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CLIMATE CHANGE AND HEALTH VULNERABILITY IN INFORMAL URBAN SETTLEMENTS OF KADUNA METROPOLIS

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ABSTRACT
Nigeria is identified as one of the hot spots of climate change, and it is projected to be affected more, due to its location and coping capacity. Urban populations living in informal settlements are widely recognized as inherently vulnerable to climate change, because of their socioeconomic characteristics. Information regarding health vulnerabilities of these populations is lacking in Nigeria, which will severely constrains the design of climate change adaptation strategies. This study has provided information for the city of Kaduna, Nigeria, by using both climate and socioeconomic information in two selected communities (Sabon-Tasha and Rigasa) where informal settlements exist. Multistage sampling technique was used in selecting target communities, while Focus Group Discussions and structured questions where used in obtaining information, in addition to the meteorological obtained from the Nigerian Meteorological Agency. Obtained information was used to compute vulnerability index. Results indicate both communities have little or no knowledge about their health vulnerability and risk to climate change. On the scale of 0 – 10, both communities show high vulnerability to changes in temperature (6.0) and rainfall patterns (5.6). While in terms of vulnerability of the nominated diseases, both communities shows high index to malaria (8.7) and cholera (8.2).

Keywords: Climate Change, Health, Vulnerability, Informal settlement, Kaduna

1.0 INTRODUCTION

According to projection by the United Nations Human Settlements Programme (UN-HABITAT) in 2012, global slum population may double from close to one billion at present to two billion by the year 2030. Currently, over 40 per cent of Sub-Saharan Africa's urban population are estimated to live in urban slums. This poses a serious health challenge to the respective governments and people living in such area, most especially with the changing climate which is expected to exacerbate prevalence of infectious diseases.

At present, about half of the entire world population are now living in urban areas, and this proportion is expected to increase. Much of the future growth in urban areas is expected to take place in developing countries, with Africa and Asia estimated to have about 70% urban inhabitants in the world by 2030 (United Nations Population Fund, UNFPA, 2007). Unfortunately, due in part to limited economic opportunities and an increasing shortage of affordable housing, the majority of urban growth in many of the developing world's fastest growing cities is as a result of the expansion of informal settlements, often referred to as slums (United Nations Human Settlements Programme, UN-HABITAT, 2008). UN-HABITAT defines informal settlements as urban areas where households lack one or more of the following conditions: access to an improved drinking water source, access to improved sanitation facilities, sufficient living area, durable housing in a non-hazardous location, and security of tenure. As one might expect, these conditions can have severe consequences for human health and are of particular concern when considering their potential impact on the spread and burden of infectious diseases (Patel and Burke, 2009). For example, tuberculosis, influenza, meningitis, typhus, plague, typhoid and cholera are among many infectious diseases historically associated with conditions now common in urban informal settlements.

Nigeria has a population of about 200 million (National Population Commission, NPC 2018) and growing rate of 2.6% per annum, with about seventy percent living in informal settlements, exposed to climate-sensitive health conditions such as diarrhoea, malnutrition and malaria (UN-HABITAT, 2012). Such communities are highly vulnerable to climate change and have little adaptive capacity to meet its many challenges (World Health Organization, WHO 2013). It is therefore pertinent to have comprehensive information on the population vulnerability, current and likely future climate-sensitive health risks, and climate-coping practices. Yet lack of data is common in developing countries, rendering locally critical features invisible and leading to possibly maladaptive practices. The underlying characteristics of a population, such as its poverty, health, and governance, determine its vulnerability, that is, its predisposition towards being adversely affected by climate change. Vulnerability interacts with and is augmented by the physical hazards associated with climate variability and change (such as drought, flood, and ecosystem impacts) and together these determine risk, which is the likelihood of adverse impacts occurring (Intergovernmental Panel on Climate Change, IPCC 2013). For example, 'social' (non-climatic) factors, such as poor access to education and health services, rapid population growth and resource conflict, can enhance vulnerability and increase risk of malaria in ecologically suitable areas (e.g. Abdussalam et al., 2014a).

Urban populations, particularly poor urban populations, are currently not well adapted to climate and weather events, with high population density often increasing vulnerability. However, the burden of disease in urban poor populations due to temperature and rainfall extremes is not well described (Kovats and Akhtar, 2008). The populations most vulnerable to the health impacts of climate change include those situated in locations that are least resilience. In many cases, the two will overlap. The potential consequences from future climate change are varied, but many are projected to be adverse overall, including impacts on human health. Increased health burdens are expected from a range of causes including malnutrition, certain infectious diseases

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(e.g. malaria), exposure to temperature extremes, and a higher frequency and/or intensity of natural hazards.

