



Local Climate Adaptation Strategies in Emerging Nigerian Cities: Addressing Environmental and Climate-Related Disasters

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Climate change, characterized by gradual and abrupt alterations in weather and climate patterns, has emerged as a significant global concern. The world faces rising temperatures, leading to heatwaves, ice melting, wildfires, and flooding. Torrential rains cause flooding, farmland destruction, erosion, and landslides, impacting food security and increasing global food prices. Severe infrastructure damage, dam collapses, power outages, and energy crises are also reported. In extreme regions, volcanic and magmatic activities have resumed due to unprecedented heat.

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Nigerian cities, particularly in Anambra State, face unique challenges from climate change. Government efforts include various laws and policies on climate mitigation. However, local actions are hindered by rising populations, a lack of population control policies, and increasing rural-to-urban migration. Notably, 28,800 trees have been planted in ecologically endangered zones within these cities. This research reveals that despite the efforts of the Government, the negative impact of Climate Change remains a concern as climate related disasters remain a challenge within the city – an evidence that the efforts of Government though has helped but have not completely solved the problem as more work needs to be done.

Keywords: Greenhouse gases; environmental impact; climate change; forecasting; CO₂; Methane; UV radiation.

1. INTRODUCTION

Atmospheric ozone layer has two effects on the temperature balance of the Earth. It absorbs solar ultraviolet radiation, which heats the stratosphere and it also absorbs infrared radiation emitted by the Earth's surface, effectively trapping heat in the troposphere. Therefore, the climate impact of changes in

ozone concentrations varies with the altitude at which these ozone changes occur. Carbon dioxide (CO₂) and methane are mostly referred to as greenhouse gases because of their climate implications. They deplete the ozone layer of the atmosphere, thereby resulting in the heating of the earth's atmosphere. When the Earth emits this heat, the gases absorb it, thereby trapping the heat near the Earth's surface [1-4]. There is

