CLIMATE CHANGE IMPACT, MITIGATION AND ADAPTATION OPTIONS IN ASABA AND ENVIRONS: A REVIEW

Esosuakpo, E.E.[1] Ogbe, I.O.[2] & Oguduvwe, J.I.P.[3]

[1]Department of Environmental Management, Faculty of Environmental Sciences, Dennis Osadebay University, Anwai, Asaba, Delta State.

Esosuakpo.evelyn@dou.edu.ng

[2]Department of Geography, Faculty of Environmental Sciences, Dennis Osadebay University, Anwai, Asaba, Delta State.

[3]Department of Geography, Faculty of Environmental Sciences, Dennis Osadebay University, Anwai, Asaba, Delta State.

Abstract

Climate change has largely impacted on the environment of man. Solving or reducing the challenges posed by climate change in our communities requires some efforts. These efforts put in place by climate experts and other stakeholders to eliminate or ameliorate the impact of climate change is referred to as mitigation and adaptation options. Mitigation deals with causes while adaptation focuses on the impact of climate change. These two responses are important in addressing climate change issues. In recent time, the River Niger area has experienced a level of climate change impact that resulted to flooding and other environmental issues. The objectives of this study therefore, are: to identify the imprints of climate change in Asaba and environs, examine the existing mitigation and adaptation options employed so far, and to proffer novel mitigation and adaptation options that are suitable for Asaba and Environs. This was achieved by doing a systematic review of published related literatures, governmental reports including conference proceedings. The study adopted the city of Asaba and the towns and villages around it as a case study. The result of the review showed that flooding, degradation of building structures and socio-economic discomfort in Asaba and environs are impacts of climate change. This study therefore, recommends the use of renewable energy, including greenspaces in planning, improving drainages, building environment friendly structures, reforestation etc.

Keywords: Climate Change, Impact, Mitigation, Adaptation, Asaba. River Niger

1. Introduction

Climate change is a global issue that has been a major concern to man in the past decades. The activities of man have been the main driver of climate change and this changing climate is severely impacting on our environment and subsequently on man. Man's activities warm up the atmosphere, ocean, and land making rapid changes in our environment. Activities such as fossil fuel burning, industrial activities, land use etc., are changing the climate subtly without taking note of the changes immediately. Human caused climate change will continue to increase and cause problems such as extreme weather conditions if not curbed (Intergovernmental Panel on Climate Change (IPCC), 2023). According to United Nations (2025), 2015 to 2024 is the warmest decade ever recorded, and the earth is about 1.41°C warmer than the pre-industrial period. This suggests that the earth is becoming warmer by the day and if not controlled, will cause more havoc than it is experienced today. Some of the havoc experienced in the environment include, sea level rise, flooding, heatwaves, land degradation,

mangrove destruction, spread of diseases, habitat loss, biodiversity loss/extinction and so on (National Oceanic Atmospheric Administration (NOAA), 2025; World Health Organization (WHO), 2023).

In Nigeria, the impacts of climate change are on the increase as it is felt globally. High temperature, sea level rise, rainfall variability, flooding, drought, desertification and so many others are the impacts felt in this part of the world (Haida, 2019). Although, the developed countries are major contributors of climate change, Odjugo, (2010) stated that climate change is impacting more on developing nations than the developed ones. He added that the ecological problems in Nigeria are associated with climate change. These changes in the environment have negative impacts on human health, food security (WHO, 2025; Chime & Oniovokuko, 2024; Food and Agriculture Organization of the United Nations, 2025). (WHO, 2021) stated that about 150,000 deaths annually are due to climate change and they also envisaged twice of this figure will occur due to waterborne diseases by 2030.

Asaba, the capital city of Delta State, one of the towns bordering the River Niger is affected by climate change (Isiwele & Akhimen , 2017; Ogbogo et al., 2025). The activities of the occupants and the built environment of Asaba impact on the climate of the place causing what is known as urban heat island. Ozabor & Ajukwu (2023) identified that climate change is a contributory factor to thermal discomfort. Climate is changing in Asaba, leading to rise in temperature, increased rainfall which causes flood in the area. One very important impact of climate change Asaba is known for, is the intense and frequent flooding especially in Anwai and smaller villages around it. This assertion is supported by Egbune & Odumodu (2024) that flash floods is most common in Asaba. A systematic review carried out by Okon et al. (2021) on climate change impacts, stated that climate change is impacting on rainfall which is affecting vegetations in southern Nigeria.