Nigeria is identified as one of the hot spots of climate change (Diffenbaugh and Giorgi 2012) because of its location and socioeconomic status, and it is projected to be affected due to the vulnerability of its population. Northern Nigeria is particularly more vulnerable to the impacts of climate change compared to other regions of the country. This is because of its physical and socioeconomic characteristics, such as widespread poverty, desertification, ecological disruption, high population growth rate, prevalence of infectious diseases, and frequent extreme weather conditions (Nigerian Bureau of Statistics, NBS 2016). Climate change is expected to aggravate health issues, such as the prevalence of infectious diseases like cholera, meningitis and malaria, especially in informal settlements. Despite the aforementioned, only very few studies have attempted to study the associations between climate variability and health in Nigeria (e.g., Abdussalam et al. 2014b), while information specifically from populations living in informal settlements is completely lacking in northern Nigeria, which severely constrains the design of climate change adaptation strategies.

Despite the fact that Nigeria is classified to be highly vulnerable to the changing climate, little is known about the state of vulnerability and health risks associated to climate change. This underscores the relevance and timeliness of this study, most especially with the new approach adopted by IPCC Conference of Parties 21 (COP21) in Paris where nations are expected to have a comprehensive roadmap for adapting to climate change. This study is the first of its kind in the urban cities of Nigeria, apart from the one carried out in Ibadan. The current study intends to employ better methodological approaches to provide new information regarding climate change and health vulnerability. Findings from this research will be relevant to authorities in mapping out strategies for adapting to climate change, and will be immensely beneficial to public health workers and researchers in other related field.

Kaduna is one of the important cities in Nigeria because of the history of its establishment, it used to be the headquarters of northern Nigeria (it's still considered to be). Like any other major city in Nigeria, Kaduna metropolis is densely populated with the population of over 3 million inhabitants. A large percentage of this population are poor people with most of them residing in informal settlements scattered across the city. As such, this study is aimed at filling this major gap by providing first-hand information on health vulnerabilities to climate change of the population living in such settlements in the Kaduna metropolis. This project aims to investigate the present and future health vulnerabilities of population living in the informal settlements of urban cities in northern Nigeria, using both climate (rainfall, temperature, and humidity) and socioeconomic information.

2.0 MATERIALS AND METHODS

The Study Area**:** The city of Kaduna (Figure 1) is comprised of four Local Governments – Chikun, Kaduna North, Igabi, and Kaduna South – which are divided into 49 wards. The city grew from a population of 250,000 in 1963 to a population of over 3 million in 2015 (Goje and Dogo, 2019). Despite increasing efforts on the part of local and state governments to address informal settlement expansion, the speed of the city's growth and the inability to invest adequately in housing and infrastructure have led to the growth of existing settlements and to the development of new ones. As a result, Kaduna now has one of the highest proportions of informal-settlement households in Northern Nigeria, with large percentage of households living in informal areas.

The city is situated in a tropical dry-and-wet climate. The wet season lasts for about six to seven months between the month of April and October with an average annual rainfall of about 1400mm. Maximum temperature can reach above 30ºC, with the months of March, April, and May being the hottest. Relative humidity ranges between 25 and 90% depending with the month of the years, with months between December and February having the lowest (Nigerian Meteorological Agency, NiMET, 2018).

