

Exploring residential characteristics as determinants of household adaptation to climate change in Lagos, Nigeria

Household
adaptation to
climate change

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Received 13 June 2021
Revised 20 September 2021
28 October 2021
Accepted 9 November 2021

Abstract

Purpose – The purpose of this paper is to examine the factors influencing residents' adaptation strategies to climate change effects in Lagos Metropolis, Nigeria.

Design/methodology/approach – The metropolis was stratified into low, medium and high residential densities. Across the residential densities, questionnaires were administered on 384 residents. The questionnaire addressed issues on resident's socio-economic and demographic attributes, awareness of climate change and factors influencing residents' adaptation to climate change. Data were analysed using both descriptive and inferential statistics.

Findings – Result indicated that the adaptation strategies adopted by residents in the different residential areas were similar but varied in magnitude as denoted by the resident response index RRI ($RRI_h = 3.32$, $RRI_m = 3.39$ and $RRI_l = 3.41$). The multiple regression analysis computed indicated the residential characteristics such as education, average monthly income, age, house type and house ownership ($p < 0.05$) were significant factors influencing resident's level of climate change adaptation strategies adopted.

Research limitations/implications – The study could be strengthened by looking at specific climate change effects such as floods or drought in major cities of Nigeria. Hence, the view presented in this paper may not be considered generalizable to the impacts of climate change in the study area.

Originality/value – In recent years, research studies on human adaptation and coping strategies to climate change have generated considerable development interest. This study contributed to this growing area of research by examining the factors influencing residents' adaptation strategies to climate change in Lagos Metropolis, Nigeria.

Keywords Nigeria, Climate change, Residents' perceptions, Coping responses, Household adaptation, Residential characteristics

Paper type Research paper

1. Introduction

Over the years, there have been global, as well as regional changes in both climate and weather elements often referred to as climate change. According to Intergovernmental Panel on Climate Change (2018), climate change refers to any significant change in measures of climate such as temperature, precipitation or wind lasting for an extended period. It is also a change attributed directly or indirectly to human activities which alter the composition of the global atmosphere, in addition to natural climate variability observed over comparable periods (United Nations



International Journal of Disaster
Resilience in the Built
Environment
© Emerald Publishing Limited
1759-5908
DOI 10.1108/IJDRBE-06-2021-0060

Framework Convention on Climate Change [UNFCCC], 1992). Similarly, it is a change in both the mean meteorological values and variability of these values (Wu *et al.*, 2016).

Globally, climate change poses serious threats to all facets of human societies (Field *et al.*, 2012). This is evidenced by the spate of frequent and intense drought, storms, heatwaves, rising sea levels, melting glaciers, warming ocean and persistent flooding in cities of global south and north (Butler and Hanigan, 2019; Taskinsoy, 2020). However, there are widespread consensus that the impacts of climate change will affect practically every aspect of human lives both in the urban and rural areas (Pincetl, 2017; Khavarian-Garmsir *et al.*, 2019). These impacts are posited to vary significantly both in space and time (McLaughlin *et al.*, 2017).

Climate change can manifest in several ways. These include slow changes in mean climate conditions, increase inter-annual and seasonal climatic variability, increased frequency of extreme climatic events and rapid climate changes causing catastrophic shifts in ecosystems. Owing to differences in the ecological and socio-economic environmental nature of hazards in different parts of the world, Savo *et al.* (2017), Mao *et al.* (2018) and Danandeh Mehr *et al.* (2020) have pointed out that the impacts of climate change are not evenly distributed. Most models as described in IPCC (2001) and Hertel *et al.* (2010), however, indicated that it will be stronger near the equator, hence, in Sub-Sahara Africa than in most other major regions on earth. By implication, Nigeria, like other countries in Sub-Sahara Africa, is highly vulnerable to the impacts of climate change (Ologeh *et al.*, 2018; Okunola, 2019). Accordingly, there is the need to gain as much information as possible on the response of people in Nigeria to climate change effects.

Some notable studies have revealed varieties of responses to climate change in terms of adaptation and mitigation (Hernández-Morcillo *et al.*, 2018; Karimi *et al.*, 2018; Waldvogel *et al.*, 2020). Both mitigation and adaptation help in reducing the risks associated with climate change (Hernández-Morcillo *et al.*, 2018; Sharifi, 2021). On one hand, mitigation requires the implementation of policies to reduce the effects of climate change, while adaptation includes the actions taken by people in response to and or in anticipation of changing climatic conditions to reduce the adverse effect of climate change. In other words, human responses are critical to understanding and coping with the effect of climate change.

The magnitude of these impacts has attracted the attention of local and international research communities, especially on adaptation and mitigation (Berman *et al.*, 2017; Thomas *et al.*, 2019; Tong and Ebi, 2019). However, most of these efforts and research studies have focused on public and private organizations with little attention to individual and household adaptation. Despite the fact that climate change is a global phenomenon, its impacts are felt at the household and individual levels. For instance, Nigeria has experienced several impacts of climate change in the recent past that necessitated individual responses. Typical example of such a climatic event in Nigeria was the 2012 flood occurrences experienced in 34 out of 36 states in the country where houses, farms, farm products, properties and even human beings were swept away (Okunola, 2019). Also, the statistics released by the southwest zonal office of the National Emergency Management Agency in 2017 show that no fewer than 5,000 persons were affected and 60 houses were destroyed in a windstorm which occurred in four states in the south-west region (National Emergency Management Agency [NEMA], 2018). How individuals and households respond to these common extreme climatic events is, therefore, worthy of examination.

