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The extent of awareness and degree of contributions of socio-community features to changing climate and its variability in Lagos Mega-city, Nigeria

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Abstract

The features of changing climate and its variability are becoming increasingly evident in different parts of the world. Lagos Mega-city in Nigeria is not an exception. Thereby, this study engaged both quantitative and qualitative surveys to examine the features of changing climate and its variability through the perception of the respondents in Lagos Mega-city, Nigeria. The research acquired data on the extent of the awareness and degree of contributions of socio-community features to changing climate and its variability through engagement of a structured questionnaire used to collect responses from 400 adult households that were randomly selected in 3 purposeful chosen communities in the Mega-city. Also, supplementary data was collected from the focus group discussions conducted on community leaders and fishmongers in the communities. The results from the participants portray through their perceptions that majority of the respondents were aware of change in annual climate parameters and patterns which included rainfall, temperature and frequency of flooding in the city. It also reveals that most of them had low understanding or knowledge of the extent or degree of contribution of various socio-community features to climate variability and change. In the end, the study proposes sustainable environmental management practises alongside a policy push supporting improved and increased knowledge of the awareness of changing climate and its contributing factors to encourage the building of resilience in the city.

Keywords Changing climate, Climate variability, Awareness, Climate parameters and Lagos Mega-city

1 Introduction

The attributes of changing climate and its variability which include its impacts on cities in different parts of the world cannot be overemphasised. This has been debated with contemporary evidence in climate scientific literature [1, 2]. Climate variability and change accompanied by localised consequences of rapid urbanisation are increasing the degree of threats to urban settings [3–6]. Urban changing climate risks are increasing



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and they include heat stress, extreme precipitation, inland, and coastal flooding, landslides, drought, water scarcity, air pollution, rising sea levels, and storm surges with implications for ecosystems as well as local and national economies [7–9]. As more than half of the global community now resides in urban communities, the security of urban spaces will only be assured when the effects of climate variability and change are essentially addressed and ameliorated.

Lagos Mega-city is one of the fastest growing urban environments in the developing world with an annual growth rate of 3.2% [10]. The present population of the city is above 20 million [11, 12]. The city continues to grow in size and population as it is attractive to migrants both locally and internationally due to its social and economic factor [13, 14]. Thereby, it is the prime commercial hub of Nigeria with two functional sea ports, an international airport and a local airport. It is located along the coastline of the Atlantic Ocean with a low-lying elevation which enhances its susceptibility to impacts of changing climate and its variability [15, 16]. This is in line with Grasham et al. [17], and Wheeler and Gober [18] inference that the levels of susceptibility and risks to changing climate are functions of cities physical attributes. Additionally, Adegun [19] and Cohen [20] also emphasise the indispensability of the socio-economic parameters in determination of the levels of risks and susceptibility of residents to changing climate impacts. Likewise, literature continually emphasise the overwhelming and noticeable signs and impacts of climate change and its variability on urban society in different parts of the world, mostly cities located around the coastlines [21–23].

Thereby, increasing awareness of changing climate by the public is indispensable in building resilience which is vital in urban sustainability [24, 25]. This is because, increasing awareness of changing climate enhances support given to policy, plan and improve public environmental behaviours [24, 26]. While, lack of awareness might result in cynicism about the certainty of changing climate, thereby affecting the attitudes of the people to the change and their expected action and support [27].

Therefore, climate variability awareness is veritable to foster the design and acceptance of adaptation and mitigation procedures which encourage the building of resilience in cities affected with its impacts. Though, large body of research has studied people's awareness of changing climate but there has not been a standardised approach creating difficulty in comparison of their results [27]. However, studies on the assessment of public perceptions of the awareness of changing variability and change with emphasis on climate parameters and patterns are not commonly known in developing economy countries because of the broad paradigm of the change when compared to developed countries [28]. This study is expected to contribute to the debate on changing climate in developing economy country cities. Thereby, it explores public awareness and perceived community contributions to climate variability in Lagos Mega-city in Nigeria. At the end, it proposes sustainable approaches that will encourage its urban climate environmental sustainability.

2 Public perceptions of changing climate and its variability in cities

Public perceptions of risks and consequences of climate variability and change are essential in achieving the laudable intentions of urban climate security which include building of resilience in cities. This is in the vein that changing climate is expected to amplify existing risks and generate new risks for natural and human systems [6, 7, 29].

Thus, the climate risks are expected to be exemplified in cities and urban environments, which house the largest concentrations of people in the world at present. Hence, urban responses to climate risks are indispensable in achieving sustainable city environments in this changing climate age.

Whitmarsh and Capstick [30] describe perceptions as an array of psychological constructs that include beliefs, knowledge, attitudes, affect, concern, and perceived risks which are shaped by cultural contexts and social processes. Previous studies show that the perceptions of changing climate are complex and cannot be generalised worldwide but may be culture and country-specific [31, 32]. Hence, the perceptions of urban residents of climate variability and change risks and consequences could be seen as the ways in which individuals who are living in cities respond to the causes of changing climate, its implications, and wider consequences [33]. According to Kwon, Kim and Lee [34], the world focuses mainly on national and local levels to take action in regard to changing climate risks and consequences; however, sustainable policies will not depend fully on these actions to function maximally but also on individuals' decisions to take laudable approaches as an agent of change.

