area, is capable of eliminating 90 % of heat gain through the ceiling, reducing 4.7 ºf (26ºC). These reduced temperature lowered air conditioning loads in Pennsylvania, Philadelphia by about one third in typical row Buildings. Typically, and without such remedial measures, surfaces of Buildings and pavement absorbs solar radiation and become extremely hot, the heat energy, through the process of convection, is transferred to the surrounding air at

1. Takeuchi W, Hashim, N, Thet KN. Application of remote sensing and GIS for monitoring urban heat island in Kuala Lumpur Metropolitan, 2010.
2. EPA 2017
3. Oregon, Portland Zoning code 2001, Title 33, Chapter 33.510 PDF
4. Washington, Seattle zoning code, 2007, Department of planning and Development-Green Factor

the lower troposphere. This heated air, rises up and further transfers the heat energy to other air molecules. The continuous heating up of these air molecules by these paved surfaces, creates an atmospheric temperature different from the surrounding atmospheric temperature, assuming the land covers of the two surrounding areas differ, which in turn warm the surrounding air. Cities that have been paved over do not receive the benefit of the natural cooling effect of vegetation, which consequently increase the rate of solar radiation on the Earth surface and increases the temperature of the Earth. One can only imagine the excruciating effects on Built environment and occupants of Buildings erected in cities with the already increasing effect of urbanization, the centre periphery pull characterized by movement of people to the city centre where infrastructure needed for modern living are provided. This is of great concern to environmentalist, particularly Environmental Lawyers and policy makers. And is necessarily captured in this work as basis for the need for a more pragmatic legal framework to curb the excessive human activities which culminate into world global warming and incidents of urban heat Island, especially, in city and urban Centres.

It is believed that more than half of the world's population live in urbanized environments and the urbanization process is increasing through time. With increasing urbanization problem in Calabar metropolis, and lack of good planning several environmental problems arise as a result of different human activities. However, among several human - induced environmental problems in the metropolis, urban thermal problems are reported to be negatively affecting urban residents in built environment in many ways e.g. discomfort at night, increasing room temperature at night, heat rashes, excessive sweat during peak and off peak periods, high energy consumption for cooling of homes etc., [5] observed that built-up structures in urbanized areas considerably alter land cover thereby affecting thermal energy flow which leads to development of elevated surface and air temperature - the phenomenon termed as urban heat island (UHI) which implies "island" of high temperature in cities, surrounded by relatively low temperature in rural areas.

This study, examines the difference in heat index in Calabar and its fringes so as to understand the impact of urbanization on atmospheric temperature and human habitation in and around buildings, as the basis for a more pragmatic enactment and effective Enforcement of Environmental Friendly Building Laws in Calabar metropolis.

1.1 Study area characteristics

Calabar metropolis is located in the southern part of Cross River State, the city lies between longitude 8º18'00" E to 8º24'00" E of the Greenwich meridian and latitude 4º54'00" N to 5º04'00" N.

It is bounded by two rivers which are the great Qua River and Calabar River. The city is bordered by Odukpani Local Government Area of Cross River at the North, Akpabuyo Local Government Area at the East, The Atlantic Ocean at the South and Akwa Ibom State at the West. Calabar was the first city in the then Eastern Nigeria and has remained more than 300 years in Nigeria. Under the Köppen's climate classification, Calabar features a tropical monsoon climate (Köppen: *Am*) with a lengthy wet season spanning ten months and a short dry season covering the remaining two months. The harmattan, which significantly influences weather in West Africa, is noticeably less pronounced in the city. Temperatures are relatively constant throughout the year, with average high temperatures usually ranging from 25 to 28 degrees Celsius.

There is also little variance between daytime and nighttime temperature, as temperatures at night are typically only a few degrees lower than the daytime high temperature. Calabar averages just less than 3,000 millimeters (120 in) of precipitation annually. The city is characterised with two main type of vegetation, which lies between two vegetative belt that is the tropical forest and the mangrove swamp along the coast.

2. Literature review

Urban heat island is primarily due to the replacement of the natural landscape with hand, non-porous surfaces that are typical in most cities [6]. Urban heat island is thus a function of urban surface characteristics thermodynamic properties of construction materials, morphology, geometry, and local climate factors like wind speed/direction, elevation, cloud cover [7]. According to Luvall and Holbo (1989) a comparison of several types of surfaces from a study in Oregon indicated a potential temperature differences that can be observed even in urban area. According to USEPA (1997), communities can take a number of steps to reduce the heat island effect, using four main strategies, increasing tree and vegetable cover; creating green roof (also called rooftop gardens or eco-roofs); installing cool-mainly reflective roofs, and using cool pavements. The mitigation of heat island effect is the function of increasing of surface albedo (Ibid). Kandya (2009) observed that several studies have documented the measured energy savings that result from the cool roof which reflect a large fraction of the incoming sunlight and keep the roof surface at lower temperature than that of the regular hot roof that absorb most of the incoming solar radiation. Synnefa *et al* (2006) studied the thermal performance of 14 reflective coating for the urban environment and demonstrated that the use of reflective coatings can reduce a white concrete tile's surface temperature under hot summer condition by 4ºC and during night time by 2ºC. Taha *et al* (1999) have reported that proper values of surface - albedo could achieve temperature reduction and peak electricity energy savings.