Some notable studies have investigated individuals and household's adaptation strategies to climatic events in the global south and north (Kreibich *et al.*, 2011; Stojanov *et al.*, 2016; Fahad and Wang, 2018). For instance, Stojanov *et al.* (2016) stated that households tend to repair damaged properties instead of implementing costly adaptation

measures in the North-Eastern part of the Czech Republic. The study of Kreibich *et al.* (2011) likewise divided household adaptation strategies into low-cost, medium and high cost adaptation strategies. The low-cost measures include the gathering of information relating to precautionary measures, the assistance of neighbours and relocation of properties at risk from the ground floor to safer locations. Medium adaptation strategies include flood insurance, securing of flood embankments and barriers and adaptation of the interior (e.g. floor replacement). While the high cost flood adaptation strategies entailed construction adjustments to the building using solid and water-resistant materials, sealing important parts of the house, raising the ground floor, constructing small anti-flood walls on the surrounding lands or fortifying the cellar and foundations of the building. This study also examined residents' adaptation strategies to climate change effects and factors influencing their choice of strategies.

A review of research works showed that some splinter studies have stated that the ability of individual households and communities to adapt to climate change depends on their previous exposure to extreme weather, long term financial reward and social acceptability (Whitmarsh, 2008; Kunreuther and Kerjan, 2009; Walker *et al.*, 2011; Porter *et al.*, 2014). For instance, Porter *et al.* (2014) argued that individuals who have experienced any form of climate-related disaster are more likely to adapt to climate stimuli than those that have not. This outcome reinforces the findings of previous studies such as Whitmarsh (2008) and Walker *et al.* (2011) that individual households in the UK who have experienced flooding show more preparedness to adopt flood preparedness and mitigation measures than households that have not experienced flooding. On the issue of social acceptability, Adger (2003) affirmed that social factors could influence residents' choice of adaptation to climate change effects. This finding supports the assertion of Kent *et al.* (2013), who noted that it is a common practice for residents in the UK to turn on the heater to keep the house warm for visitors during the winter. Concerning the third factor influencing households' climate change adaption, Kunreuther and Kerjan (2009) and Porter *et al.* (2014) affirmed that individuals and households would be more willing to adapt to the effects of climate change if they perceive the long term financial reward of adaptation. While the conclusion of these studies could be considered adequate, the effort was also made in this current study to examine factors influencing residents' adaptation to climate change effects in the study area.

Grothmann and Patt (2003) while examining adaptive capacity and human cognition to climate change identified self-motivation and perceived ability as other major factors influencing adaptation to climate change. The study further stated that often at times, people are self-motivated to take precautionary measures to protect themselves against climatic risks, without necessarily having an external motivation. Also, Ihemezie *et al.* (2018) examined the drivers and some socio-economic factors influencing individual and household adaptation to climate change in Leeds, UK. The study established that house type, house ownership, income, were significant factors affecting the level of adaptation strategies adopted. These studies on factors influencing residents' adaptation to climate change focused on the UK. This study examined factors influencing residents' adaptation strategies to climate change limited to the West African Sub-region, Lagos, Nigeria in particular.

In Nigeria, there are studies that have examined the factors influencing residents' adaptation to climate change effects. For example, Afon *et al.* (2016) examined residents' socio-economic attributes as drivers of adaptation to climate change effects in Ibadan metropolis, Nigeria. The study established that the adaptive strategies adopted by residents in different residential areas were similar despite the difference in socio-economic attributes. This study was limited to socio-economic factors that might influence residents' adaptation strategies to climate change. Furthermore, Chete (2019) in a study conducted in Osun State,

Nigeria, identified access to credit and to extension agents, household size, farm income and access to climate change information as factors influencing farmers' choice of adaptation methods to climate change. However, the study focused on strengthening the adaptive capacity of farmers in rural areas to climate change. Factors influencing resident's adaptive capacity to climate change in urban area was not considered. Therefore, the study intended to complement the literature by investigating factors influencing residents' adaptation to climate change in African cities with particular emphasis on Lagos, Nigeria.

2. Research methodology

2.1 Study area

Lagos Metropolis (Figure 1) is situated within latitudes $6^{\circ}23'N$ and $6^{\circ}41'N$ and longitudes $2^{\circ}42'E$ and $3^{\circ}42'E$. It has an average density of over 20,000 persons/km² in the built-up areas and a total Land Area of 999.6 km²; it is made up of 16 Local Government Areas (Figure 2). Eti-Osa local government area (LGA) has the largest land area of 299.10 km², the second and the third largest are: Ojo and Alimosho LGAs with 182 km² and 137.8 km², respectively. The total population that made up the metropolis has the largest concentration at Alimosho LGA (2,047,026), while the second and third in terms of population size are: Ajeromi – Ifelodun LGA (1,435,295) and Mushin LGA (1,321,517) (Lagos State Government Digest of Statistics, 2013).