For all these problems identified as impacts of climate change to be reduced, man has to put in some efforts. These efforts are known as mitigation and adaptation options. Mitigation strategies are techniques employed to reduce the emissions of greenhouse gases in order to reduce the impact of climate change in the future. While adaptation strategies are practices employed to adjust to present and future climate change impacts. Lawler et al. (2013), defines mitigation as actions that reduces anthropogenic influences on climate while adaptation strategies are actions that make human or natural systems withstand the changes caused by climate change.

With the different climate change impacts experienced in Asaba, several mitigation and adaptation strategies have been suggested and practiced. Farmers in Asaba and environs, practiced indigenous adaptive measures to curb the impacts of climate change. These indigenous practices include mulching, planting cover crops, zero tillage to avoid loosening of the soil, etc. Isiwele & Akhimen, (2017) investigated how built environment has affected the physical environment, causing climate change. The study suggested that when building structures, the physical environment should be considered. That is to say, the ecosystem should be integrated in built environment for the survival of the environment and its inhabitants. The study also suggested the involvement of the different tiers of government to ensure that adaptation measure be taken across the different sectors. The study by Ogbogo et al. (2025) did a comparative study on the impacts of changing temperature on building structures and their findings indicated that the impact of changing temperature on walls, roofs and other building

materials are more in Asaba compared to Okwe. This suggests the impacts of urban heat island.

The study therefore, suggested that building engineers should give attention to climate responsive designs such as reflective roofing etc. This study also suggested that, there should be increase in green spaces, town planners should encourage sustainable urban growth and drainages should built to reduce the impact of flooding on buildings.

Several studies have been carried out on the impacts of climate change in Asaba and environs (Ogbogo et al. 2025; Isiwele & Akhimen 2017; Okon et al. 2021) only very few, if not just one study has related these impacts to flooding (Egbune & Odumodu, 2024). Wilcox et al. (2013) supported the fact that the lower Niger area are liable to flood and the study stated that strategies for coping with climate change in the Niger Delta include planting fast maturing variety of crops, erecting wooden bridges during flood to enable them go about their daily activities, and following the patterns of rainfall to plant their crops to avoid wastage.

Some indigenous adaptive measures have been carried out by the locals and some mitigation and adaptation measures have been suggested but these problems still persist. It shows that more effective or novel options need to be implemented. This study therefore, looks at the imprints of climate change in Asaba and environs, examines the mitigation and adaptation options employed so far and suggests novel mitigation and adaptation options most suitable for Asaba and environs. This study gives the understanding that several sectors are affected by climate change, and this guides the options/solutions taken, which reduces the vulnerability of the populations and ecosystems thereby leading to sustainable development.

2. Materials and Methods

2.1 Study Area

The study area, Asaba and its environs include the city of Asaba, Igbuzor, Okpanam, Anwai, Okwe, Ugbolu, and Iyiba. It is situated on a hill at the west of the River Niger which connects the eastern, western and northern Nigeria (Ofido et al., 2024). The area lies in Latitude 6º 08′ 00″ to Latitude 6º 16′ 00″ N, and Longitude. 6º 38′ 00″, and Longitude 6º 45′ 00″ E (Ofido et al., 2024). The study area has a tropical equatorial climate with wet and dry season. Temperature varies from 19.44℃ - 31.67℃ in the year. Rainfall period spans for about 10 months (February to December) while dry season is for just three months, from December to February (Ogbogo et al., 2025; Weather Spark, 2022). Its annual rainfall is about 2700 mm (106 in) (Isiwele & Akhimen, 2017). Asaba town has been devoid of trees due to urbanization and this has given room for increase in temperature and some other hazards associated with the lower atmosphere. The part of Asaba and environs covered by forest, has the tropical rainforest and this forest is noted for some economic trees such as obeche and iroko trees. Asaba is drained by Amilimocha and Niger river (Ogbogo et al., 2025).