Takeuchi Hashim & Thet (2010) [8] in his study on the application of remote sensing and GIS for monitoring urban heat island in Kuala Lumpur Metropolitan using on MODIS data of Kuala Lumpur Metropolitan City, Indonesia from 2008-2009, land surface temperature (LST), which was retrieved and used to get the pattern of urban heat island (UHI). The monthly MODIS data were divided into four

5 Gudina, L. Role of vegetation in mitigating urban heat island, 2009.

6 Martilli, *et al*. Mitigating the urban heat island with green roof infrastructure, 2002.

7 Oke TR. Mitigating the urban. Heat island effect, 1982.

8 Takeuchi W, Hashim N, Thet KN. Application of remote sensing and GIS for monitoring urban heat island in Kuala Lumpur Metropolitan, 2010.

seasonal period i.e. North East Monsoon (November to March), South West Monsoon ((May to September) and two period of intermediate monsoons (April and October respectively). About 56 locations of known pixels within the area of Kuala Lumpur Metropolitan City were selected through systematic sampling to develop GIS contour map using Arc-GIS software. The preliminary result showed that the mean highest LST occurred in South West Monsoon period i.e. 309o Kelvin in daytime, while area with high urban imperviousness coverage is the most notable UHI gradient. Surface urban heat islands are typically present day and night, but tend to be strongest during the day especially in the Northeast monsoon. The existence of urban Cold Island in some season can be associated with the occurrences of urban green patch within the metropolitan area. This study also suggests that the MODIS-LST data retrieved from the University of Tokyo is the most viable information to monitor urban heat island pattern in Malaysia.

Lastly, Aremu, Bello, Aganbi & Machoko (2017) [9] in their study on the application of remote sensing and GIS in assessing the urban heat island (UHI) in Akure town. A time series of Landsat data, from 1986 to 2014, were used in the present study to determine the urban growth and the intensity of urban heat island. The study also examines the spatial distribution of urban surface temperature and NDVI with remotely sensed data in the urban area. It was observed that the greatest urban growth occurred in Akure South with 54.22 per cent and 58.96 per cent in the two periods of study. Also, the greatest urban growth occurred in the second period with a total of 60.20km² compared to the total of 49.96km² in the first period. The urban growth over the entire study area showed a yearly increase of 47.79sqkm. Changes in LULC were accompanied by changes in NDVI and LST. In 1986, it was found that average NDVI (mean ± S.D.) in the non-built up area was 0.30 ± 0.07 and for the built-up area, it was 0.16 ± 0.09. However, this statistics reduced to 0.28 ± 0.06 and 0.13 ± 0.06 in 1999 respectively. Furthermore, the statistics was 0.24 ± 0.05 for non-built up and 0.06 ± 0.04 for built-up in 2014. It was found that average surface temperature (Mean ± S.D.) in the non-built up area in 1986 was 24.01 ± 1.21 and 27.28 ± 1.12 for the built-up area but this difference jumped to 26.52 ± 2.02 and 29.86 ± 1.66 in 1999 and further to 31.48 ± 2.03 and 33.82 ± 1.07 in 2014. It was also observed that the temperature differences between the urban built-up and the non-built up significantly widened and this have led to the high intensity of urban heat island.

3. Materials and Method

3.1 Research design

The research design is centred on the plan, structure and strategy of investigation undertaken by the researchers. This work involved field measurement using global positioning system (G.P.S) and weather tracker device. It adopted tele-methodology to collect data simultaneously from seven locations within Calabar metropolis and its urban fringes.

3.2 Types of data

The study adopted the use of both just continuous data. The continuous data are data that exist as a fluid or flow in a field. They do not have a unique property and they exist as a continuum of values, unlike field or discreet data that exist simply. Based on the objective of the study, the continuous data used include: humidity, elevation, temperature, Heat index and relative humidity, wind speed and wind direction, cloud cover, land cover, and urban heat island intensity.

3.3 Source of data

The study adopted both primary and secondary data in carrying out the objective of the study. The primary data are obtained from the field with the use of weather tracker devise and G.P.S. The secondary data are obtained (the elevation data is a secondary type data so therefore it was gotten from a source, please what is the source?) from internet materials, journals, textbooks, seminar/workshop papers. The data types were both continuous and discreet types.