The climate of the study area is the tropical savanna climate (Köppen climate classification "Aw") that is similar to that of the rest of southern Nigeria. It is located partly in the swampy mangrove and partly rains forest regions of West Africa having bimodal

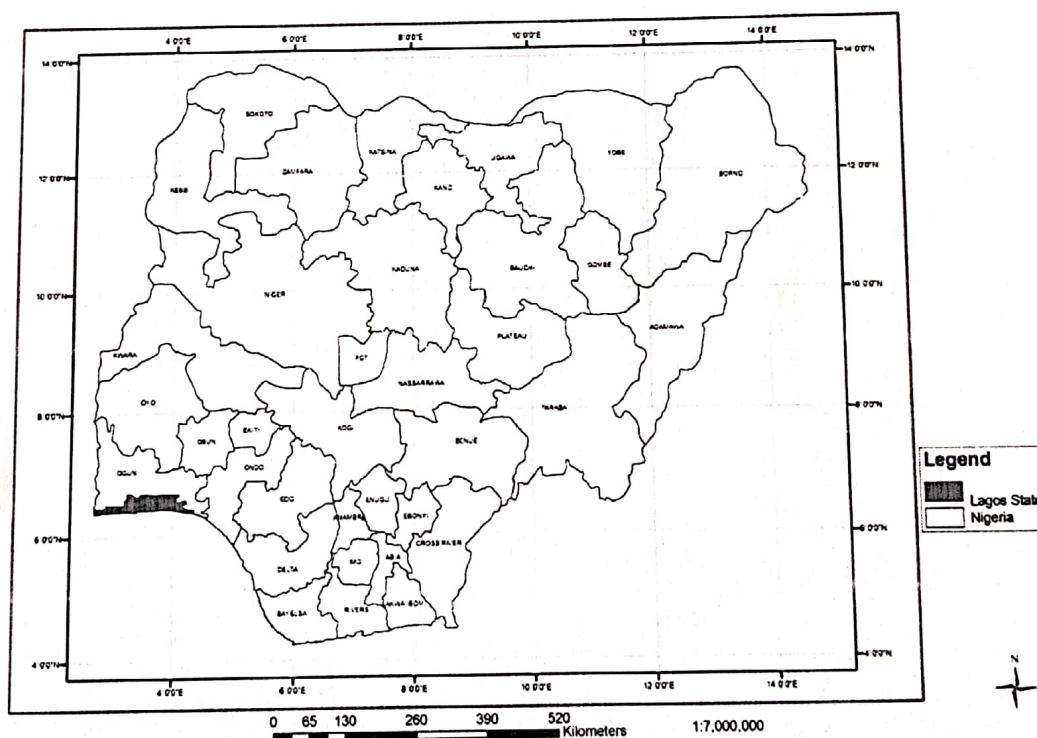
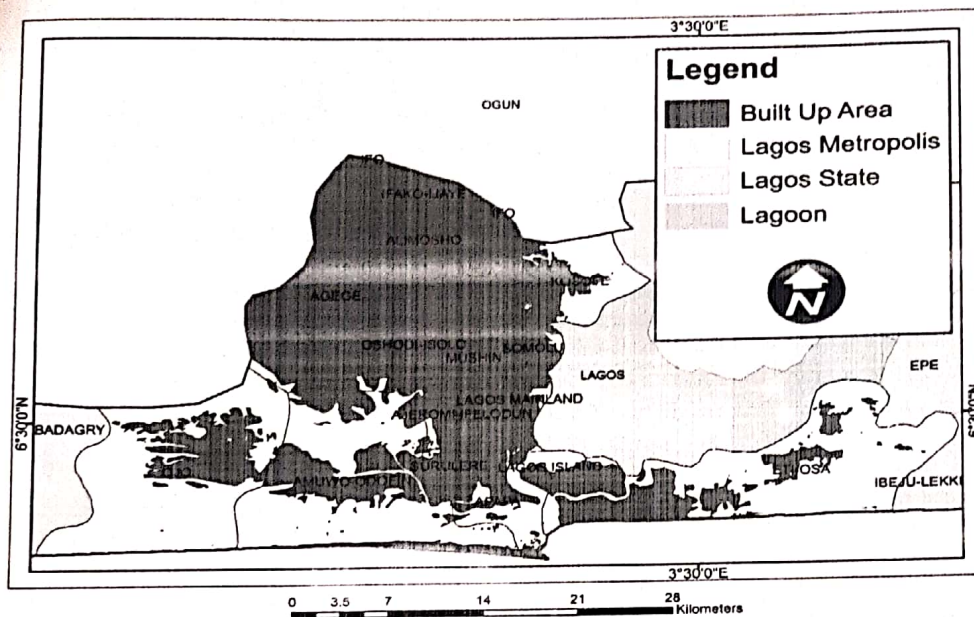