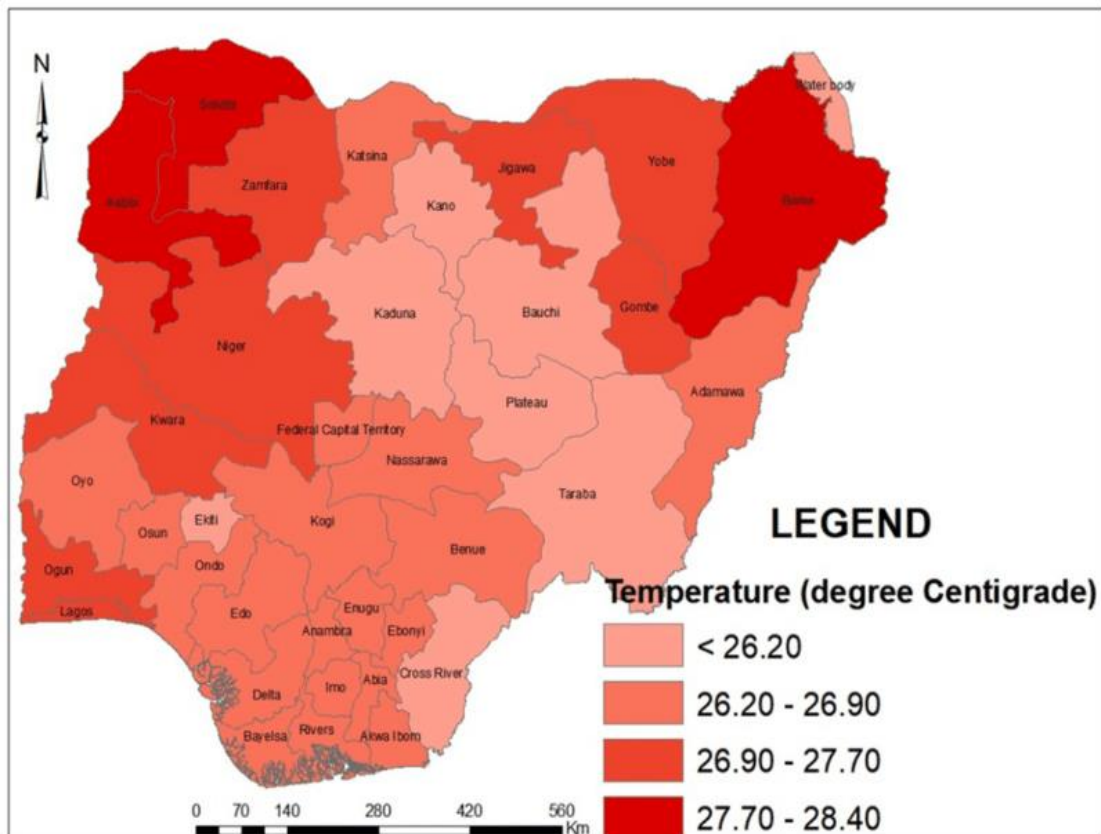


Fig. 1. Mean temperature over Nigeria. (1901–2020)

Source: Derived from CRU dataset via Climate-change Knowledge Portal-World Bank

(1) (PDF) Trends in climate, socioeconomic indices and food security in Nigeria: Current realities and challenges ahead; Available from: https://www.researchgate.net/publication/362411650_Trends_in_climate_socioeconomic_indices_and_food_security_in_Nigeria_Current_realities_and_challenges_ahead [accessed Aug 14 2024]; (Phil-Eze, P.O. 2022)

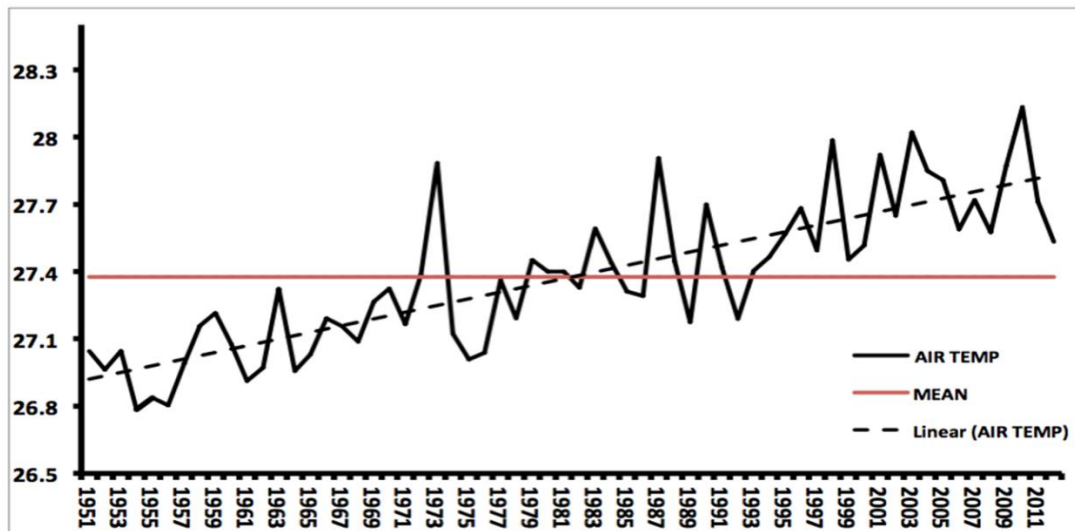


Fig. 2. Map of Nigeria showing a graphical view of temperature distribution from 1951 to 2011
(Phil-Eze, P.O. 2022)