However, individual perceptions of changing climate risks and consequences are influenced by the variability of local weather from time to time when compared to the long-term change in climate, which is significant [35, 36]. Previous studies by social scientists have demonstrated that risk perception is indispensable in people's responses to hazards [37, 38]. Therefore, public perceptions of the risks and consequences of changing climate will always influence individual and collective climate actions [2]. Therefore, the understanding of the public perceptions of changing climate is critical in building extensive public engagement and development of effective educational and communication approaches that will enhance the development of socially vigorous technologies, and the adoption of acceptable policies that are vital for the adaptation and mitigation approaches for climate variability and change [30].

Since cities are essentially places of innovations, technologies and inventions, urban residents' perceptions of climate issues, which include the imminent risks and dangers, are fundamental to public acceptance, and stimulates their support for the climate policies alongside encouraging them to put to use the formulated and developed adaptation and mitigation technologies [39, 40]. Lund [41] reiterates that there is a need to enhance changing climate perceptions to encourage policy acceptance and support for adaptation and mitigation strategies in developing economy countries that are known to have weaker socio-economic, political and information infrastructures. Similarly, the perception of changing climate issues, risks and consequences vary extensively among individuals and countries, and it is commonly perceived sometimes to be spatially and temporally distant challenges whose risks could be underrated [42].

Evidence from diverse surveys conducted worldwide has shown that public perceptions of climate variability and change have continued to increase over the last 30 years and are becoming nearly universal in most of the developed economic nations in the global north, which include the United Kingdom and the USA while it is quite low in developing economy countries in the global south like the Indian subcontinent and sub-Saharan Africa regions [33]. The Gallup World Poll of 2007/2008, representing a sample of 119 nations, shows that changing climate awareness and perception of risks were unevenly distributed in the world, with over 90% highest awareness in the developed

world (which includes Europe, Japan and North America), while the majority of persons surveyed in developing countries from the Middle East to Asia and Africa reported they had never heard of changing climate [31]. A study conducted by the Pew Research Centre in 2015 found that the perception that anthropogenic-induced changing climate could signify serious challenges and as one of the greatest threats of that time among many scientists was high with 41% of British, 19% of Chinese, 45% of Americans and 29% of Israelis sharing this perception, while the research also affirmed relatively high scepticism among participants [43].

Past evidence in the USA indicates that people's changing climate risk perceptions are always formed through experiences of climate extremes or hazards such as excessive flooding or when participating in individual or collective responses [2, 44]. Likewise, studies in the Global South have shown that climate perceptions often stem from lived experiences, such as flooding, rather than scientific education [33, 44]. Consequently, programmes and policy thrusts for amelioration, mitigation and adaptation of climate issues and extremes require some degree of individual involvement, which may include attending to policy dictate and expectations of active behavioural transformation [33, 45]. Therefore, building collective individual risk perceptions in cities is essential in eliciting public involvement in nurturing a culture of adaptation behaviour necessary for public support for climate security policy and approaches.

3 Methodology and data collection

Fasona et al. [46], surmise that an understanding of the contemporary and anticipated future patterns in climate systems is indispensable for urban or city environments since it will support and encourage the development and preparation of effective adaptation and mitigation strategies against the impending consequences of changing climate. Hunt, William and Hillis [44] emphasise that climate action is facilitated by the perceptions of climate risks which is indispensable in driving environmental behaviour and encouraging initiation and support for public policy. This is mediated by changing climate awareness.

3.1 Selection of the study areas in the Mega-city

Lagos Mega-city has more than 100 slums and unregulated developments located in its fragile communities making its urban environment susceptible to negative implications of climate variability and change [13, 47, 48]. Hence, the study targeted communities in the city that are known to be susceptible to the implications of changing climate. Therefore, the study purposefully chose 3 communities based on their documented household income and their vulnerability to changing climate due to their locations on the coast of the mega-city as revealed in preceding literature [49, 50]. Thus, Makoko (low-income) in Lagos Mainland Local Government Area (LGA), Ajegunle (low-income) in Ajeromi-Ifelodun LGA, and Bariga (low or middle-income) in Somolu LGA were chosen for the study.

3.2 Study approach

The study engaged both quantitative and qualitative surveys to examine the features of changing climate through the perception of the respondents in the 3 purposively selected communities to acquire the perception on the extent of the awareness of

changing climate and its variability in Lagos Mega-city, Nigeria. Thereby a structured questionnaire was used to collect responses from 400 adult household representatives through random point sampling of the 3 purposeful chosen communities. The, random point sampling was employed from spatial maps through Geospatial Modelling Environment (GME) tool for the three selected communities. For each selected geospatial point, the household located at or nearest to that point was identified, and an adult household member (aged 18 or above) was interviewed. However, where a selected household declined to participate or no eligible respondent was present, the next nearest household was approached as a replacement. Figures 1, 2, 3 below show the sampling points selected through the GIS tool GME in Makoko in Lagos Mainland LGA, Ajegunle in Ajeromi-Ifelodun LGA, and Bariga in Somolu LGA respectively.

Supplementary data was collected from the focus group discussions when community leaders and fishmongers were engaged in the 3 communities. Data from the structure household questionnaires were analysed using Statistical Package for Social Sciences (SPSS) while that of the focus groups were subjected to content analysis. The results from the analysis were complemented by related secondary data.