3.4 Sampling techniques

The sampling technique adopted for the study is a quota sampling method. The quota sampling method is a sampling method which group objects into quotas or groups like a cluster, and randomly selects the number of samples needed based on the quota allotted for each sampling group. As a result, three sample locations were selected from the Calabar South Local government area, which include: Watt market Round about, Orok Orok junction and Jebs/Ibesikpo/Iman junction and another three sample were chosen from Calabar municipality (Ibom layout/crunches, SPCC Junction and Mobil Junction) which make up the Calabar metropolis, while the control was taken at Atimbo/Esuk Ekpo-Eyo across the Akpabuyo bridge, which is within 1km radius from the urban center. In this study, the control point serves as a reference area for comparing observable change heat index parameters. The sub-urban or semi urban region in this study serves as the control point for the study, while the urban region serves as the study point. The study points include: Orok-Orok junction, Jebs/Ibesikpo/Iman junction, Ibom layout/ Crunchies, SPCC Junction and Mobil Junction.

3.5 Method of data analysis

Data gathered from field work were subjected to statistical analysis, G.I.S analysis, tables, graphs, charts and the adoption of the student t-test, to assess the level of significance in the difference in heat index between urban and semi-urban region in Calabar metropolis.

[9] Aremu O, Bello E, Aremu P, Aganbi B, Machoko J. Monitoring and analysis of urban heat island using remote sensing data, a case study of Akure, Ondo State, Nigeria, 2017.

4. Result and Discussion of findings

Table 1a: Summary results showing the meteorological information within Calabar Metropolis, Cross River State

Location	Temperature				Health intensity				Relative humidity			
	Min	Max	X	Cv (%)	Min	Max	X	CV (%)	Min	Max	X	CV (%)
Ibom layout/ crunches roundabout	30.0	3.00	2.83	2.69	40.10	7.20	5.23	2.40	0.70	9.80	8.63	5.39
Atimbo/ Esuk Ekpo Eyo (rural surrounding)	9.80	3.00	0.78	2.80	38.90	2.20	0.94	2.79	0.60	9.80	5.27	41.09
SPC junction (Highway)	30.0	3.00	2.83	2.69	40.10	7.20	5.23	2.39	50.70	59.80	46.63	5.39
Mobil junction (Highway)	30.00	33.0	2.83	2.69	40.10	46.2	45.23	2.39	50.70	59.80	41.63	5.39
Watt market	0.00	3.00	2.83	2.69	40.10	48.2	45.23	2.40	50.70	59.8	45.62	5.39
Ibesikpo/Jebs and Iman junction	0.0	3.00	2.83	2.69	40.10	46.2	45.23	2.40	50.70	59.8	47.62	5.29
Atimbo before bridge head (Rural surrounding)	29.1	33.1	30.76	2.8	39.1	42.2	40.35	2.16	48.2	59.8	55.93	7.78

Table 1b: Summary results showing the meteorological information within Calabar, Metropolis, Cross River State

Location	Wind speed				Vegetation cover				Building area			
	Min	Max	X	Cv (%)	Min	Max	X	CV (%)	Min	Max	X	CV (%)
Ibom layout/ crunches roundabout	0.60	1.50	1.09	3.22	0.70	0.70	0.7	3.43 E - 06	0.30	0.30	0.30	1.91 E - 06
Atimbo/ Esuk Ekpo Eyo (rural surrounding)	0.60	1.80	1.13	25.10	0.70	0.70	0.7	3.47 E - 06	0.30	0.30	0.30	1.91E - 06
SPC junction (Highway)	0.60	1.50	1.09	23.22	0.70	0.70	0.7	3.47E - 06	0.30	0.30	0.30	1.91E - 06
Mobil junction (Highway)	0.60	1.50	1.09	23.22	0.70	0.70	0.7	3.47E - 06	0.30	0.30	0.30	1.91E - 06
Watt market	0.60	1.5	1.09	23.22	0.70	0.70	0.7	3.47E - 06	0.30	0.30	0.30	1.91 E - 06
Ibesikpo/Jabes and Iman junction	0.6	1.5	1.09	23.22	0.70	0.70	0.7	3.47E - 06	0.30	0.30	0.30	1.91E - 06
Atimbo before bridge head (Rural surrounding)	0.6	1.8	1.103	30.15	0.8	0.8	0.8	0	0.20	0.20	0.20	0

Table 2: Latitude, Longitude, Deviation and Metrological parameters in the urban centre

	Urban centre	Lat.	Long.	Elev.(m)	Temp (mean °C)	Heat index (mean)	Rel. Humidity
1.	Ibom layout	4.9686 (dg. Ck)	8.3383	52	32.83142	43.8659	48.2618
2.	Ibeskipo	4.9306	8.3122	22	31.83214	42.86792	45.27134
3.	Watt market	4.9572	8.3203	41	82.83214	44.86782	45.869
4.	Mobil junction	5.0169	8.0339	92	32.83216	45.9245	41.28790
5.	SPC junction	5.0216	8.3337	71	32.8614	44.86715	46.2567
6.	Orok orok	4.9492	8.3378	56	32.8614	45.26862	43.2881
7.	Atimbo I	4.9671	8.3667	9	30.23461	40.28969	55.2468
8.	Atimbo II	4.9428	8.4022	50	30.23461	40.2964	55.2468