Figure 1.
Map of Nigeria
indicating Lagos
state

Source: Cooperative Information Network (COPINE) (2018)



Household
adaptation to
climate change

Figure 2.
Map of Lagos
metropolis showing
built-up area

Source: Okunola (2021)

rainfall maxima annually. It receives a mean annual rainfall of about 2,000 mm. There are two rainy seasons, with the heaviest rains falling from April to July and a weaker rainy season in October and November. There is a brief relatively dry spell in August and September and a longer dry season from December to March. Monthly rainfall between May and July averages over 300 mm (12 inches), while in August and September it is down to 75 mm (3 inches) and in January as low as 35 mm (1.5 inches). The main dry season is accompanied by harmattan winds from the Sahara Desert, which between December and early February can be quite strong. The average temperature in January is 27°C (79 °F) and for July it is 25°C (77 °F). On average the hottest month is March; with a mean temperature of 29°C (84 °F); while July is the coolest month (Ajani *et al.*, 2019).

Lagos recorded the first flood in the early 1970s and it has become a perennial event which has left many homes swamped with a resultant loss of property and lives (Nigeria Environmental Study/Action Team [NEST], 2003). Flood disasters as a result of heavy rainfall in the Lagos metropolis have resulted in the submerging and destruction of many buildings in Ikeja, Oshodi, Mushin, Yaba and Agege. For instance, in 2005, more than 4,000 people were rendered homeless; while more than 200 buildings were flooded and destroyed (Okunola, 2019). Similarly, in 2012, a section of the Lagos-Abeokuta expressway was cut off on both sides by flood and a portion of the Murtala Mohammed International airport road by Mobil Filing station was submerged. In the same year, about 200 families were rendered homeless as their roof tops and ceilings were completely pulled off by wind storm.

Conclusively, Nigerian towns and cities have experienced a lot of events directly or indirectly related to climate change (Echendu, 2020; Raimi *et al.*, 2021). Hence, communities in Lagos metropolis with a similar residential patterns and seasonality were investigated to ascertain factors influencing residents' adaptation to climate change.

2.2 Research design

Data for this study were obtained through the administration of questionnaires in selected communities of Lagos from July 2018 to April 2019. For the study, purposive sampling was used to select three residential areas across the city. These were Ijora Badiya, Surulere and Lekki Peninsula. These communities were selected because they represent different residential densities situated in different geographical locations of Lagos. Ijora Badiya is a slum located on a swampland in mainland Lagos and dominated by low income earners (Iroham *et al.*, 2021). The area is densely populated with over 600,000 residents occupying a total land mass of 1.6Km². Ijora Badiya is characterized by sub-standard housing, lack of waste disposal services, extreme poverty, congestion and poor drainage systems (Ajibade *et al.*, 2015; Iroham *et al.*, 2020). Surulere is dominated by residential and commercial activities and can be categorized as medium residential density based on Lagos State population per km² standard of 10,001–20,000 persons/km² (Lagos State Government, 2013). While Lekki Peninsula is located in the eastern part of Lagos city and is dominated by high-income earners and a few middle-income groups. Google Earth Map (2020 version) revealed that within the three residential areas, there were 3,091, 1,394 and 1,132 residential buildings, respectively (Table 1). In total, 10% of residential buildings were randomly selected from each residential area and the first building where respondents were surveyed was selected randomly. A total of 309, 139 and 113 buildings were selected for the survey.

The household head or oldest member of the household as at the time of the survey was selected per building. In the case of storey buildings, respondents were selected from the first household on the ground floor. A total of 450 copies of the questionnaire was administered and a total of 384 was retrieved (i.e. 85.3%) comprising 229, 94 and 61 questionnaires in Ijora Badiya, Surulere and Lekki Peninsula, respectively. These numbers were considered adequate as the response rate for this type of survey normally ranges between 30% and 60% (Saunders *et al.*, 2012). Data on socio-economic attributes of residents and adaptation strategies were analysed with frequency percentage distribution, Likert scale, one-way analysis of variance (ANOVA) and multiple regression analysis.

2.3 Data analysis

The choice of analytical tools was guided by the specific objectives and the nature of the data collected. Data obtained on residents' socio-economic characteristics were analysed using descriptive statistics of frequency, percentages and one-way ANOVA. Information obtained on residents' response to climate change was measured in this study through a personally devised index termed resident response index (RRI). Residents rated the identified responses which were obtained through literature review using one of the five Likert scales of Very Important (VI), Important (I), Just Important (JI), Not Important (NI) and Not at all Important (NA). To arrive at RRI, the following steps were followed:

Table 1.
The number of
buildings in the
selected study areas

City	Community	Buildings identified	Buildings selected for survey (10%)	No. of questionnaire retrieved
Lagos metropolis	Ijora Badiya	3,091	309	229
	Surulere	1,394	139	94
	Lekki Peninsula	1,132	113	61
	Total	5,617	561	384

- A weight value of 5,4,3,2 and 1 was attached, respectively, to each rating of very important, important, just important, not important and not at all important.
- Summation of weight value (SWV) was calculated. This is the addition of the product of the value attached to a rating and the respective number of residents to the rating.
- The SWV divided by the number of residents gives the mean weight value (MWV).
- The average level of importance attached to the variables in the study area was arrived at by the ratio of the sum of the MWV to all variables and the total number of variables rated. Thus:

$$RRI = \sum \frac{MWV_i - i}{n} \quad (1)$$

where:

MWV = Mean Weight Value for the study area;

n = number of the respondents to rating i ; and

MD = Mean deviation was used in this research in describing the extent to which values were away from the arithmetic mean.