4 Results and discussion

4.1 The respondent’s perceptions of what they understand of climate variability and change in Lagos Mega-City

When the respondents were asked what they understood by climate variability and change, only a few respondents (2%) claimed they didn’t know about it. The majority of the respondents (94%) claimed climate variability and change was temperature increase, while 67.5% stated it was late and erratic rain and 67.75% indicated it was a frequent natural disaster such as a flood. Furthermore, 81% of the respondents stated that climate variability equals the change in seasons, 17% claimed it was low crop yields, 8.5% said

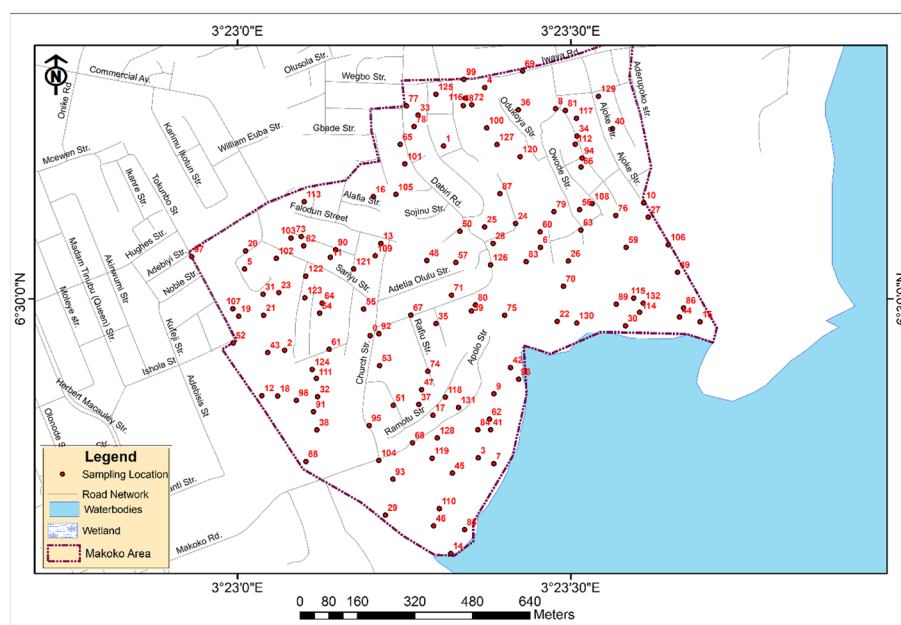


Fig. 1 Geospatial map of Makoko in Lagos Mainland LGA of Lagos Mega-city showing the sampling points

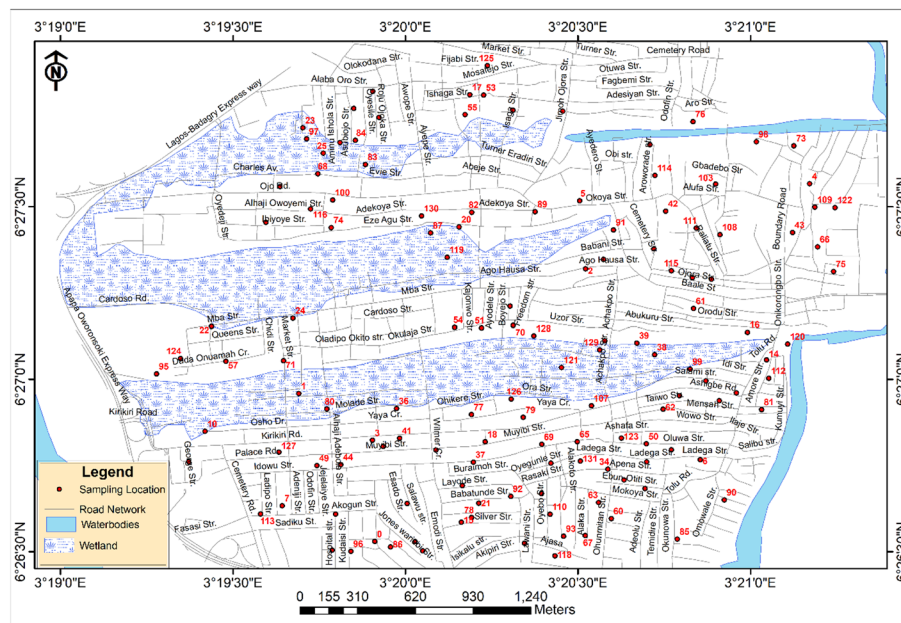


Fig. 2 Geospatial map of Ajegunle in Ajeromi-lfelodun LGA of Lagos Mega-city showing the sampling points

it was the death of livestock and 4.75% indicated it was a storm. This is represented in Table 1.

The responses show that respondents referred to the multiple characteristics associated with climate change, especially the prominence of extreme weather events and variables as impacts on livelihoods. Additionally, the participants in the focus group discussions and the key interviews conducted also expressed their awareness of changing climate linked to weather-related changes and their impacts. Furthermore, one of the elderly (above 70 years old), a participant in the focus group discussion in Ajegunle community described changing climate as ‘too much rainfall that is witnessed nowadays which was not the experience in those days’. Similarly, a participant in the focus group discussion in Bariga community said it was an ‘increase in heat, increase in the intensity of rainfall and excessive flooding that we always experience now’. Bradley et al. and Toole et al. [51, 52] state that the understanding of the concept of climate variability and change by the stakeholders is essential in the development of the processes for amelioration, adaptation, and mitigation of the impacts of changing climate in every society.