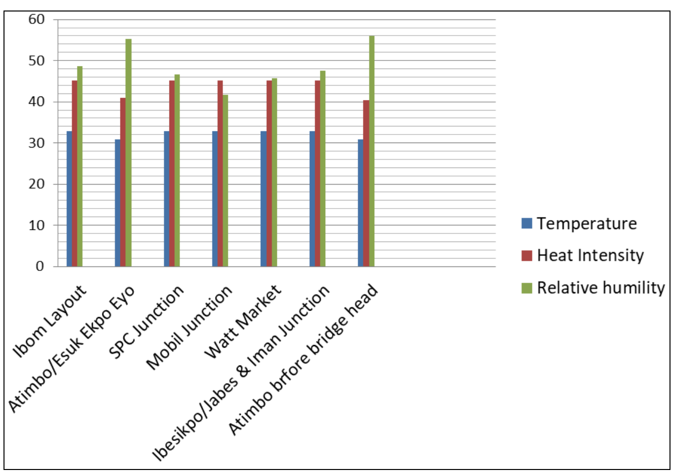

Fig 1: Mean temperature, heat index and relative humidity in the study area

4.2 Heat index between urban and semi urban environ

Test of Hypothesis

Hypothesis

Ho: There is no significant difference in the heat index between urban centre and the surrounding semi urban area in Calabar metropolis.

H_1: There is a significant difference in the heat index between the urban centre and the surrounding semi urban area in Calabar metropolis.

The t-test was calculated as using the formula below

T-calculation = X1 - X2

mean urban area

$$X_1 = \sqrt{\frac{\Sigma(X1 - X2)^2 + \Sigma(X_2 - \overline{X_2})}{n_1 + n_2 - 2}\left(\frac{1}{n} + \frac{1}{n_2}\right)}$$

X_1 = mean urban area

X_2 = mean rural area

$\Sigma (X_1 - X_2)^2$ = standard deviation for urban

Degree of freedom = $(n_1 + n_2) - 2$

Table 3: T-test result for mean comparison heat index between urban and semi urban area

Meteorological parameters	t-cal	t-critical	
Temperature	17.00576222	6.313748599	Xxx = significant 1% level
Relative humidity	2.15620417^{ns}	6.313748599	ns - not significant
Heat index	9.592211 ^{xxx}	2.131846	
Windspeed	=1.99993001^{ns}	6.313748599	
Mean X =	6.6886	5.2682	

Table 3 shows the student t-test for the hypothesis, which states that there is a significant difference in the heat index between urban and rural area in Calabar area. This is because the t-calculation, for temperature between the urban and rural area is significant at 0.01level. The null hypothesis (H_0) is rejected and the alternative (H_1) is accepted. That is, there is a significant difference in the heat index between the urban centre and the surrounding semi urban area in Calabar metropolis.

4.3 G.I.S analysis

Figure 2 shows the spatial distribution of the mean temperature in both urban and rural areas. In this case Atimbo (1) and (2) were the semi urban areas (control point), while State Housing Mobil Junction, Ibom layout, watt market, orok orok Junction and Ibesikpo were the urban areas.