Multiple linear regression analysis was used to determine socio-economic factors influencing the level of climate change adaptation in the study area. A number of tests and modifications were carried out to ensure that data satisfied certain assumptions for linear regression. For instance, a test for normality was carried out to assess the normality of the distribution of the data as well as other key assumptions to ensure the validity of the regression result. The Kolmogorov-smirnov statistics (0.172) show a non-significant value of 0.1300 (p -value > 0.05) which indicates that the data are normally distributed. In this study, the dependent variable was the level of adaptation which was obtained by converting from categorical to continuous variables, by adding up the number of adaptation features adopted by each respondent. This was subsequently regressed with a set of socio-economic variables such as age of respondents, monthly income, education level of respondents, household size, gender, house type, house ownership and years lived in the home.

The multiple regression analysis is of the form:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 \quad (2)$$

where y assumes the dependents variable (level of adaptation strategies adopted). The predictors as used here are explained below:

X_1 = age of respondents, X_2 = average monthly income, X_3 = education level of the respondents, X_4 = household size, X_5 = gender, X_6 = house type, X_7 = house ownership, X_8 = years lived in home.

3. Findings

3.1 Residents' socio-economic and housing characteristics

Independent studies have established that there is a correlation between residents' socio-economic, demographic attributes and response to environmental issues (Westin *et al.*, 2018; Lukanov and Krieger, 2019). Attributes such as age, income level of education, household size and house tenure are hereby important to this study to determine their influence on resident's response to climate change in the Lagos metropolis. Findings revealed that 69.8% of the residents were female while 30.2% were male. This affirmed the earlier assertion of

Thomas *et al.* (2019) that women play a critical role in response to climate change because of their local knowledge of sustainable resource management at the household and community level. Also, the age of household head in the three identified residential densities of Lagos Metropolis was grouped into three. The age groups were: 19–30 years (the youths), 31–55 years (the young adults) and 56–65 (the adults) (Okunola, 2019). It was evident from Table 2 that the majority (70.6%) of respondents in the Lagos metropolis was young adults. While youth and adult respondents accounted for 12.8% and 16.7%, respectively. The implication of this according to Lee *et al.* (2020), is that the reasoning level of mature adults with respect to response to climate change is expected to be high, and thus, facilitate their involvement in mitigation and adaption to climate change effects.

In this study, the income group for household heads was based on the income classification adapted from Kakooza-Mwesige *et al.* (2017) using the minimum wage implemented by the Federal Government of Nigeria as the benchmark (2019). Therefore, household heads who earned less than N30,000 (US\$1 = N386.92 (Kenneth and Onyedikachi, 2021) monthly were regarded as low income earners, N30,000–N 150,000 were referred to as middle income earners, while the high income earners earned above N 150,000. Further

Table 2.
Socioeconomic and
demographic
characteristic
distribution of the
respondents

Residential characteristics	High density (%)	Medium density (%)	Low density (%)	Study area (%)
<i>Gender</i>				
Female	70.4	73.4	62.2	69.8
Male	29.6	26.6	37.8	30.2
<i>Age group</i>				
19–30	14.0	5.3	19.7	12.8
31–55	72.9	73.4	57.4	70.6
56–65	13.1	21.3	23.0	16.7
<i>Income group</i>				
Less than 30,000	34.5	8.5	3.5	19.5
30,000–150,000	38.4	48.9	17.5	34.9
Above 150,000	27.1	42.6	79.0	45.6
<i>Education status</i>				
Primary	38.3	21.6	18.4	33.9
Secondary	46.1	35.1	28.9	30.7
Tertiary	15.6	43.3	52.7	35.4
<i>Household size</i>				
Small (<=6)	33.7	78.7	90.2	59.6
Medium (7–10)	45.2	21.3	9.8	33.7
Large (>10)	21.1	–	–	6.7
<i>House type</i>				
Bungalow	19.1	10.1	5.5	11.6
Storey building	76.5	71.2	45.7	64.5
Duplex	3.5	11.2	32.6	15.8
Terrace building	0.9	7.5	16.2	8.2
<i>House ownership</i>				
Rented	81.5	74.3	45.7	67.1
Owner-occupied	18.5	25.7	55.3	32.9
<i>Length of residence</i>				
1–5	51.4	27.4	48.5	42.8
6–10	25.9	25.9	25.4	25.8
Above 10	22.7	46.7	26.1	31.4
Total	<i>n</i> = 229 (100.0)	<i>n</i> = 94 (100.0)	<i>n</i> = 61 (100.0)	<i>n</i> = 384 (100.0)

findings from the analysis of average monthly income in the metropolis revealed the average monthly income of N 38,176.00K, N94,456.98k and N189,653.06k in the high, medium and low residential densities, respectively. It was further shown that 34.5%, 8.5% and 3.5% of respondents in the high, medium and low residential densities, respectively, were in the low income bucket. Further analysis revealed that variation in income of respondents across the three residential densities was statistically significant ($F = 183.484$ and $p = 0.000$) at 95% confidence level. This implied that residents' financial capacity in responding to climate change will vary in the three residential areas of the metropolis.