4.2 Respondents’ levels of awareness of change in the annual patterns of climate parameters of Lagos Mega-city

The study examined the awareness levels among the respondents about changes in the annual patterns of climate parameters in Lagos Mega-city. These were done for rainfall patterns, temperature patterns, frequency of flooding, and coastal erosion. Sullivan and White [2] surmise that there may be a gap between the public and the expert’s perceptions of issues about changing climate. Analysing the respondents’ perceptions of the levels of awareness of the change in annual patterns of climate parameters may be a veritable strategy for communicating its impacts as well as delineating the mitigation and adaptation approaches to be engaged [30, 33, 41]. Figure 4 below shows respondents’

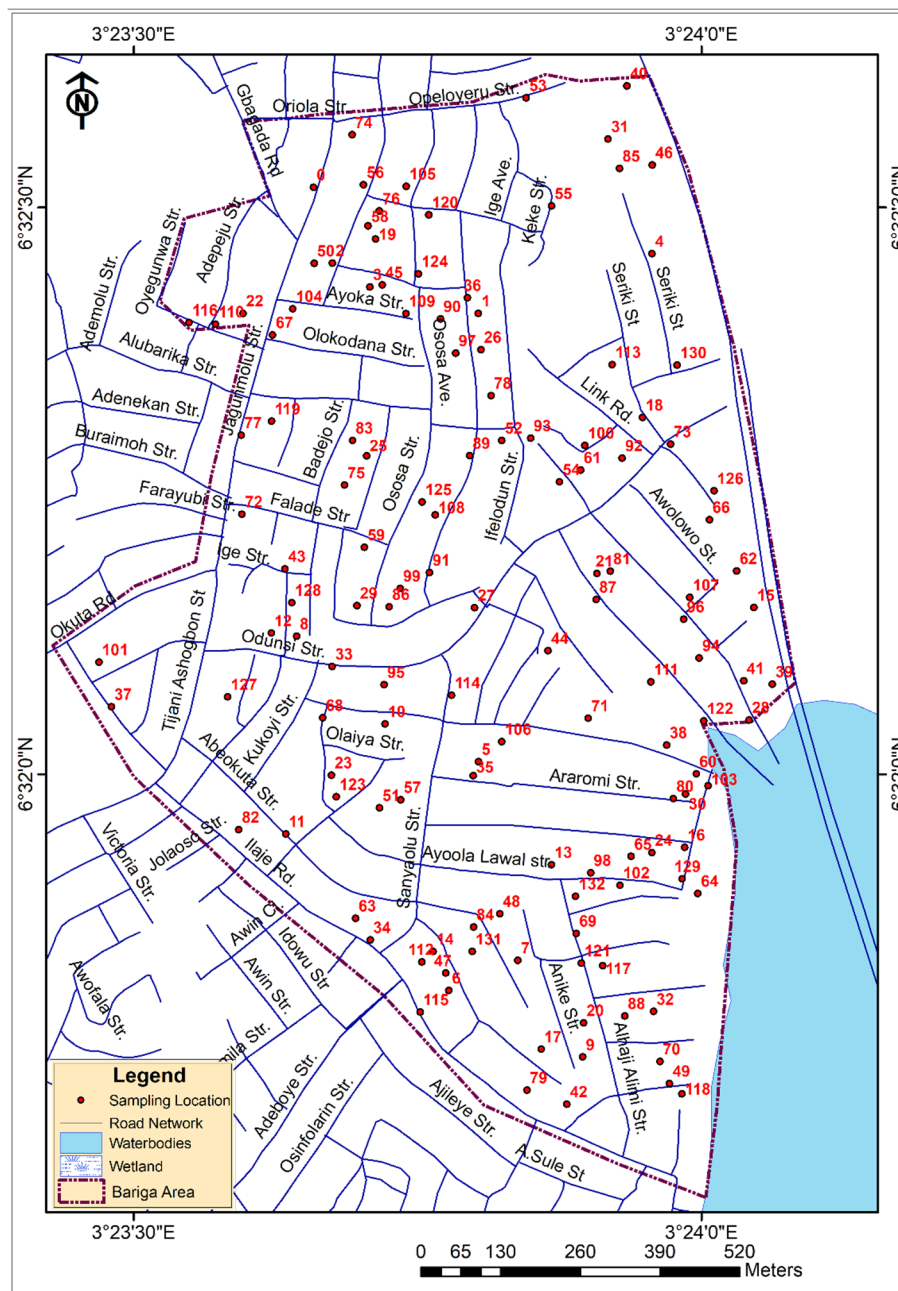


Fig. 3 Geospatial map of Bariga in Somolu LGA of Lagos Mega-city showing the sampling points

perceptions of the levels of awareness of change in the annual patterns of climate parameters in Lagos Mega-city.

The result revealed that the majority of the respondents (88.75%) affirmed they were aware of changes in the annual patterns of rainfall, while only 4.25% rejected this assertion and 7% of the respondents indicated that they did not know about it. Concerning temperature, the majority of the respondents (88.5%) affirmed there were levels of awareness of change in its annual pattern, while fewer respondents (5.5%) denounced the assertion and about 6% stated they did not know about the issue. The majority of the respondents (92%) affirmed there were levels of awareness of change in the annual

Table 1 Respondents’ perceptions of what they understand by climate variability and change (n = 400)– affirmative responses

Understanding of climate variability and change	Frequency	% of respondents
Do not know	8	2
Temperature increase	376	94
Late and erratic rains	204	51
Frequent natural disasters such as floods	271	67.75
Change in seasons	324	81
Low crop yields	68	17
Death of livestock	34	8.5
Others (such as storms)	19	4.75