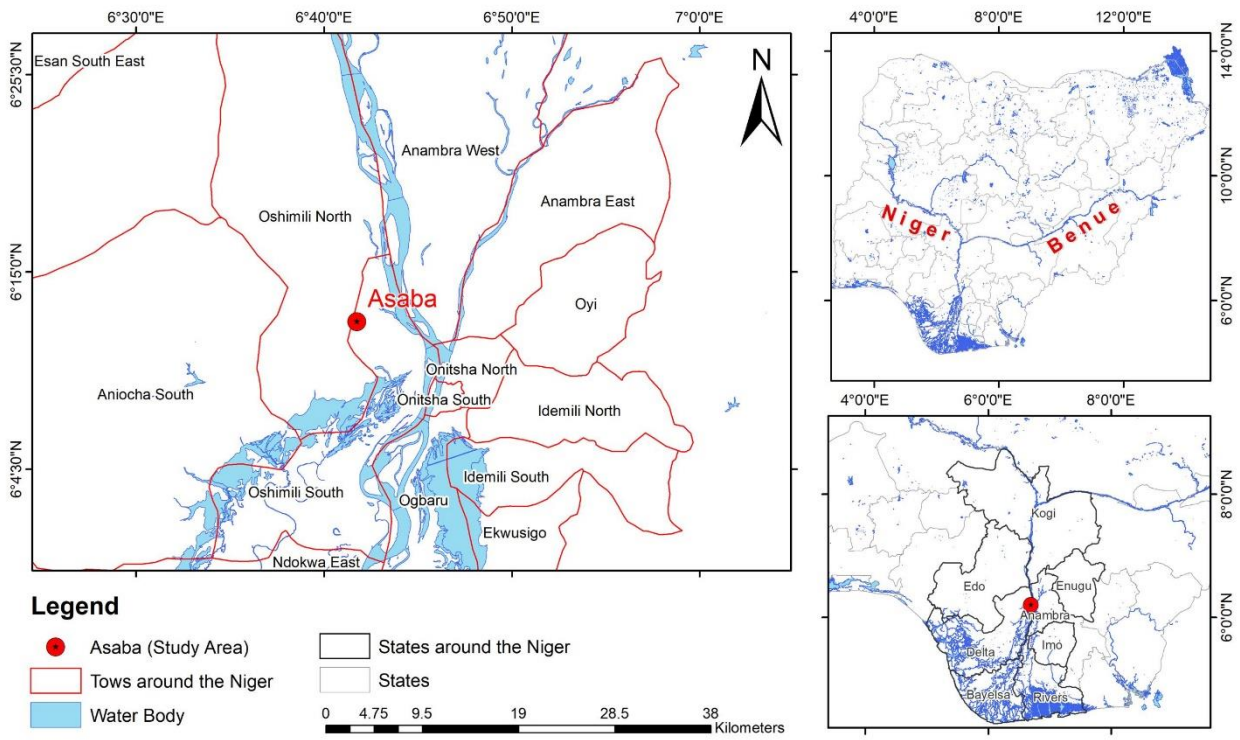

Figure 2. Asaba and Environs

Source: Researcher, 2025

2.2. Review Methodology

This study adopted the systematic review method, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to synthesize peer-reviewed reports, reports from governmental organizations and conference proceedings, on the impacts of climate change, mitigation and adaptation strategies in Asaba and its environs. This was applicable to every part of the work, from abstract to the discussion of findings. Searches were carried out on Google scholar database, reports from governmental organizations and conference proceedings between 2010 – 2025 (Table 1). Figure 1 shows the step-by-step process of systematic review. It identified the number of records made and showed records included an excluded with the various reasons.

Table 1. Systematic Review

AUTHOR	TITLE	SOURCE TITLE	DOCUMENT TYPE	PUBLICATION DATE
Chime, C.C. & Oniovokukor, R.R.	Investigation on Adaptation to Climate Change Impacts and Occupant Window Control in Federal Secretariat Building Asaba.	Building climatology	Article	2024
Dimuna et al.	Climate Change Impact on the Architectural and Built Environment Dwellers Well-being in Niger Delta Region	Architecture	Review	2024
Effiong et al.	Exploring Loss and Damages from Climate Change and Global Perspectives that Influence Response Mechanism in Vulnerable Communities.	Sustainability	Article	2024
Egbuna, O.K. & Odumodu, U.J.	Urban Growth and Flood Vulnerability in Asaba, Delta State.	Urban Planning	Article	2024
Ikenga,et al.	Climate Adaptation Measures of Aquaculture Enterprises in Delta State, Nigeria	Agriculture	Article	2023
IPCC	Synthesis Report	Climate Change	Intergovernmental Report	2014
IPCC	Climate Change 2022: Impacts, Adaptation, and Vulnerability.	Climate Change	Intergovernmental Report	2022
IPCC	Climate Change. Synthesis Report, Summary of Policymakers.	Climate Change	Intergovernmental Report	2023
Isiwele, A.J. & Akhimien, N.G.	Climate Change and the Built Environment Perspective of Climate Change-A Case Study of Asaba	Urban Climatology	Article	2017
NASA	Responding to Climate Change	Climate Change	Governmental Report	2025
NOAA	Climate Change Impacts	Climate Change	Governmental Report	2025
Nzeadibe et al.	Climate change awareness and adaptation in the Niger Delta Region of Nigeria	Urban Climate	Article	2011
Ofido et al.	Mapping Flood Risk Zones in Asaba, Delta State, Nigeria. Using Remote Sensing and GIS Approach	Remote sensing and GIS	Book Chapterr	2024
Ogbogo et al.	Comparative Studies of Changing Temperatures on Buildings Structures in Asaba and Okwe	Urban Climate	Article	2025
Okafor et al.	Climate Change Mitigation and Adaptation in Nigeria: A Review	Urban Climate	Review	2024
Olajuyigbe et al.	Climate Change and Human Settlement Adaptation Strategies: A Case Study of Asaba, Nigeria.	Urban Climate	Article	2013
Onafeso, O.D.	General Circulation Model of Climate Change in the Lower River Niger Region, Nigeria.	Climatology	Article	2020
Osayande, M.	Delta Agency Begins Flood Control Operations in Asaba	Urban Planning	Article	2025