Findings on respondents' level of education revealed that 38.3%, 46.1% and 15.6% of respondents in the high residential area had primary, secondary and tertiary education, respectively. In the medium density, it changed to 21.6% for respondents that had primary education, 35.1% for secondary school holders and 43.3% for those that obtained tertiary education certificates. Furthermore, there was a significant improvement in respondents' level of education in the low residential density with 18.4% of primary school holders, 28.9% and 52.7% had secondary and tertiary education, respectively. The study, therefore, established that there was variation in the respondents' educational status in the three identified residential densities.

Other identified indicator in relation to residents' response to climate change is household size. Household size was, therefore, categorized into three. Household with 6 members and below, a household that contained 7 to 10 members and household with more than 10 members. These were, respectively, regarded as the small, medium and large sized households. From the summary presented in Table 2, low residential density had the largest proportion of respondents with small sized households. This group accounted for 90.2% of the households within Lagos metropolis. Households in the high and medium residential densities with small sized households were 33.7% and 78.7%, respectively. Also, the analysis of the households that were medium sized revealed that the largest proportion was in the high residential density. This group accounted for 33.7% in metropolitan Lagos. Also, the difference in household size across the three residential densities was confirmed by result of the one-way analysis of variance ($F = 4.304$; $p = 0.014$ at 95% confidence level).

House type of respondents was also considered relevant to this study. According to Derkzen *et al.* (2017), house type measures the social status of residents and influences their adaptation strategies to climate change. From the summary presented in Table 2, four major house types were identified in the three residential areas, namely, bungalows, storey buildings, duplexes and terrace buildings. Findings showed that the most prominent house type in the study area was story building. This accounted for 64.5% of the buildings in the three residential densities. Also, house tenure was considered as the major determinant of residents' climate change adaptation in this study. Findings revealed that in the study area, 67.1% of the residents sampled lived in rented apartments while the remaining 32.9% lived in their houses. This implied that the majority of respondents are tenants and could leave the house if they perceive that the area is vulnerable to climate change impacts. This is in line with the study of Isunju *et al.* (2016) that as a result from feelings of ownership, homeowners always want to invest in making their dwellings safer, which tenants do not have a mandate to do. In line with this, a number of year(s) a household has been in the study area is considered relevant to this study. This is based on the postulation that environmental concern is a function of the length of residence (Junot *et al.*, 2018). Findings revealed that almost a third of the residents (31.4%) had lived for more than 10 years in their residential areas; a quarter (25.8%) had spent 6–10 years while 42.8% of the residents had lived for a maximum of 5 years in their residential areas. From this analysis, it could be

deduced that the residents were familiar with their environment and their length of residence could be a factor for their climate change adaptation behaviour.

3.2 Spatial variation in adaptation to climate change effects

To assess factors influencing residents' adaptation to climate change, it is important to first analyse residents' level of awareness on the effects of climate change in the different residential areas. It was established in Table 3 that 91.4% of the respondents believed that climate change had affected them negatively in the Lagos metropolis. Further analysis on residents' level of awareness in the different residential areas revealed that 85.7%, 90.4% and 98.2% of respondents in the high, medium and low residential densities were aware of the effects of climate change in their residential areas. Apart from the statement of awareness, the study also examined residents' perceptions on changes in climate over time in their residential areas. Result indicated that a larger percentage of the respondents rated the intensity of flood (82.6%) and heat (71.6%) in the city ranging from intense to very intense. Furthermore, respondents were asked to rate their level of concern about climate change in the study area. Findings revealed that 65.4% of the respondents are either concerned or extremely concerned about climate change in their residential areas.

Further, respondents were asked to identify and rank the effectiveness of climate change adaptation strategies adopted by residents in the study area and these are presented in Table 4 below. Result indicated that repair and replace damaged property was the adaptation strategy with the highest rank ($MD = 0.64$), while comply with a setback during property development was ranked least ($MD = -0.43$). In total, 6 of the 18 adaptation measures were expressed as (positive) important, while 12 were expressed as (negative) not important. Adaptation measures such as repair and replace damaged property, cleaned or helped to maintain public drainage systems from waste, construction of more drainages system by government and community groups, Relocation from climate risk areas, avoid haphazard bush burning and listening to information on climate change were adaptation