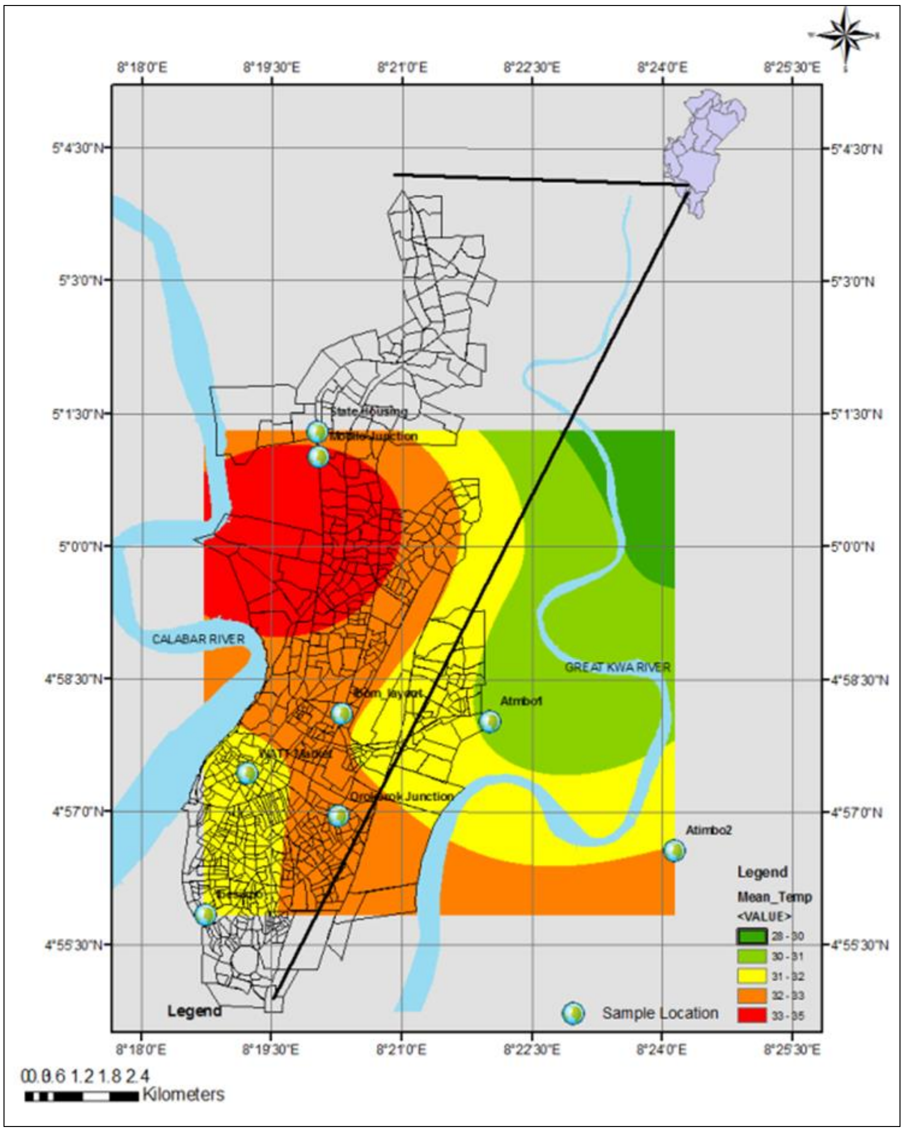

Fig 2: Spatial distribution of mean temperature in Calabar metropolis

From the analysis above, temperature increases from Atimbo 1 and 2 towards the city centre. The green colour represents low temperature ranges from 28ºC – 30ºC in the rural area. Several factors may contribute to this e.g. vegetation cover and proximity to river. While yellow, brown and red represent high temperature ranging from 30ºC – 33ºC. Mobil junction happens to have the highest 33ºC because of proximity to industrial layout (EPZ). The temperature difference is 2ºC – 3ºC between the urban centre and the rural area. The result shows that there is urban heat island in the urban centre. Temperature gradient is shown graphically in figure 3.