Ozabor, F. & Ajukwu, G.A.	Thermal Comfort Perception in Asaba, Delta State	Urban Climate	Article	2023
UNDP	What is Climate Adaptation and Why is it Crucial?	Sustainability	Governmental Report	2024
United Nations	Climate Change Action	Sustainability	Governmental Report	2025
Wang et al.	Climate Strategies for Mitigation and Adaptation Strategies.	Sustainability	Review	2023
Wilcox et el.	Climate Change and Niger Delta: Some Socio-Economic Implications and Coping Strategies	Sustainability	Review	2013
WHO	Climate Change	Health	Institutional Report	2021
WHO	Climate Change	Health	Institutional Report	2023
WHO	Climate Change	Health	Institutional Report	2025

2.3. Searches and Source Document

Searches were done between 2010 – 2025 from Google Scholar. The reason for this to have a wider coverage of literature.

2.4. Search Strategy

The author conducted searches using Google Scholar database as shown in table1, using the keywords stated and grouping them. Also, other databases like WHO Library database was employed. The process involved are as follows:

- Listing keywords from other articles relevant to this study.
- Searching for synonyms and alternative terms.
- Using Boolean operators (OR and AND) to connect significant terms.

The keywords are the words related or are in use in this topic, such as “Climate Change” and “Mitigation”, “Climate Change” and “Adaptation”, Climate Change” and “Its Impacts” or Effects of Climate Change”. To search articles for review, the reviewers vetted the articles based on the topic, abstract, and full text.

2.5. Systematic Review

The authors employed the inclusion and exclusion criteria to select studies for systematic review.

2.5.1. Exclusion Criteria

The authors excluded all unpublished reports/articles, Non-English reports/articles, all studies not within the same subject under review, and publications not within 2010 – 2025. Materials were excluded after title and abstract screening.

2.5.2. Inclusion Criteria

The authors selected twenty-six (26) studies from Google Scholar for review. The inclusion criteria were made up of peer reviewed articles between 2010-2025 and written in English. Studies on the impacts of climate change in Asaba and environs were eligible. Also, articles, governmental reports, and conference proceedings focusing on climate change impacts, mitigation and adaptation options were considered. In addition, related studies on the Niger Delta were considered. Studies.