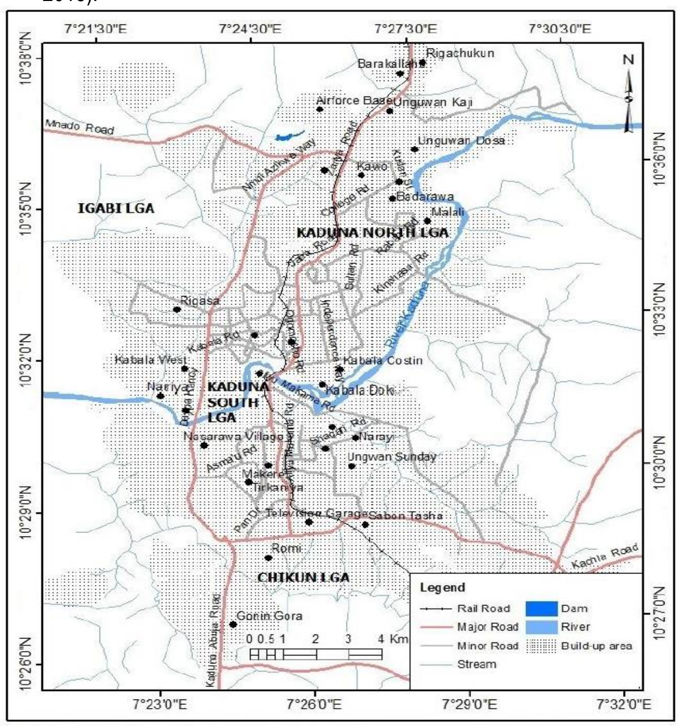

Figure 1: Map of Kaduna Metropolis

Two communities (Rigasa and Sabon Tasha) were targeted for this study because apparent presence of informal settlements. A detailed social, demographic, economic, and environmental and health data from sampled communities within these informal settlements were collected, likewise, observed climate for the closet meteorological station to the selected communities were obtained.

Demographic and Socioeconomic data: Systematic and Multistage sampling method was used in selecting the communities and households that participated in data collection. Household questionnaire that contains questions aimed at capturing key community characteristics regarding sanitation; access to and use of resources such as food and energy; income, assets and financial credit; and demography, health and climate was administered. The wording of the questions were made specific and simple to improve the accuracy of the responses and avoid misinterpretation. Multiple-choice responses for frequency

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ranges were used where possible on scales basis.

In order to obtain an in-depth feelings and perceptions of the community members, six Focus Group Discussions (FGDs) were conducted (three in each community), particular attention was given to the composition and degree of diversity of the participants in the focus groups to ensure effective representation both in terms of age and in terms of sex of the communities. The FGDs were carried out using a community-based risk screening tool (CRiSTAL) version 14.2 (e.g. Robledo et al., 2012) that is used to identify local climate and non-climate hazards, determinants of local adaptive capacity and contemporary coping strategies. The participants nominate important climate threats and climate- sensitive diseases and provide information about seasonal and interannual variation as well as their current coping strategies.

The interview questions were grouped into six (6) segments as presented in Table 1. The sampling procedure was as follows: on arrival at the village, the team visited the village head to obtain permission to enter the village. The first household to be selected is usually that of the village head. The survey was carried out between March and May, 2018. A relatively high non-response rate was encountered in all the communities with some prospective respondents citing that no personal benefits will be derived from the interview. In all, the study covered a total of, 49, and 52 respondents in Rigasa and Sabon Tasha communities respectively, giving a sample size of 101.

Climate data: Observed climate data on four variables (maximum and minimum temperatures, precipitation, and humidity) were obtained from NiMET for the between 1981 and 2017.

To assess the level of vulnerability, the study draws insights from the livelihood vulnerability index developed by Hahn et al. (2009). This index uses multiple indicators to assess health vulnerability and covers (1) the level of exposure of health to climate variability (2) socio-economic characteristics of households which influence their ability to adapt, and (3) the sensitivity of households to climate change in terms of health, food, and shelter.

Table 1: Grouped Interview Questions

Vulnerability Factors (Based on IPCC 2013)	Major Components	Subcomponents	Scale
Exposure	Livelihood Exposure to climate variability	Rainfall	1 - 5
		Temperature	
		Wind	
Risk/Sensitivity	Climate change sensitivity to health	Infectious diseases	1 - 5
		Non-infectious diseases	
		Physical Injuries	
		Previous cases	
Capacity	Socioeconomic status of household head	Age	1 - 5
		Household size	
		Level of education	
		Daily income	
		Number of rooms	
	Accessibility to health care centre	Distance of home from healthcare centre	
		Availability of health professionals	
	Domestic water and sanitation	Source of water	
		Type of toilet facilities	
		Sewage/gutters	
	Other capacities	Nature of job	
		Use of preventative measures e.g Mosquito net	
		Source of fuel	

3.0 RESULTS AND DISCUSSION

As a result of poor economic opportunities and an increasing shortage of affordable housing, much of the spatial growth in many of the world's fastest-growing cities is a result of the expansion of informal settlements where residents live without security of tenure and with limited access to basic infrastructure. Although inadequate water and sanitation facilities, crowding and other poor living conditions can have a significant impact on the spread of infectious diseases, analyses relating these diseases to ongoing global urbanization, especially at the neighborhood and household level in informal settlements, have been infrequent.