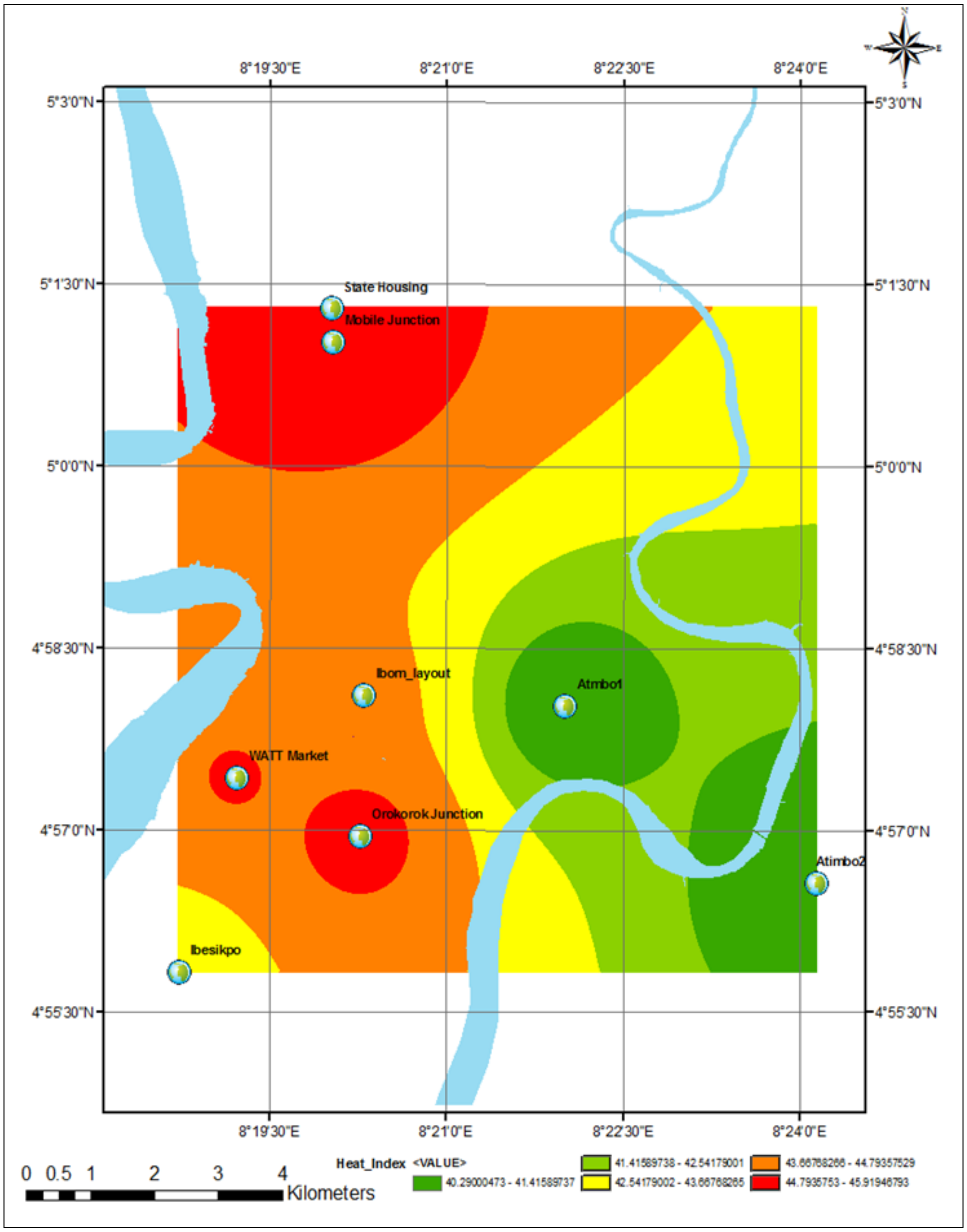

Fig 3: Distribution of heat index depicting heat wave characteristics in Calabar metropolis

The above map shows heat index gradient from the rural area (Atimbo 1 & 2) to the Urban centre. There is a steady increase as you move towards the urban centre. The green colour indicates heat index from 40.2900ºC to 41.415ºC, light green shows 41ºC - 42ºC, the yellow shows 42.54-43ºC. Brown and red colours range from 43ºC-44ºC and 44ºC-45ºC respectively.

Heat index takes the actual air temperature and factors in the relative humidity to arrive at the temperature the human body feels. Heat index justifies that temperature alone is not enough parameter to determine the degree of heat in Calabar Metropolis.