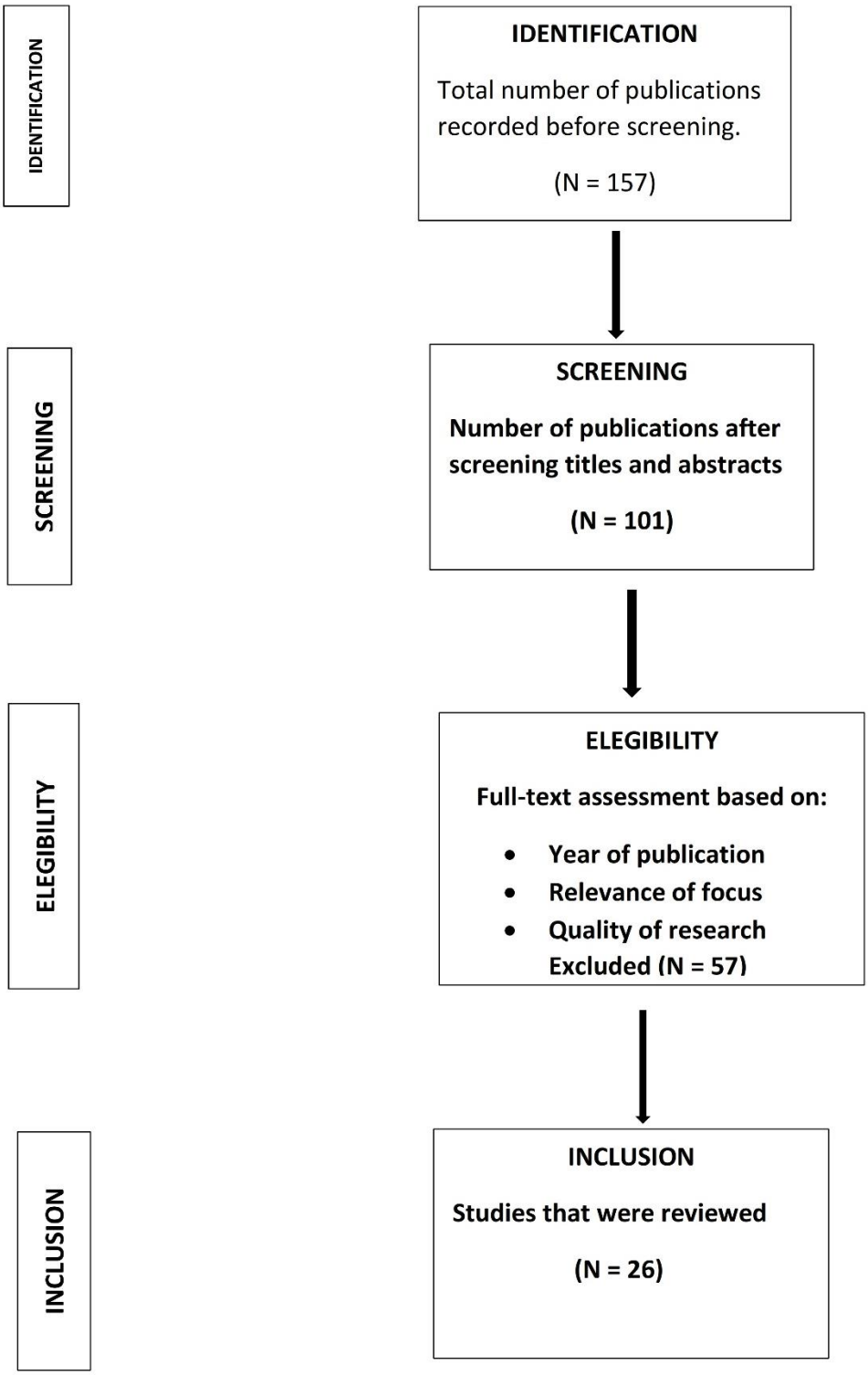

Fig. 1: Flow chart of Selection of publication

3. Discussion of Findings

3.1 Indicators of Climate Change in Asaba and Environs

There has been persistent rise in temperature over the years globally. Asaba and environs are not exempted from this rise (Ogbogo et al. 2025: Ozabor & Ajukwu 2023). Asaba and environs experiences high temperature which is above 30 degrees Celsius. Temperature is one of the major indicators of climate change in the area. Air temperature and radiant temperature are both significant in the indoor environment. These two factors and a few other factors affect the thermal comfort of an individual. The indoor thermal environment of an individual is taking into consideration when building (Ozabor & Ajukwu, 2023).

The human day to day activities both indoor and outdoor have effects on the environment. Most times the activities of man contribute majorly to the increase of temperature through the burning of fossil fuel that keeps increasing of greenhouse gases (GHG) (Chime & Oniovokukor, 2024). The continuous increase in the release of carbon dioxide (CO_2) which is the most potent GHG has led to the continuous warming if the atmosphere (Chime & Oniovokukor, 2024). For cities like Asaba, the concentration of residents, buildings (residential, commercial and industrial) and other urban fabrics and the activities has led to what is known as Urban Heat Island (UHI), a condition that makes the temperature different from the surrounding rural areas (Ogbogo et al., 2025).

3.2 Impacts of Climate Change

Climate change is impacting on every aspect of Asaba and Environs. It is impacting on built environment, on architecture, on agriculture, on flood etc. Climate change is a major problem of concern in the world today. Human induced climate change has caused a lot of damages to man and nature and that the rise in extreme weather and climate conditions have caused irreversible impacts as these have pushed human and natural system beyond the ability to adapt (IPCC, 2022). The activities of man are gradually changing the environment. Asaba is not different from the rest of the world. This study found out that several studies carried out on Asaba and environs are in agreement with the fact that climate is changing and it is affecting our environment. Ogbogo et al. (2025) reported the case of urban heat island, using Asaba and Okwe, stating that Asaba is warmer than Okwe a rural community. In addition, the study by Effiong et al. (2024) reported another evidence of climate change impact in Asaba, stating that human activities contributed immensely to the hydrological changes in the lower River Niger region. Isiwele & Akhimen (2017) did a study on the impact of climate change on built environment and the finding was that the physical climate has impact on the built environment. The study by Chime & Oniovokukor, (2024) stated that the size of a window determines the amount of free flow of air. This means that one way to adapt to climate change is to construct a window size that will allow enough air flow thereby increasing thermal comfort. According to Olajuyigbe et al, (2013) climate change concerns should be integrated into urban planning. This statement is in consonant with a recommendation made by Ugbogo et al. (2025) The study recommended that early warning systems, trainings on sustainable climate change adaptive methods should be carried out.