an additional factor that indirectly links ozone depletion to climate change; namely, many of the same gases that are causing ozone depletion are also contributing to climate change. These gases, such as the chlorofluorocarbons (CFCs), are greenhouse gases, absorbing some of the infrared radiation emitted by the Earth's surface, thereby effectively heating the Earth's surface [5-7]. As the planet heats up, it causes changes like the loss of sunlight-reflecting snow cover, amplifying global warming. This is to say that phenomena of climate are a result of gaseous and heat energy reaction giving rise to radiations and global heat events. This Phenomenon of radiation and global heat events is called Climate Change, which has its consequences on the environment [8-12]. Over the years, Government and stakeholders at all levels have made several efforts to address the matter of Climate Change but detailed records have not been taken to assess the extent to which they have helped in addressing the problem. This has led to non-availability of data to track the efforts of Government [13-16]. The paper aims to review local climate adaptation efforts in Nigerian cosmopolitan cities, the effectiveness of Government efforts and explore ways to strengthen these efforts.

2. HISTORIC REVIEW OF THE RISE IN GLOBAL TEMPERATURES

Climate change is of global concern for so many years. Human activities and civilizations across

many years have an impact on the climate, with things getting worse as the years go by. There was little net warming between the 18th century and the mid-19th century. Climate information for that period comes from climate proxies, such as trees and ice cores. Thermometer records began to provide global coverage around 1850. Historical patterns of warming and cooling, like the Medieval Climate Anomaly and the Little Ice Age, did not occur at the same time across different regions [17-20]. Temperatures may have reached as high as those of the late-20th century in a limited set of regions. There have been pre-historical episodes of global warming, such as the Paleocene–Eocene Thermal Maximum. However, the rise in temperature and CO₂ concentrations in recent time has been so rapid that even abrupt geophysical events in Earth's history do not approach current rates [21-25].

Evidence of warming from air temperature measurements are reinforced with a wide range of other observations. There has been an increase in the frequency and intensity of heavy precipitation, melting of snow and land ice, and increased atmospheric humidity [26-30]. Flora and fauna are also behaving in a manner consistent with warming; for instance, plants are flowering earlier in spring. Another key indicator is the cooling of the upper atmosphere, which demonstrates that greenhouse gases are trapping heat near the Earth's surface and preventing it from radiating into space [31-34].

3. REGIONAL ASPECTS TO TEMPERATURE RISES – EASTERN NIGERIA IN PERSPECTIVE

Regions of the world warm at differing rates and the pattern is independent of where greenhouse gases are emitted because the gases persist long enough to diffuse across the planet. Since the pre-industrial period, the average surface temperature over land regions has increased almost twice as fast as the global-average surface temperature. This is because of the larger heat capacity of oceans, and because oceans lose more heat by evaporation. The thermal energy in the global climate system has grown with only brief pauses since at least 1970, and over 90% of this extra energy has been stored in the ocean. The rest has heated the atmosphere, melted ice, and warmed the continents.

4. METHODOLOGY

Being a review paper, the study will gather data through a variety of ways and shall utilize Awka, Nnewi and Onitsha in Anambra State as emerging cosmopolitan cities: The scope of the research follows the;

- a. Review various Climate related disasters and their impacts
- b. Review of the National Policy on Climate Change
- c. Review of relevant National and State laws on Climate Change
- d. Review of Institutional arrangements on Climate Change across the cities as it may affect the cities under review.
- e. Review of Government efforts on Climate Change
- f. Adoption of Questionnaire outcome for Climate Change awareness.
- g. Review the presence or absence of dedicated Climate Change professionals in decision making in several organs of the Government.
- h. Review tree planting efforts in Select State Government establishments aimed at combating climate change.
- i. Report on Tree planting efforts in dedicated State-led climate change adaptation efforts.
- j. Review waste management practices across cosmopolitan cities in Nigeria.

5. RESULTS AND DISCUSSION

5.1 Impacts of Climate Change

The basic question will be what happens when temperatures rise within a system? Temperature rise in any situation will cause immediate, short term and long term consequences and have strong impacts on systems connected to it. Hence a chain reaction is triggered across the systems and all other systems connected to it. Table 1 show how several climate parameters produce both environmental, social and economic consequences within the locality. This shows that climate change is not just an environmental challenge, but also an economic, agricultural, security threat and health risk as well among other far reaching consequences.