In Nigeria, most of these urban dwellers are living in informal urban settlement. Such communities are highly vulnerable to climate change and its associated health risks, because of the little or non-adaptive capacity to meet its many challenges. Based on the available studies that classified Nigeria as one of the hotspots of climate change, one could conclude that the vulnerability of these population in Nigeria will be on the high side (Abdussalam et al., 2014a), most particularly those residing in the northern part of the country, where diseases and poverty are more prevalent (NCDC, 2012). Urban populations living in informal settlements in this region are characterized by overcrowding, poor-quality housing, lack of basic infrastructure, and poverty.

This study first investigate the socioeconomic characteristics of individuals, e.g., age, gender, education, level of income, and occupation in the target communities. This characteristics play an important role in how they perceive risks to climate change and also affect their level of vulnerability (Combest-Friedman et al., 2012). The socioeconomic characteristics of the respondents in this study are presented in Table 2. It was observed that the modal age range of the heads of household is 45 – 55 years, and only two respondents were above 80 years. Moreover, about 60% of the household heads who responded are within the legal working age of 18-60 years. The relationship between age and climate change perception is somewhat ambiguous. For example, Apata et al., (2009) found a positive relationship between age and risk perception while Aphunu and Nwabeze (2012) found a negative relationship. About 74% of our respondents are males which suggest that they are less likely to perceive risks from climate change.

It is important to note that household size used in this study does not necessarily refer to the size of the nuclear family but includes every one living in the same house with the respondent which includes relatives, grandchildren, and wards. About 50% of the respondents have had some form of formal education; however, only 3 of the respondents have a university degree. Since knowledge of climate change tend to increase with level of education (Nzeadibe et al., 2012), the educational qualification of the respondents suggests that most of them might not have the proper understanding about the risks associated with climate change.

The study indicates that only 63 of the 101 respondents have heard the term climate change in the past even though most of them did not remember where they heard it, but noted that their personal experiences played a role mainly because their source of livelihood seems to be threatened. 90% of all the respondents perceived that there have been changes in climate variables over

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the years, albeit at different levels. About 60% of the respondents perceived that the length of the average rainy season, which used to be from March/April to November, has changed significantly. The perceived change in the length of the average rainy season also implies perception of change in that the timing of the average rainy season and amount of rainfall over time. In particular, 42% of the respondents perceived that the amount of rainfall and the timing of the average raining season have changed significantly, respectively. In particular, all respondents agree that temperature is on the rise.

Combest-Friedman et al., (2012) used meteorological data to examine whether households' perception are in line with observed data on climate variables. This study also compared households' perception with meteorological data for temperature and rainfall using obtained data from Kaduna International Airport meteorological station. We observe that most of the perceptions are in line with the observed data. For example, rainfall occurred for between the month of May and October, which is in line with the households' perception on changes in the length of the average rainy season and changes in the timing of the average rainy season. The trend of rainfall has a positive gradient indicating that there is a general increase in the amount of rainfall over the years, especially from 2010. In terms of increase in temperature, all respondents perceived an increase, which corroborate available meteorological data that temperature is increasing. The trends show that monthly average of daily maximum is increasing while minimum temperature is slightly increasing.

Table 2: The socioeconomic characteristics of the respondents in the study area

Socioeconomic Characteristics	Scale (1 – 5)	Communities/Number of respondents		All communities [n=100]
Age of household head	25 - 35	0	2	2
	36 - 45	4	7	11
	46 - 55	11	8	19
	56 - 65	8	4	12
	65 - above	2	4	6
Household size	1 - 4	0	2	2
	5 - 8	7	11	18
	9 - 12	9	7	16
	13 - 16	6	4	10
	16 above	3	1	4
Level of education of household head	No formal education	11	9	20
	Up to Primary	6	12	18
	Up to Secondary	6	2	8
	Up to Diploma/NCE	2	1	3
	Up to University	0	1	1
Average daily income of household	0 – 750	6	4	10
	2 – 1000	11	14	25
	3 – 1500	6	5	11
	4 – 2000	1	0	1
	5 – 2500	1	2	3
Number of rooms	1 – 2	6	5	11
	3 – 4	11	9	20
	5 – 6	7	8	15
	7 – 8	1	3	4
	9 – 10	0	0	0

In terms of vulnerability, it was observed that households in each of the selected community are vulnerable in all subcomponents of the vulnerability index. All communities shows vulnerability to changes in rainfall patterns with an index of 5.6. The vulnerability score for temperature for each community is above 6.0 which corroborates the findings of Abdussalam et al., (2014b) and Leckebusch & Abdussalam (2015). In all, the vulnerability scores show that the two communities are either very vulnerable or somewhat vulnerable in relation to exposure to climate change.