Also, the study discovered that majority of the studies done in Asaba and environs were on the impact climate change on the built environment (Ogbogo et al., 2025; Isiwele & Akhimien, 2017). Asaba is vulnerable to flooding considering its location of bordering the River Niger and the variable patterns of rainfall due to climate change, but very few studies

have been carried out on climate change and flooding. It is an area of concern because it is a recurrent phenomenon in Asaba and environs (Egbuna, & Odumodu, 2024; Ofido, et al., 2024). This is a very serious gap in the study of climate change impact in Asaba and environs.

3.3 Climate Change Vulnerability

Climate change is one problem that has posed to be a global threat (Effiong et al., 2024). Some communities are more vulnerable to climate change than the other due to their location and other factors. Climate change can cause devastating damages to vulnerable communities. Asaba and environs are low lying communities and as such, are faced with climate change disasters such as flooding, and this has led to loss of farmlands, farm produce, and as well as infrastructures causing losses to the owners (Effiong et al., 2024). This condition has become increasingly common in low lying communities (Egbuna & Odumodu, 2024). Flooding in urban areas is driven in part by climate change, particularly rise in sea levels and uncontrolled human activities. Flooding is heightened in coastal communities by increased population growth and lack of proper urban planning (Egbuna & Odumodu, 2024). Human encroachment to the flood prone area can exacerbate the dangers of flooding.

The built environment in Asaba and the human activities has favoured the increase atmospheric temperature compared to surrounding communities (Ogbogo et al., 2025) such as Ugbolu. This condition known as urban heat island. Urban fabrics such as the tarred roads, buildings, etc. has made the area prone to high temperature. Heat and humidity are problems found in cities (Dimuna et al., 2024). Due to the increase in temperature in cities, the use of air conditions, generators, and other means of reducing the impact of heat, has increased the atmospheric temperature the more because of the release of GHG. This is one of the reasons the atmospheric air temperature is continuously on the increase (Chime and Oniovokuko, 2024).

3.4 Climate Change, Mitigation and Adaptation

The different studies reviewed revealed that although, the people have their indigenous interventions, lack of finance, poor sensitization of the people on climate change, therefore, the people do not see it as a priority to practice any climate change intervention and technical knowledge of implementing these options. Ikenga et al. (2023) has suggested that local coping strategies and traditional knowledge should be used in synergy with government and local interventions. Mitigation and adaptation strategies are two basic keys for tackling these climate change problems. They go alongside each other as mitigation takes a long time for it to make visible impact.

Another major problem is that Modern adaptation strategies are limited in developing countries like Nigeria and building strong resilience is somehow very weak (Okon et al., 2021; ND-GAIN, 2021). Some of the modern options of ameliorating climate change impacts which are not easy to implement in developing countries considering their setbacks are, vigorous public enlightenment on mitigation and adaptation options, engaging in organic farming which involves the production of high-quality food without tilling or reduced tilling of the soil and the return of plant and animal residue as manure to the soil (Wang et al., 2023). Adopting renewable and clean energy such as biomass, geothermal, water, wind, solar which are natural resources that can be converted into to clean energy (Wang et al., 2023). For Asaba and environs where flooding is a major issue, early flood warning systems and the construction of good drainage system is very essential (Okon et al., 2021). The cultivation of flood tolerant crops such as water yam should be encouraged, planting of native trees to reduce erosion. It is also important that buildings in flood prone areas should be elevated from the ground to prevent

the houses been flooded. In addition, as mentioned by (Ogbogo et al., 2025; Okon et al., 2021), construction of buildings should be such that are resilient to climate change impact, that have the adaptive capacity during flood period. Dimuna et al. (2024) also supports the assertion that architectural designs should use flood resistant designs and materials. For mitigation, the use of energy efficient stove, reforestation, converting waste to manure etc., should be encouraged.

4. Conclusion

This study reviewed the impact of climate change, mitigation and adaptation in Asaba and environs. It selected materials, comprising journal articles, studies from conference proceedings, government and institutional reports and data sourced from databases were reviewed, adopting the systematic review method, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. From the articles reviewed, this study revealed that climate change is actually impacting on Asaba and environs. Studies have revealed there have continuous increase in the release of GHG into the atmosphere. The use of air conditions, generators, and other means of reducing the impact of heat, has increased the atmospheric temperature the more because of the release of GHG.