Level of awareness	High density (%)	Medium density (%)	Low density (%)	Study area (%)
<i>Awareness on climate change</i>				
Yes	85.7	90.4	90.2	88.7
No	14.3	9.6	9.8	11.3
<i>Intensity of climate change</i>				
<i>Flood</i>				
Very intense	83.5	81.2	81.9	82.6
Intense	12.4	8.4	13.1	11.1
Not intense	4.1	10.4	5.0	6.4
<i>Heat</i>				
Very intense	69.1	74.2	68.4	71.6
Intense	23.2	19.8	25.3	22.3
Not intense	7.7	6.0	6.3	7.1
<i>Rise in temperature</i>				
Very intense	55.7	64.1	55.4	58.4
Intense	31.2	33.7	12.7	25.9
Not intense	13.1	2.2	31.9	15.7
<i>Drought</i>				
Very intense	8.7	10.1	15.4	11.4
Intense	13.1	2.2	31.9	15.7
Not intense	78.2	87.7	52.7	72.9

Table 3.
Residents level of
awareness on climate
change

Adaptation strategies	High density		Medium density		Low density		Study area		Household adaptation to climate change
	RRI	MD	RRI	MD	RRI	MD	RRI	MD	
Cleaned or helped to maintain public drainage systems from waste	4.09	0.38	4.01	0.33	4.71	1.11	4.27	0.60	
Repair and replace damaged property	4.21	0.50	4.25	0.57	4.47	0.87	4.31	0.64	
Construction of more drainages system by government and community groups	4.19	0.48	4.11	0.43	4.28	0.68	4.19	0.53	
Relocation from climate risk areas	3.72	0.01	3.91	0.23	4.13	0.53	3.92	0.25	
Sensitizing fellow residents' about causes of climate change	3.84	0.13	3.71	0.02	3.39	-0.21	3.65	-0.02	
Construction of high wall to prevent flood	3.62	-0.09	3.48	-0.21	3.57	-0.03	3.56	-0.11	
Shun haphazard bush burning	3.79	0.08	3.61	-0.08	3.87	0.27	3.76	0.09	
Listening to information on climate change	3.82	0.11	3.53	-0.16	3.78	0.18	3.71	0.04	
Enforcement of building codes/ guidelines	3.41	-0.30	3.72	0.03	3.45	-0.15	3.53	-0.14	
Construct property above flood level	3.32	-0.40	3.85	0.17	3.52	-0.08	3.56	-0.10	
Planting of trees for shading from sun heat and breaking wind speed	3.72	0.01	3.51	-0.18	3.42	-0.18	3.55	-0.12	
Provide efficient mechanisms for disaster risk reduction	3.58	-0.13	3.49	-0.20	3.35	-0.25	3.47	-0.19	
Emplacement of storm surge barriers by government and community groups	3.79	0.08	3.51	-0.18	3.14	-0.46	3.48	-0.19	
Adoption of green roofs in building	3.61	-0.11	3.67	-0.02	3.45	-0.15	3.58	-0.09	
Children staying at home until flood subsides	3.65	-0.06	3.91	0.23	3.24	-0.36	3.60	-0.07	
Use of windbreaks/ shelter belts	3.58	-0.13	3.36	-0.33	3.11	-0.49	3.35	-0.32	
Complied with setback during property development	3.48	-0.23	3.29	-0.40	2.94	-0.66	3.24	-0.43	
Restriction of land reclamation activities in newly developed areas by government	3.45	-0.26	3.41	-0.28	2.91	-0.69	3.26	-0.41	
Mean score	3.59		3.69		3.72		3.67		

Table 4.
Intra-urban
responses to climate
change in Lagos
metropolis

measures with high level importance in the study area. It could be concluded from the results that respondents in the three residential densities relied more on coping measures to climate change effects than anticipatory measures. These findings corroborated the studies of Afon *et al.* (2016) and Okunola (2019), who asserted that response to climate change-related disasters in major cities of Nigeria is reactive rather than anticipatory. On the other hand, the three adaptation measures expressed to have the lowest importance were, namely, emplacement of storm surge barriers by government and community groups, provide efficient mechanisms for disaster risk reduction, use of windbreaks/shelter belts and restriction of land reclamation activities in newly developed areas by the government. Furthermore, the average RRI for the study area was 3.67, while the RRI of the high, medium and low residential densities were 3.59, 3.69 and 3.72, respectively. These responses indicated that the intensity of responses to climate change effects was on the increase along the residential densities.

3.3 Factors affecting level of adoption of adaptation strategies

Multiple linear regressions analysis was used to determine factors influencing residents' level of adaptation strategies to climate change in the study area. The result of the analysis is presented in Table 4. The multiple regression coefficient $R^2 = 0.549$ (Table 4), significant at 0.001, confirmed that 54.9% of the variance in the factors influencing residents' level of adaptation strategies to climate change in the study area was explained by the model. The result also indicated that education, average monthly income, house type, house ownership and age of respondents were significant at 5% level of significance, indicating that these variables affect residents' level of adaptation strategies adopted to climate change in the study area. It could be concluded from the foregoing that resident's level of education, average monthly income, house type, house ownership and age are the major factors influencing resident's adaptation to climate change effects in Lagos, Nigeria.