5.2 Controlling and Mitigating Climate Change – Global and Local Outlook

Reducing and Recapturing emission is the core objective of climate Change mitigation. All efforts in the reverse of the climate are in these two (2) areas of emission reduction and Recapturing. These have to be as a way of proactive and reactive measures.

- a. Emission Reduction (Proactive Measure)
- b. Emission Recapturing (Reactive Measure)

Emission Reduction (Proactive Measure) – Ways, Targets locally and globally

Climate change can be mitigated by reducing greenhouse gas emissions. This is a point source pollution control mechanism, where efforts are made to control, stop or reduce greenhouse gases from being generated or let out into the atmosphere. In order to limit global warming to less than 1.5 °C with a high likelihood of success, global greenhouse gas emissions needs to be net-zero by 2050, or by 2070, with a 2 °C target. This requires far-reaching, systemic changes on an unprecedented scale in energy, land, cities, transport, buildings, and industry. To reduce pressures on ecosystems and enhance their carbon sequestration capabilities, changes would also be necessary in agriculture and forestry, such as preventing deforestation and restoring natural ecosystems by reforestation.

5.3 Emission Recapturing (Proactive Measure) Through Aggressive Tree Plantin

While other agencies and private organizations are doing their best, available records showed

that a total of Twenty –Eight Thousand Eight Hundred (28,800) trees have been planted by the State strictly focused on ecologically endangered areas. The other tree planting efforts by the State could not be documented due to lack of data.

5.4 Forest Conservation and Climate Change Mitigation – An Emission Recapturing Strategy

- a. Policy options – This involves making laws that requires Nations, organizations and individuals to take emission recapturing initiatives. This may be in the form of gas recycling and gas trapping.
- b. Global Tree planting Targets – Nations and cities may be required under this initiative to set land to vegetation cover targets. Nations may place a target to have at least 40% - 50% of their land covered with

- vegetation. This National target gets broken down into city/County/local tree planting targets. These targets may differ from city to city looking at each city’s pollution index and air quality level. Cities with high pollution index may be required to raise their land to tree percentage. This is popularly called Land-Use-Land Cover (LULC).
- c. Local Tree Planting Targets – In keeping with the above as discussed in global tree planting, local countries and cities will be required to build its own LULC ration and work to implement the same.
- d. Individual Tree planting Targets – Individual land owners and developers may be required to meet certain LULC ratios in and within their properties and in such manner reach the local target and by extension the global target.

Table 1. Table showing global impacts of climate change and its physical, socio and economic outcomes

S/n	Global Impacts of Climate Change	Physical, Environmental and Socio-Economic Outcomes and Consequences
1	Severely rising global temperatures	Heat waves Ice melting Wild Fires Flooding Volcanism and Magmatic Activities
2	Torrential Rainfalls	Flooding Destruction of farm lands Erosion Landslides Negative impact on food security Global rise in food prices Infrastructure damages Dam Collapse leading to Power Outages Energy Crises.
3	Desertification	Deseret Encroachment Waters Scarcity Disruption of Agriculture and negative impact on food security Herders migration Communal and Conflicts between farmers and herders.
4	Adverse and Irregular and unpredictable Weather patterns	Failure of prediction and negative impacts on any reasonable planning Rapid physical Environmental changers Impacts on biodiversity Species extinction Diseases Food Crises Economic Losses Energy Crises



Fig. 3. Flood ravaged community in Ayamelum Local Government Area of Anambra State South Eastern Nigeria
(Phil-Eze P.O. 2023)



Fig. 4. Erosion progressing into the settlement in Ezioko

5.5 Impacts of Climate Change Effects on Increased Eroison Rate

The implication of this will be more surface run-off associated with both increase in land use and associated climate change induced rise in precipitation, the doom day is projected to be

between the next 25 to 50 years as we expect to cross the 50-50 land use land cover balance in the adjoining areas within the next 25 years. This projection does not take into account long distance travelling waters from other catchments contributing to the basin as development generally rises in upland areas.