Although fewer studies were carried on flooding in Asaba and its environs, the review showed that Asaba and environs are susceptive to flooding because of its low-lying nature, the activities of man, poor planning of the areas. For the problem of flooding to be reduced, studies have suggested proper urban planning and construction and cleaning of drainages.

From the review done, it showed that climate change is impacting on the study area and for this to be abated, novel mitigation and adaptation option must be put in place. Studies recommended: construction and cleaning of drainages, construction of resilient buildings, raising structures high above the ground, planting of crops that can stand excess water (adaptation options), the practice of indigenous adaptive methods such as cover cropping should be encouraged. The use of energy efficient stove, reforestation, converting waste to manure (mitigation options) should also be adopted. It was also recommended that is the indigenous intervention already known by the people should be improved upon. Although it has been stated that developing nations have challenges of implementing mitigation and adaptation options, but vigorous sensitization and the adoption of easier and suitable options for their environment will encourage implementation.

This study recommends that future research should be directed towards the impacts of climate change on flooding in the area. The study should be extended to smaller rural surrounding communities so as to depict differences between climate change impact on flooding in urban areas and climate change impact on flooding in rural communities. This study is also suggesting that the future study should find out the most likely adaptation methods in the various communities. The use of climate data such as rainfall and temperature and questionnaire to get their perception on the impact of climate change and what mitigation and adaptative methods they have employed in their localities or methods much easier for them.

5.0 References

Chime, C.C. & Oniovokukor, R.R. (2024). Investigation on Adaptation to Climate Change Impacts and Occupant Window Control in Federal Secretariat Building Asaba. *Scope* 14(1), 802-816.

Coppola D.P. (2015). Recovery. Introduction to International Disaster Management (Third Edition). Butterworth-Heinemann, 405-460 eBook ISBN: 9780128017036

Dimuna, K.O., Ekhaese, E.N., Ndimako, O.O. (2024). Climate Change Impact on the Architectural and Built Environment Dwellers Well-being in Niger Delta Region. *Frontiers in Climate* 6:1498938. doi:10.3389/fclim.2024.1498938

Effiong C.J. Musa, W.Z., David, H. & Sugden, F. (2024). Exploring Loss and Damages from Climate Change and Global Perspectives that Influence Response Mechanism in Vulnerable Communities. *Sustainable Environment* 10(1), 1-19

Egbuna, O.K. & Odumodu, U.J. (2024). Urban Growth and Flood Vulnerability in Asaba, Delta State. *International Journal of Climate Change and Sustainability*. 1(2), 1-16

Fonjong, L., Matose, F. & Sonnenfeld, A.D. (2024). Climate change in Africa: Impacts, adaptation, and policy responses, *Global Environmental Change,* 89. https://doi.org/101016/j.gloenvcha.2024.102912.

Food and Agriculture Organization of the United Nations (2025). Climate Change, https://www.fao.org/climate-change/en

Haider, H. (2019). Climate Change in Nigeria: Impacts and Responses. The Institute of Development Studies and Partner Organizations. Report. https://hdl.handle.net/20.500.12413/14761

Ikenga, V.U., Ogisi, O.D. & Gbigbi, T.N. (2023). Climate Adaptation Measures of Aquaculture Enterprises in Delta State, Nigeria. *Journal of Agriculture and Food Environment* 10(3): 24-29

Intergovernmental Panel on Climate Change (IPCC) (2014). Synthesis Report. Contribution of Group I II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri RK, Mayer LA (eds.)]. IPCC, Geneva, Switzerland. 151

Intergovernmental Panel on Climate Change (IPCC) (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability, Working Group II Contribution to the Sixth Assessment Report. https://www.researchgate.net/publication/362431678_Climate_Change_2022_Impacts_Adaptation_and_Vulnerability_Working_Group_II_Contribution_to_the_Sixth_Assessment_Report_of_the_Intergovernmental_Panel_on_Climate_Change

Intergovernmental Panel on Climate Change (IPCC) (2023). Climate Change. Synthesis Report, Summary of Policymakers. IPCC_AR6_SYR_SPM%20climate%20change.pdf

Isiwele, A.J. & Akhimien, N.G. (2017). Climate Change and the Built Environment Perspective of Climate Change-A Case Study of Asaba. Conference: Sub-Sahara African's Desire for Sustainable Development.

National Aeronautics and Space Administration (NASA) (2025). Responding to Climate Change. https://science.nasa.gov/climate-change/adaptation-mitigation/

National Oceanic and Atmospheric Administration (2025, June 13). Climate Change Impacts. https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts

ND-GAIN (2021). Ranking of Country index. https://gain.nd.edu/our-work/ country-index/rankings/.