4. Discussion

The analysis on residents' level of awareness to climate change effects established that there is high level of awareness and concern on the impacts of climate change among residents of Lagos metropolis. These findings contradict the findings of earlier studies such as Chatterjee (2008), Pugliese and Ray (2009) and Rao (2011) that most people in developing countries, particularly sub-Saharan Africa are still unaware of climate change. The level of awareness in the study area could be attributed to the frequent and severity of floods and heats in Lagos in recent times. It also implied that residents are increasingly becoming

Table 5.
Multiple regression
analysis result on
factors affecting level
of adoption of
adaptation strategies

Adaptation factors	Coef.	Std. err.	T	P > t	[95% Conf. interval]
Age	3.270981	1.242523	2.74	0.003	0.8285916
Income	0.0316017	0.0628511	0.85	0.395	-0.1551462
Education	1.352717	1.980286	2.22	0.001	-5.245304
Household size	2.17675	0.4230391	1.17	0.004	1.345195
Gender	7869766	1.266782	1.31	0.193	-1.703097
House type	0.655275	0.1371152	0.67	0.093	0.3857519
House ownership	1.626906	0.3825998	1.02	0.005	0.8748412
Length of residence	3.316017	1.628511	3.99	0.004	0.3857519
_constant	7.625898	5.152126	0.71	0.140	-2.501477

Notes: a. Dependent variable: level of adaptation strategies adopted $R = 0.741$, $R^2 = 0.549$, $F = 22.189$, $p = 0.001$

conscious about climate change phenomenon in their environment. These findings, thus, substantiate earlier assertions by Okaka and Odhiambo (2018), who reported that most of the residents expressed the occurrence of climate change in terms of changes in the trends of temperature, rainfall and strength of the wind, particularly during the rainy season.

Household adaptation to climate change

It was also found that respondents adopted similar reactive or ex-post adaptations strategies which support them in coping with the effects of climate change in the study area. The coping strategies do not reflect much of government interventions, hence, they resort to personal efforts. These coping strategies could be classified as coping responses (Porter *et al.*, 2014). They are behavioural changes that require no premeditated plan; they occur spontaneously and often take place after the impact of climate change has been experienced. This finding is in accordance with Mertz *et al.* (2009), who found that coping response actions against extreme weather events are common among households in developing countries.

Furthermore, analysis of factors influencing the level of adaptation strategies to climate change revealed that education, average monthly income, house type and house ownership are the key factors influencing residents' level of adaptation strategies to climate change in the study area. This implied that formal education may have a more significant role in determining people's level of risk and their adaptive capacity. This outcome further reinforces the findings of previous studies such as Wamsler *et al.* (2012) and Alexander *et al.* (2016) that education plays a determinant role for residents in relation to their capacity to adapt to climate change effects. The study further suggests that individuals who own their house tend to adopt more adaptation strategies than those individuals living in rented apartments. This finding confirms the findings of previous studies such as Ihemezie *et al.* (2018) that house owners are more motivated to adopt more adaptation strategies as a protective measure against their property more than tenants who have little stake or self-interest in the building.

In line with this, the type of house one lives in is likely to affect one's level of adaptation to climate change effects. It was discovered during the field observation and interaction with respondents that residents living in duplexes, high rise buildings tend to adopt more adaptation strategies. This might be attributed to the relatively high income of such households as against households living in bungalows terraced houses who mostly fall under low/middle income class. This finding further buttressed the significance of income level in influencing residents' level of adaptation to climate change effects and corroborated the assertion of Uddin *et al.* (2014) and Ihemezie *et al.* (2018), who argues that households with higher income are more likely to adopt more adaptation strategies.

5. Conclusion

This study provides an analysis to determine factors influencing residents' level of adaptation strategies to climate change effects. Understanding these factors is a step in the right direction towards strengthening households' resilience to climate change effects. The result indicated that the level of climate change awareness is high among the residents surveyed, most importantly in the low residential density. The study also established that the strategies by residents in the different residential areas were similar and reactive rather than anticipatory. More importantly, it is obvious that government support is needed to strengthen the socio-economic status of individuals and households to evolve anticipatory adaptation to long-term climatic risks such as flood and storms in urban and rural communities across Nigeria. In minimizing the cost of household adaptation, it is essential to implement and develop community adaptation and mitigation strategies among various

stakeholders such as the community, government, non-governmental organizations and private sectors to enable smart and resilient adaptation strategies to climate change effects. There is a need to embark on further pragmatic research that will identify and confirm other factors influencing climate change adaptation not covered in this study.

Furthermore, awareness of climate change impacts is necessary for inculcating into the residents and community groups the culture of climate change preparedness, prevention, mitigation, response and recovery. Public sensitization should be embarked upon by authorities to increase the level of awareness of residents about climate change, its causes and effects, preventive and post-recovery measures, the importance of community participation, etc. This would serve as a channel of teaching residents early to be anticipatory in response to climate change effects. Opportunities should also be provided for residents to voice their concerns and opinions and take responsibility for changes in their community. It is also important to advance the early warning system through inclusive media channels that would be accessible to all residents to overcome mitigation and adaptation obstacles. Environmental education and enlightenment programme can also be embarked upon through speeches to audiences where every socio-economic status will be present. Such congregation may include as we have in churches, mosques, vocational centres, primary, secondary and tertiary schools.

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