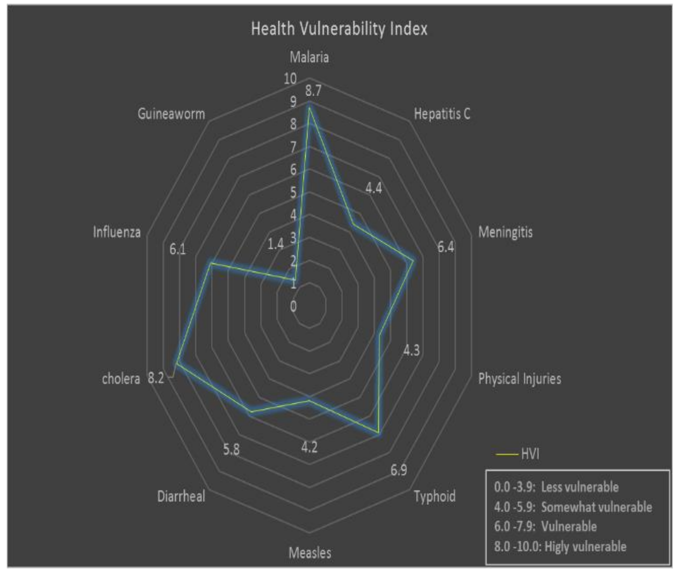

Figure 2: Health Vulnerability Index for the two communities (Sabon-Tasha and Rigasa)

Health vulnerability for the two communities is presented in Figure 2. For the sensitivity aspect of the vulnerability to nominated diseases, result shows that the two communities are very vulnerable in most subcomponents. For malaria and cholera, which captures the number of times where the homes of the selected respondents have been affected by the diseases, the vulnerability scores for the two communities is up to 8.2 and 8.7 respectively. This implies that the communities are very vulnerable in relation to malaria and cholera. Similarly, the vulnerability scores for other candidate diseases show that the two communities are also very vulnerable. It is important to note some these diseases are inter-related, and are mostly triggered by certain socioeconomic conditions, such as education level, population density and access to portable drinking water. For example, in their study to examine the climate and socioeconomic influences on cholera in Nigeria, Leckebusch & Abdussalam (2015) found a significant relationship between climate and socioeconomic factors in influencing the incidence of cholera. All other nominated diseases shows vulnerability 4.2 to 6.1, with measles having the lowest.

The results of the subcomponents of adaptive capacity are similar to those of exposure and sensitivity, with the exception of level of dependence. For household with high literacy, results show that the vulnerability score for each of the two communities is below 5.0. This indicates the propensity of the households with less education capacity to these diseases. The vulnerability scores of livelihood diversity for the two communities are between 3.0 and 5.0 indicating that most households are somewhat vulnerable due to low income capacity.

The vulnerability score of extent of livelihood adaptation for each community is below 4.0, indicating that households are finding it difficult to adapt to changes in climate variables. Many respondents noted that they are adapting to high temperatures by staying under the shade during the day and sleeping in the open during the night, which up course is exposing them the more mosquitos bite and subsequent malaria.
All the respondents affirmed that not having sufficient financial resources is a major challenge in engaging in more sustainable adaptive measures. Other challenges selected by the respondents in descending frequency include lack of adequate knowledge about these diseases, and lack or limited access to quality health care services.

4.0 Conclusion
Informal settlements in developing countries, especially those in urban areas, are vulnerable to climate change because of their very low coping capacity and propensity to diseases due to both climate and socioeconomic factors, such as poverty, population density, and level of education. To reduce the potential impact of the adverse effects of climate change, households in these communities need to engage in sustainable climate change adaptation measures. Adaptation measures will be more successful if the households have good perception of the risks and vulnerability they are facing. As such, this study has confirmed the vulnerability of people living in such areas, and the urgent for relevant authorities to provide necessary awareness and required infrastructures.

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