5.6 Addressing the Causative Factors of Climate Disasters

5.6.1 The accelerating human settlement challenge

Overpopulation has long been an issue for Nigeria as thousands of people migrate from rural areas to major cities in search of pasture green. This rising population in major cities is putting massive pressure on housing.

5.6.2 Addressing the population explosion factor

Total world population reached 7 billion just after 2010 and is expected to be 9 billion by 2045. Projections put Nigeria's population at above 200 million and Anambra State on the way to 10 Million people with the highest number of people living in the three (3) urban centers of Awka, Onitsha and Nnewi. Other emerging urban centers will also include Ekwulobia and Ihiala.

Available records do not show that there is any deliberate effort to control population neither is there any to control rural to urban migration. On the strength of the above, the impact of rising

population and the associated rural to urban migration of the rising population continue to put enormous pressure on the cosmopolitan cities. The relationship between rising population, waste generation, tree planting and energy consumption remain on the upward trend and thus, putting a shrink on climate resilience.

5.7 Way Forward for Emerging Cosmopolitan Cities in Tackling Climate Related Disasters

Use your car less, whenever possible. People should instead, use sustainable transportation, such as bicycles, or use public transportation more often. In the case of long-distance travel, trains are more sustainable than airplanes, which cause a great deal of the CO₂ emitted into the atmosphere. If you're into cars, remember that every kilometer that you increase your speed will considerably increase CO₂ emissions. According to the CE, each liter of fuel that your car uses, equals 2.5 kilos of CO₂ emitted into the atmosphere. Government at all levels should invest more in alternative energy and other things to reduce emissions.

Table 2. Number of trees planted at ecologically endangered areas of the State from within the last five years (NEWMAP 2023)

S/N	Name of Site	Newmap – World Bank	Nigeria Conservation Foundation	Ministry of Agriculture
1	Amachalla	400	00	00
2	Neros Plaza	400	00	00
3	Abagana	1500	00	1500
4	Omagba	1000	00	00
5	Nnewichi	1500	2700	2500
6	Ojoto	1500	00	00
7	Enugwu Ukwu	1500	1800	00
8	Abidi Umuoji	500	00	00
9	Ekwueme Square	00	00	00
10	Ikenga Ogidi	500	00	00
11	Ugamuma Obosi	500	00	00
12	Nkpor Flyover	500	00	00
13	Ire Obosi	500	00	00
14	Other Interventions to Communities reached under the SCCF Intervention on seedling distribution	10,000	00	00
Total		20,300	4,500	4,000

Grand Total = (20,300 + 4,500 + 4,000) = 28, 800 Trees Planted



Fig. 5. Erosion progressing into the settlement in Ubahu Nanka)

6. CONCLUSION AND RECOMMENDATIONS

The study concludes that climate change remains a critical problem in emerging cosmopolitan cities causing severe damages and consequences. The study recommends that without a reasonable population control policy, adequate control of rural and urban migration and adequately addressing climate change resilience in emerging cosmopolitan cities will be impossible, leading to more climate related disasters especially in cosmopolitan cities of South Eastern Nigeria.

To be able to manage the issue of Climate Change, and its threat to existence, the State and local Government authority needs to do the following:

- a. Raise its budgetary funding to the Climate Change management sector.
- b. Create Climate change desks and directorates in all Local Governments areas of the State.
- c. Scale up awareness on the issues of Climate Change through the media and other measures.
- d. Engage funding opportunities for the Climate change sector through leveraging in foreign grants and aids in the sector for ecologically endangered African Nations. Such funding are available with the World

Bank, the African Development Bank and the Special Climate Change fund, amongst others.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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