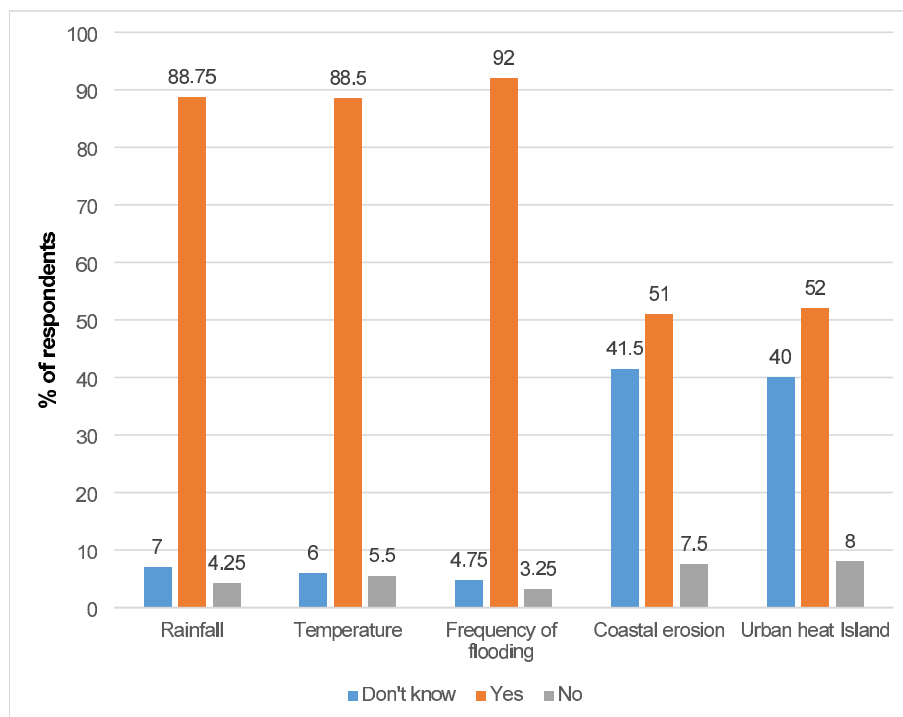


Fig. 4 Respondents’ perceptions of the levels of awareness of change in the annual patterns of climate parameters in Lagos Mega-city (n = 400, in %)

pattern of the frequency of flooding (often associated with extreme rainfall events), while 3.25% rejected the assertion and 4.75% said they did not know of the issue.

The responses resonate with findings in the literature that severe rainfall is likely to inform people’s perceptions of climate change as one of the most visible and tangible experiences of changes [49, 53] and that increased rainfall and flooding is evident in Lagos Mega-city [10, 54, 55].

Regarding coastal erosion, just about half of the respondents claimed they were aware of changes in its annual patterns, while 7.5% did not share this assertion and 41.5% stated they did not know about it. For urban heat island, about half of the total respondents (52%) affirmed they were aware of changes in its annual pattern, while 8% of the respondents denounced the assertion and 40% indicated that they did not know. The lower proportions of respondents who were aware of coastal erosion and the urban heat island effect resonate with earlier assertions that people tend to be more aware of more direct and visible aspects of climate change such as rainfall and flooding. Todaro et al.

[56] surmise that the perceptions and awareness of changing climate and climate variability are significant factors in understanding climate risks and essential in the development of strategic climate adaptation actions. Hoa et al. [57]. infer that the awareness and understanding of changing climate and climate variability do not translate directly into action but influence and promote successful household adaptive capacity through access to information and management of resources for effective responses.

4.3 Respondents' levels of awareness of the physical changes in the intensity of the annual climate parameters of Lagos Mega-city in the recent years (0–5 years) as compared to 5 years and above

The study assessed the respondents' levels of awareness of the physical changes in the intensity of the annual climate parameters in Lagos Mega-city in recent years (0–5 years) as compared to 5 years and above (Table 2 below). The results indicate that the majority of the respondents (88.75%) perceived that there was a physical change in the intensity of rainfall in their communities in recent years (0–5 years) when compared to 5 years and above, while 4.25% of the respondents felt that physical changes in the intensity of rainfall in their communities did not occur, and 7% claimed they did not know about it. In relation to the temperature in the city, the majority of the respondents (88.5%) affirmed that there was a physical change in the intensity of temperature in their communities in recent years (0–5 years) when compared to 5 years and above while 5.5% stated that there was no change and 6% claimed that they did not know about it. Likewise, slightly more than half of the respondents (51%) perceived there was a physical change in the intensity of the coastal erosion in their communities in the Lagos Mega-city in recent years (0–5 years) when compared to 5 years and above while 7.5% declared that they were not aware and 41.5% stated they did not know.

Furthermore, about half of the total household respondents (52%) perceived there had been a physical change in the intensity of the urban heat island in the city, while 8% indicated that they were not aware of changes and 40% indicated they did not know. Additionally, the majority of the respondents (92%) indicated that there was a change in the frequency of flooding in their communities in recent years (0–5 years) when compared to 5 years and above, while 3.25% stated no and 4.75% said they did not know. The findings reveal that changes in the intensity of rainfall, temperature and the frequency of flooding had considerably higher levels of awareness among the respondents than other parameters that were analysed. This may be due to increased perceptions and awareness of the impacts of changing climate by the residents because of recurrent excessive flooding events that were witnessed in the city in recent years [58–60] as well as that these aspects are tangible and experienced directly. Also, the participants during the focus group discussion identified heavy rainfall, massive and destructive floods,