Nwokolo, S.C., Singh, R., Khan S., Kumar, A. & Luthra, S. (2023). Impacts of Climate Change in Africa, CSR, Sustainability, Ethics & Governance, in: Africa's Path to Net-Zero, 0, 237-262, Springer.

Nzeadibe, T.C., Egbule, C.L., Chukwuone, N.A. & Agu, V.C. (2011). Climate change awareness and adaptation in the Niger Delta Region of Nigeria. *African Technology Policy Studies*, 57, 1-32

Odjugo, A.O. (2010). General Overview of Climate Change Impacts in Nigeria. *Journal of Human Ecology* 29(1): 47-55

Ofido, W.I., Ojiaku, J.C. & Eze, C.G. (2024). Mapping Flood Risk Zones in Asaba, Delta State, Nigeria. Using Remote Sensing and GIS Approach. *International Journal of Engineering Research and Development* 20(11), 21-33

Ogbogo, R., Ojoh, C.O. & Boyitie, P.O. (2025). Comparative Studies of Changing Temperatures on Buildings Structures in Asaba and Okwe. Global Journal of Earth and Environmental Science 10(1), 8-18

Okafor, Ajaero, C. C., Madu, C. N., Nzekwe, C. A., Otunomo, F. A., & Nixon, N. N. (2024). Climate Change Mitigation and Adaptation in Nigeria: A Review. *Sustainability* 16, 7048

Okon, E.L. Okon, E.M., Falana, B.M., Solaja, S.O., Yakubu, S.O., Alabi, O.O., Okikiola, B.T., Awe, T.E., Adesina, B.T., Tokula, B.E., Kipchumba, A.K. & Edeme, A.B. (2021). Systematic review of climate change impact research in Nigeria: implication for sustainable development. *Helion* 7(9) https://doi.org/10.1016/j.helion.2021.e07941.

Olajuyigbe, A.E., Balogun, I.A., Akinrinola, O.O. & Ebiyegbagha, A.B (2013). Climate Change and Human Settlement Adaptation Strategies: A Case Study of Asaba, Nigeria. Journal of Sustainable Technology, 4(1).

Onafeso, O.D. (2020). General Circulation Model of Climate Change in the Lower River Niger Region, Nigeria. *African journal of Science and Nature* 10, 39-48

Onyedika, E.J. & Idowu, S.B. (2024). Mapping and Analysis of Urban Drainage System in Asaba Metropolis Delta State Using Remote Sensing and Geographic *Information System. Global Journal of Engineering and Technology Advances* 18(03), 033-047

Osayande, M. (2025). Delta Agency Begins Flood Control Operations in Asaba. The Guardian https://guardian.ng/news/nigeria/metro/delta-agency-begins-flood-control-operations-in-asaba/

Ozabor, F. & Ajukwu, G.A. (2023). Thermal Comfort Perception in Asaba, Delta State, Nigeria. *Nigerian Geographical Journal*. 17(1), 45-57.

Savvidou G. & Canales N. (2023). Three Major Gaps in Climate-Adaptation Finance for Developing Countries. https://www.preventionweb.net/news/three-major-gaps-climate-adaptation-finance-developing-countries

UNDP, (2024). What is Climate Adaptation and Why is it Crucial? https://climatepromise.undp.org/news-and-stories/what-climate-change-adaptation-and-why-it-crucial

United Nations (2025). Climate Action. https://www.un.org/en/climatechange/science/key-findings

Wang, F., Harindintwali, J.D. Wei, K., Shan, Y. Mi, Z., Costello, M.J. Grunwald, S., Feng, Z., Wang, F., Guo, Y. Wu, X., Kumar, P., Kästner, M., Feng,X Kang, S., Liu, Z., Fu, Y., Zhao, W. Ouyang, C., (2023). Climate Strategies for Mitigation and Adaptation Strategies. *The Innovation Geoscience* 1(1) https://doi.org/1059717j.xinn-geo.2023.100015

Weather Spark, (2022). https//weatherspark..com

Wilcox, R.I., Essien, A.U. & Anthony, P. A. (2013). Climate Change and Niger Delta: Some Socio-Economic Implications and Coping Strategies. *International Journal of Social Sciences and Humanities Review*. 4(1): 179-184

World Health Organization (WHO), (2021). Climate Change. https://www.who.int/heli/risks/climate/climatechange/en/.

World Health Organization (2023, October 12). Climate Change. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

World Health Organization (2025). Climate Change. https://www.who.int/health-topics/climate-change#tab=tab_1