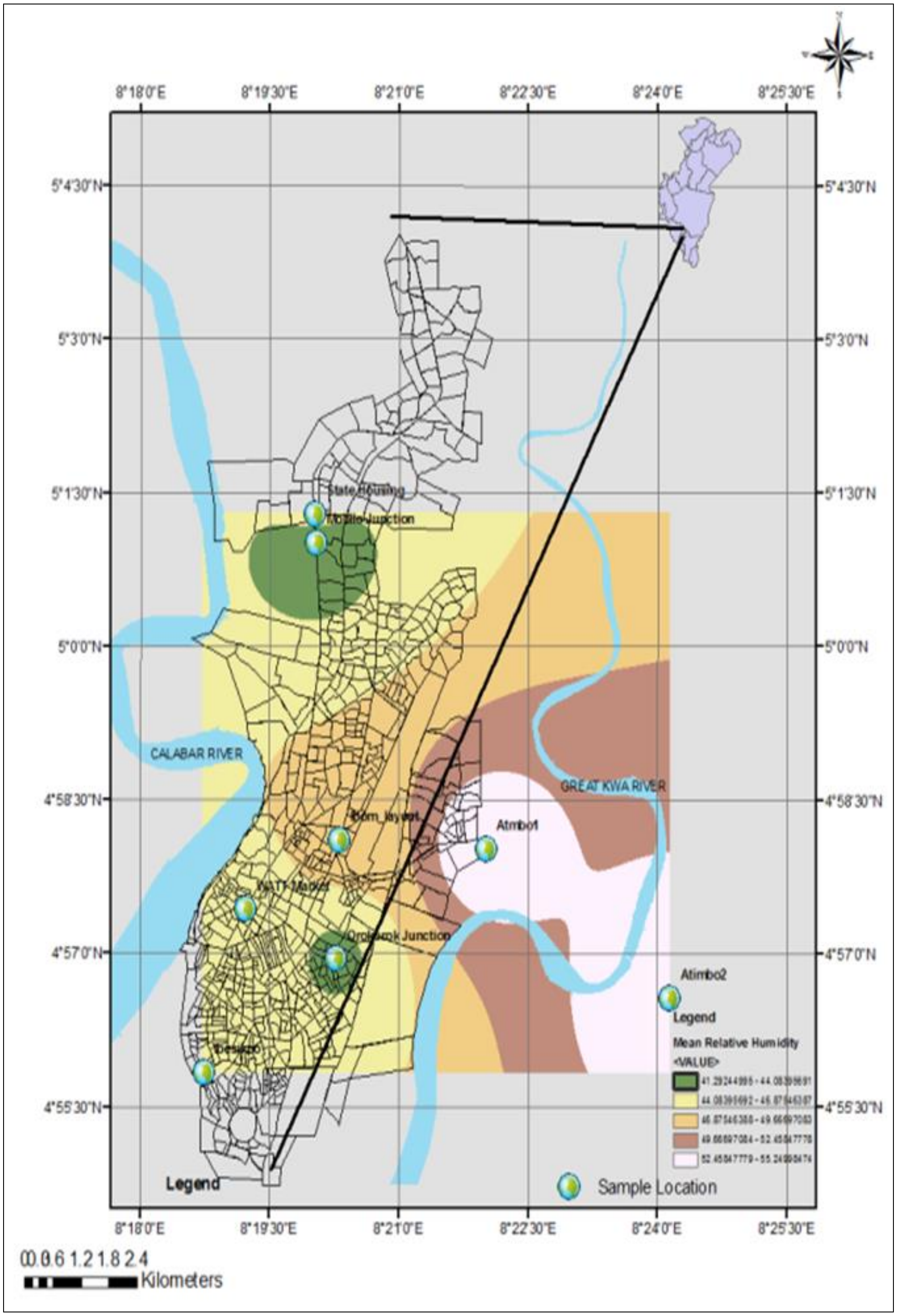

Fig 4: Spatial distribution of mean relative humidity in Calabar metropolis

The distribution map above shows that Atimbo 1 and 2 have the highest relative humidity. While Orok Orok and Mobil junction have the lowest relative humidity. In this case the reverse is the case in the heat index map. Relative humidity reduces from the rural area as you move toward the urban centre.

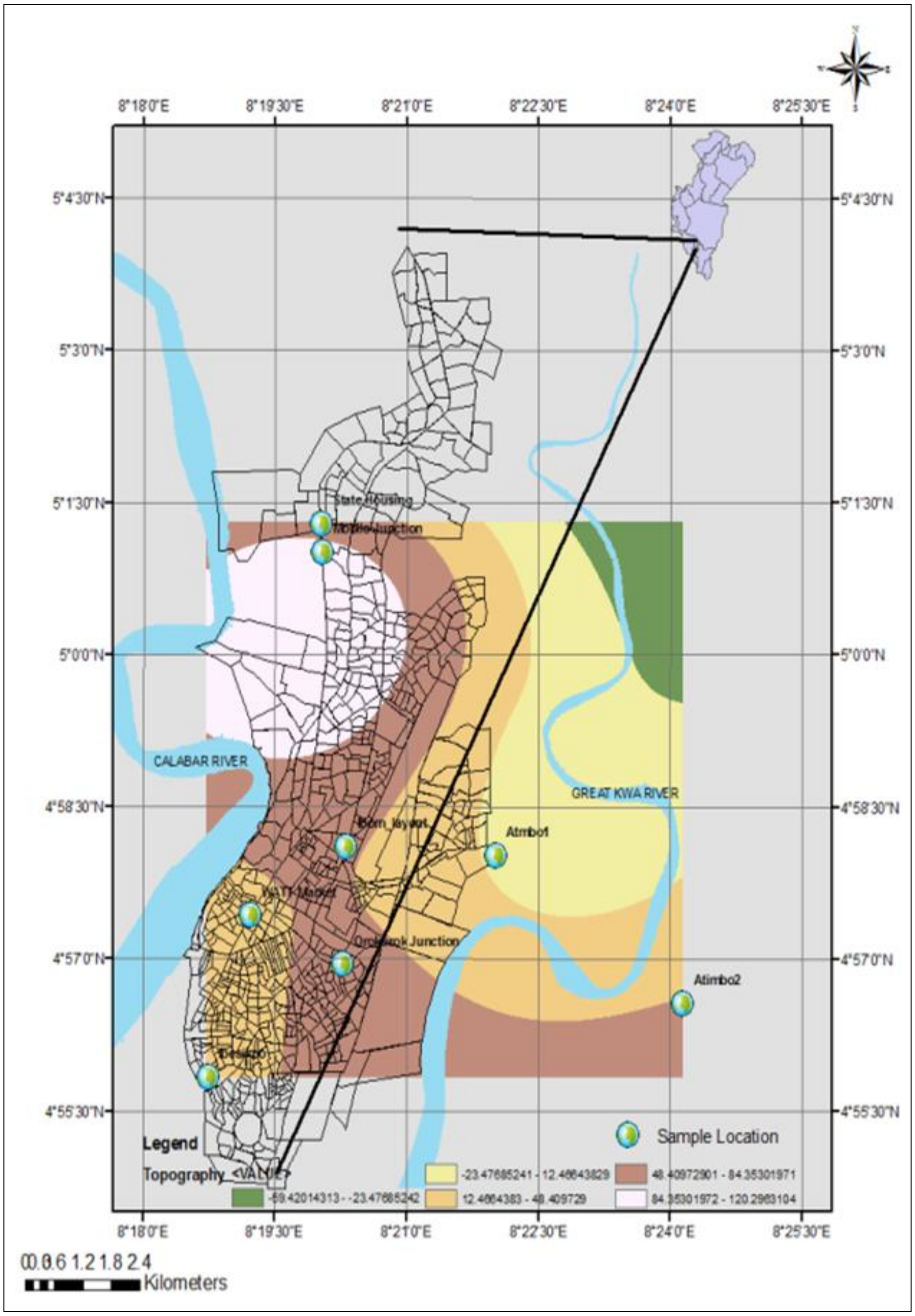

Fig 5: Topographical configuration of the study area determine in meters

This analysis shows that Atimbo (1) has the lowest elevation in the study area with -23.47 meters -12.46 meters above sea level and Mobil junction recorded the highest point. The legend explains in colour and figures for proper understanding.