Table 2 The respondents' levels of awareness of the physical changes in the intensity of the annual climate patterns of Lagos Mega-city in the recent years (0–5 years) as compared to 5 years and above ($n = 400$)

Climate parameters	Don't know (%)	Yes (%)	No (%)
Rainfall	7	88.75	4.25
Temperature	6	88.5	5.5
Frequency of flooding	4.75	92	3.25
Coastal erosion	41.5	51	7.5
Urban heat Island	40	52	8

Table 3 The rating of respondents' perceptions of the extent or degree of contributions of some socio-community and environmental features to climate variability and change (n=400, in %)

Socio-community and environmental parameters	Don't know	Not important at all	Slightly important	Important	More important	Very important
Air pollution	61	4.75	2	4.25	7.75	20.25
Land pollution	64.5	11.5	2.75	3.75	7.25	10.25
Water pollution	63.25	11.75	2.5	4.25	6.75	11.5
Clearing/removal of trees	49	0.75	0.25	1.5	4	44.5
Use of fossil fuels	63.5	4.25	0.75	3.75	4.25	23.5
Genetically modified crops	81.75	16.5	–	0.75	0.75	0.25
Hazardous wastes	76.75	14.5	2	1.75	2.25	2.75
Loss of wildlife	82.25	14.75	2	0.25	0.25	0.5
Ozone depletion	75.75	11.25	5.25	5.25	0.75	1.75
Use of pesticides and herbicides	73.25	9.5	4.75	6.75	3	2.75
Poor farming practices	68.5	6.75	4	7.5	4.75	2.75
Increasing human population	58.25	10	3.75	5.25	3.25	19.5
Increasing poverty	60.75	15.75	3.5	4.5	2.75	12.75
Traffic congestion	61.25	12.25	5.25	7.75	5	8.5

high temperatures, and heatwaves (too much sunshine) as common physical changes in the annual climate parameters of the city. The results from the above (both quantitative and qualitative) concur with the analytical study carried out by Abolade et al. [61] for the years 2003 to 2012 in Eti-Osa local government of Lagos State when they revealed noticeable, observable changes in climatic parameters, especially rainfall and temperature. The knowledge and understanding of the perceptions of the public to the impacts of changing climate are vital to inspiring successive mitigation and adaptation procedures [2]. However, the study acknowledge that respondents' awareness may be shaped by short-term weather events rather than long-term climate trends.

4.4 The extent or degree of contributions of some socio-community features to climate variability and change

This section aims to quantify, through the respondents' perceptions, the extent or degree of the contribution of some socio-community features to climate variability and change in the city. These are socio-community features that commonly exist in growing cities, as noted in the literature review. These include air pollution, land pollution, water pollution, increase in human population, poverty, use of fossil fuels, etc. However, their contributions were examined based on their ability and potential to increase the concentrations of greenhouse gases in the atmosphere, which may enhance global warming. Hence, the assessment of the environmental awareness, behaviour, and degree of these socio-community features' contributions to climate variability and change in the study area is indispensable in the formulation of climate actions, sustainable urban policy, and approaches to be engaged in its communities against changing climate issues [2, 30, 61]. Therefore, it is crucial in the attainment of expected aspirations of urban climate security. Table 3 below represents the household respondents' rating of the extent or degree of contributions of some socio-community parameters to climate variability.

The study found that more than half of the total household respondents in the survey (61%) affirmed that they did not know the extent of the contribution of air pollution to changing climate and climate variability. Also, 4.75% claimed it was not important

at all, while 2% stated it was slightly important and 4.25% indicated it was important. Only 7.75% said it was more important and 20.25% affirmed it was very important. On the contrary, there is evidence in the literature that air pollution contributes to changing climate and climate variability [62, 63]. Furthermore, previous studies have indicated the contributions of air pollution to changing climate through emissions of gases which include CO₂, which is a foremost driver of changing climate [64]. Lagos Mega-city is the most industrial part of the country Nigeria having 70% of the country's economic activities with diverse sources of air pollution, which includes vehicular emissions from its numerous vehicles and commercial buses, emission from fossil fuels, and chemical activities from industries and dumpsites, etc [65]. Therefore, knowledge and understanding of the levels of air pollution are essential in the city's sustainable environmental practices that will encourage adequate climate actions.

Out of all the household respondents, 64.5% said they did not know about the contribution of land pollution to climate variability and change in the city, while 11.5% claimed it was not important at all and 2.75% indicated that it was slightly important. Furthermore, 3.75% affirmed that it was important, while 7.25% stated that it was more important and 10.25% claimed it was very important. The survey indicates that the majority of the respondents claimed they did not know land pollution's contribution to climate variability and change in the city. Subsequently [66], surmises that changes in the conditions of land contribute to changing climate while changing climate also exacerbates the process of land degradation. In addition, there is evidence in the literature that degraded land releases soil carbon alongside nitrous oxide into the atmosphere, thereby making it a big contributor to climate variability and change [67].

On water pollution's contribution to climate variability and change, 63.25% of the respondents claimed they did not know. That means they do not know the extent of its contribution. Furthermore, 11.75% claimed that it was not important at all, while 2.5% affirmed that it was slightly important, 4.25% indicated that it was important, 6.75% stated that it was more important, and 11.5% agreed that it was very important. However, Hobbie and Grimm [1], Ginkel et al. [68] and Mukwirimba et al. [69] related the changing climate and the issue of water insecurity and the process of population growth which is indicative of the need for adequate and sustainable water management for city dwellers in this climate variability era. On the other hand, water pollution may contribute to a change in the city's climatic conditions through the generation of greenhouse gases that will produce the greenhouse effect from the toxic chemicals or its by-products from mostly industrial effluents [70].

Similarly, on the contribution of the clearing or removal of trees to climate variability and change, 63.5% of the respondents said they did not know, 4.25% indicated that it was not important at all, while a negligible percentage (0.75%) affirmed it was slightly important, 3.75% claimed it was important, 4.25% stated that it was more important and 44.5% declared it was very important. Carter et al. [71] echo that process of tree removal is an important variable that determines the future of changing climate and the levels of greenhouse emissions. Therefore, the clearance or removal of trees is implicated in increasing atmospheric CO₂ (greenhouse emissions), resulting in the alteration of mass-energy balance, which eventually encourages changing climate [72]. Therefore, the changes in trees or forest cover through deforestation, afforestation, and reforestation always have impacts on changing climate [66].

On the contribution of the use of fossil fuels to climate variability and change in the city, 63.5% of the respondent said they did not know, 4.25% claimed it was not important, while a negligible percentage (0.75%) declared it was slightly important, 3.75% affirmed that it was important, 4.25% claimed it was more important and 23.5% affirmed that it was very important. Scientific knowledge identifies the burning and use of fossil fuels as one of the drivers of changing climate [64]. Likewise, on the use of genetically modified crops in the city, about four-quarters of the respondents (81.75%) claimed they did not know about it, 16.5% claimed it was not important, while 0.75% claimed it was important, 0.75% affirmed it was more important and one respondent stated that it was very important. However, there is currently not yet a fixed position taken by scientists on the contribution of genetically modified crops to climate variability and change at present, though some studies say it is beneficial to the environment or carbon footprint while others say it is adverse [72, 73].

Similarly, on the contributions of hazardous waste to climate variability and change in the city, 76.75% of the respondents claimed they did not know about it, while 14.5% of the respondents said that it was not important, 2% indicated that it was slightly important, 1.75% declared that it was important, 2.25% affirmed that it was more important, and 2.75% declared that it was very important. Wastes such as biodegradable wastes are known to decompose to methane and CO₂, which are veritable greenhouse gases [74]. However, most wastes, including hazardous waste, are disposed of through high temperatures or using incinerators in cities, thus they end up increasing their carbon footprint [75]. Therefore, hazardous waste is part of the contributor to climate variability and change.

Also, on the contributions of the loss of wildlife to climate variability and change in the city, 82.25% of the respondent claimed they don't know, while 14.75% affirmed that it is not important at all, 2% agreed that it is slightly important, a negligible percentage (0.25%) affirmed it was more important, and 0.5% claimed it was very important. Wildlife is the main terrestrial biodiversity in the world whose loss may have a profound negative effect on their environment since they are indispensable in the maintenance of a healthy forest through the dispersals of seeds that are vital in the growth of vegetation [76]. Hence, the loss of wildlife (defaunation) has the potential to accelerate global warming by wearing down the forest's carbon-storing capacity [77]. However, the majority of the household respondents claimed they did not know about the implication of the loss of wildlife on changing climate. This necessitates the need for continued wildlife conservation, particularly raising awareness about its importance among communities.

The contributions of the depletion of ozone to climate variability and change were also assessed through the household respondents' perceptions. About three-quarters (75.75%) of the respondents claimed they did not know about the contributions of the depletion of ozone to climate variability and change, 11.25% affirmed that it was not important at all, 5.25% claimed it was slightly important, 5.25% declared that it was important, 0.75% stated it was more important and 1.75% acknowledged that it was very important. Thus, the majority of the respondents indicated they did not know about the contributions of the depletion of ozone to climate variability and change. However, changes in stratospheric ozone over some period of years have implications on changing climate apart from its unavoidable implication on human and ecosystem health [78].

Thus, the understanding of the city residents needs to be improved about ozone depletion to support its sustainable management.

The survey showed that 73.25% of the household respondents in the city affirmed through their perceptions that they did not know of the contributions of the use of pesticides and herbicides to climate variability and change, while 9.5% claimed it is not important at all, 4.75% claimed that it is slightly important, 6.75% acknowledged that it is important, 3% stated that it is more important and 3% declared that it is very important. Again, the majority of the respondents did not know of the contributions of the use of pesticides and herbicides to climate variability and change. However, previous studies have shown that the use of pesticides and herbicides as agrochemicals contribute to greenhouse effects and global warming, which encourage changing climate [78, 79].

Furthermore, the household respondents' perceptions were assessed on the contributions to climate variability and change by poor farming practices in the city [80]. Slightly more than two-thirds of the respondents (68.5%) claimed that they did not know that poor farming practices can contribute to climate variability and change, while 6.75% claimed it is not important at all, 4% said that it was slightly important, 7.5% affirmed that it was important, 4.75% declared that it was more important and 8.75% claimed it was very important. Poor farming practices are shown in literature as a contributor to changing climate with the use of fertilisers and other agrochemicals to increase yields, except only when the farming practice is improved to reduce the carbon footprint [81]. Furthermore, as shown by [82], climate variability and change have substantial impacts on agriculture and food production, which contributes to food insecurity that leads to unsustainable farming practices and the use of biodiversity that causes climate change and variability. The intricate relationships between land use (especially those directly linked to livelihoods and food security) and climate change and variability are generally not understood by the respondents. This was also noted by one of the key informants who stated that 'people are experiencing climate change but they tend not to be aware of the various factors that cause climate change, including the activities that they are involved in.'