4.4 Discussion of findings

The study revealed that, there is a significant difference between the urban center and its surrounding rural area as indicated in table 3. Fig 2 shows that the temperature gradient from the rural area is significant at 2ºC to 3ºC, which means there is an urban heat island in the metropolis. This is found to have contributed to increasing room temperature and discomfort at night, heat rashes, excessive sweat during peak period. This has of necessity led to high energy consumption for cooling homes and offices in the city areas.

The GIS analyses, however, avail that temperature alone cannot depict the heat intensity in the study area, meaning that there are some forms of interactions with other variables. For instance, Atimbo recorded a high level of relative humidity (55%) as well as high level of vegetation cover with low elevation. These factors have greater influence on the air temperature in the area. In the urban centre the reverse is the case, every point in the metropolis has low relative humidity, low vegetation cover, high built up area and high elevation. These factors also increase the heat index level. And therefore, calls for revision of existing scheme with a more pragmatic result oriented planning schemes in keeping with the findings of this research.

Again, from the spatial mean index distribution map (Figure 3), the Central Business Districts (C.B.Ds) recorded the highest heat index level. The implication is that it will affect the thermal productive hours in this areas. Excessive heat exacerbates discomfort and inversely impact on micro climate and climatic elements greatly influence urban heat intensity. Buildings therefore in metropolis should by law be designed and built according to as they will reduce the excessive heat trappings, allow free flow of Air and Ventilation. For instance, the ceiling height should by law be increased from the current 8.5 meters allowed by the Cross River State Building Regulation of 1984 as amended in 1987. There is no doubt that as excessive heat is being battled in line with the recommendations in this work, the Thermal Productive Hours will be improved and economic viability will be enhanced, as against the recorded loses in the work force due to increase death due to heat wave condition especially during dry season.

5. Conclusion and Recommendation

Urban heat island is a significant phenomenon with a lot of adverse effect to human, buildings and environment. Urban Heat Island causes increase in temperature that affects human comfort. It causes heat cramps, heat strokes and exhaustion. Dark coloured textures like asphalt, concrete and non-pervious surfaces traps heat and re-radiates heat at night to increase heat intensity in cities. Heat island, coupled with heat wave condition during dry reason can cause serious human discomfort and death rate.

Urban heat island is a characteristics warmth difference between urban centres and its surrounding rural area. The phenomenon was observed ranging from 1ºC and 3ºC in the metropolis. The intensity was high in places that are densely populated. The implication is that built-up areas contribute to increase in temperature. Heat island intensity depends on land cover, where there is thick vegetation cover the intensity is low and where vegetation is less temperature increases. One of the major causes of heat island is vegetation lost due to building of roads, houses etc. If construction is made with adequate plan of not removing land cover, heat island intensity will reduce. Urban centre will not have a significant difference in temperature as compare to the rural area surrounding it. Furthermore the architectural design of buildings is relevant in controlling the rate of expansion and contraction of buildings so as to allow for easy reflection of heat during night hours.

As thus, it was recommended that:

1. Green buildings and sustainable architectural designs for urban centers should be encouraged especially in newly developed areas. In other words environmental friendly materials like hollow Blocks etc, should be used in building construction, while only walk ways should be paved in the study area. Hollow blocks do not allow heat to be trapped in Buildings thereby reducing the negative impacts of heat island identified in the work.
2. A “one man one tree” principle should be practiced by stakeholders since this will restore vegetation cover in the urban centers. As part of the city planning scheme, ever building construction must be preceded by the planting of trees.
3. The use of energy serving bulb and green technology should be enforced at homes, offices, industries, institutions, in Calabar metropolis. The revised Building Law must make provision for observation of green technology.
4. Urban Landscaping should introduce as much of greenery and trees so as to act as zinc in absorbing excessive emissions of atmospheric pollutions and heat episodes. For instance, parrking lots should be designed with grasses planted by the side, while green belt centers should be cited in areas that records the highest heat index.
5. The United States Environmental Protection Agency (USEPA) strategies for reducing heat island effects should be adopted by urban residents in the study area. These include:
   1. Increasing trees and vegetation cover.
   2. Creating green roof also call roof top gardens or eco-roofs
   3. Installing cool reflective roofs and using cool pavement.

These will go a long way in ensuring that planning and Building Laws is not left at the mercy of politicians who can access funding for Building super monumental structures that may defy the essence of sustainable development.

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