Additionally, the household respondents' perceptions were also assessed on the contributions of the increasing population to changing climate. More than half of the respondents (58.25%) claimed that they did not know whether the increasing human population contributes to changing climate and climate variability, while 10% of the respondents declared that increasing the human population was not important at all, 3.75% of the respondents affirmed that it was slightly important, 5.25% stated it is important, 3.25% claimed it was more important and 19.5% affirmed that it was very important. Generally, more than half of the respondents claimed that they did not know whether the increasing human population contributes to changing climate and climate variability. However, increases in the human population are a veritable driver of changing climate through patterns of consumption, affluence, and increasing technology [83]. Thus, the demands for land and forest, mostly in growing urban and cities, lead to changes in land use, thereby affecting environmental carbon storage [84]. An urban environment such as Lagos Mega-city, due to its continuously growing population, is also a hotspot for changing climate vulnerability [85]. Sustainable urban agricultural practices that need to be encouraged can be a pathway to climate mitigation and adaptation, thereby contributing to livelihood and food security as well as environmental/biodiversity security [85, 86].

Moreover, 60.75% of the household respondents declared that they did not know whether an increase in poverty contributes to changing climate and climate variability, while 3.5% affirmed that it was not an important contributor to climate variability and change, 4.5% declared that it was slightly important, 2.75% stated that it was important, another 2.75% affirmed it was more important and 12.75% acknowledged that it was very important. However, there have been direct and indirect relationships between changing climate and poverty in society, connected to how people fall and escape from poverty that is linked to levels of vulnerability as noted in the literature [16, 87, 88]. Thus, the perceptions of its contribution and interrelatedness are essential in a city's sustainable development, especially given the prominence of urban poverty in most developing countries [21, 89–91]. Poverty also influences the types of energy sources people use, as discussed earlier, as well as livelihood practices that contribute to climate change and variability. Given the high levels of poverty associated with socio-economic vulnerabilities in Lagos Mega-city, it is of concern that the majority of the respondents do not see the link between poverty and climate change and variability.

Likewise, 61.25% of the household respondents affirmed they did not know whether traffic congestion contributes to climate variability and change, while 12.25% indicated that it was not important at all, 5.25% stated that it was slightly important, 7.75% claimed it was important, 5% declared that it was more important, and 8.5% acknowledged that it was very important. Road transport which comes along with traffic congestion in most densely populated cities constitutes a high level of carbon footprint which is a driver of changing climate [92–95]. Therefore, the level of understanding of one of the drivers of changing climate in the city is low since the majority of the respondents indicated a lack of awareness of transportation's contribution to climate change and variability. This is particularly relevant in the Lagos Mega-city context, where Maduekwe, Akpan and Isihak [96] show that the transportation sector of Lagos is responsible for about 50% of the greenhouse gas emissions in Nigeria.

5 Conclusion

Urban society sustainability and socioeconomic development would only be achievable in the atmosphere planned on the veritable goals of urban climate security. This will only be attainable when the communities have real knowledge of changing climate and its indices that will propel their actions for mitigation and adaptation processes. The study affirms through perceptions of the participants that majority of the respondents were aware of change in annual climate parameters and patterns which included rainfall, temperature and frequency of flooding in the city which is indispensable in encouraging positive response to policy, mitigation and adaptation procedures to climate variability. It also reveals that most of them had low or no understanding or knowledge of the extent or degree of contribution of various socio-community features to climate variability and change. This indicates there was less knowledge about what contributes to increasing climate variability and change, including aspects that directly impact their lives, such as poverty or practices that they are involved including the use of fossil fuels and generating waste, by the majority of the household respondents. On the other hand, they did not grasp or understand climate and how their actions may contribute to increasing the change and, invariably, their vulnerability. Therefore, the need for increased awareness of the contributing factors associated with climate variability and change is critically

important in supporting the goals of urban climate security. It is also important to note that many of the contributing factors are interrelated. For example, poverty influences the use of fossil fuel-based energy use, land clearing for the construction of homes (often in vulnerable locations) and the poor management of waste. The multidimensionality of contributing factors is, therefore, also important to consider. In general, knowledge and understanding of the causes of climate change and variability are essential for the development of climate actions that will enhance the objectives of urban climate security. Hence, the need for targeted environmental education and cross-sectoral climate adaptation strategies cannot be overemphasized. Also, the Mega-city will require sustainable environmental management practises along with policy push supporting improved and increased knowledge of the awareness of changing climate and its contributing factors to encourage the building of resilience in the city. However, it is important to acknowledge that climate perception studies are often shaped by their specific context and their results may not be generalized across all Nigerian or African cities.

Author contributions

The article was prepared from the unpublished PhD of OA and supervised by UB.

Data availability

Data can be requested from the corresponding author.

Declarations

Competing interests

The authors declare no competing interests.

Ethical approval

The publication was drawn from my unpublished PhD thesis. Ethical approval was sought for the protocol from the University of KwaZulu-Natal's Humanities and Social Sciences Research Ethics Committee (HSSREC) on 17th September 2019 and full approval was granted on 28th November 2019 to enable data collection. Ethics norms were engaged with consent sought and obtained from every participant prior to their participation in the study. There was no external funding for the research.

Consent for publication

All authors consented to submit the article in *Discovery Global Society*.

Received: 27 March 2025 / Accepted: 7 July 2025

Published online: 06 September 2025

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