The Perceived Evidence of Climate Change and its Effects on Groundwater Availability in Auchi, Edo State, Nigeria

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ABSTRACT

This primary aim of this paper is to evaluate the perceived evidence of climate change and its effects on groundwater availability in Auchi, Edo State, Nigeria. So, the paper recognized and stated specific objectives towards the attainment of the primary aim. The specific objectives recognized and stated are: the major causes of climate change, the perceived evidence of climate change in Auchi in relation to historical meteorological shifts, the factors influencing groundwater availability under changing climate patterns, the effects of climate change on groundwater resources availability, and the coping and mitigating strategies in the face of climate-induced stressors in Auchi, Edo State, Nigeria. In order that the overall aim and specific objectives of this paper are actualized, the researchers used both primary and secondary research methods to collect the data required for the paper. At present, that is, 2026, the projected population of the study area (Auchi) is 255,600 people (after, NPC, 2006). Four hundred (400) respondents which represent 0.16% (zero point one six percent) of the population in the study area were considered. Following the above, four hundred (400) questionnaires were administered to the sample population in the study area. The recognizance and actual field surveys revealed that there are 25 communities in the study area, and that the population is not evenly distributed across the study area. Owing to the above observation, the questionnaires were distributed in the various communities to reflect their population sizes. The data obtained were analysed using tables, graphs and, percentages. The results reveal the major causes of climate change, the perceived evidence of climate change in Auchi in relation to historical meteorological shifts, the factors influencing groundwater availability under changing climate patterns, the effects of climate change on groundwater resources availability, and the coping and mitigating strategies in the face of climate-induced stressors on groundwater availability in Auchi, Edo State, Nigeria. Following the findings of this paper, the following actionable policy recommendations are made: regular creation of awareness, orientation and sensitization on the evidence of climate change that can impact groundwater availability in Auchi Edo State, Nigeria; introduction and practicing of current coping and mitigation strategies to alleviate the effects of climate change on groundwater availability; measures should be put in place to help modify climatic conditions in order that the temperature near the earth surface can be moderated to avoid excessive heat, evaporation/evapotranspiration, and reduced relative humidity; sustainable practices to help in treating water against water borne diseases without harming the environment should be emphasized; and governments at all levels (federal, state and local) should as a matter of great concern and urgency work out actionable modalities/interventions to make groundwater available to the locals all year round in Auchi, Edo State, Nigeria. This paper is therefore, concluded by imploring the governments at all levels to implement the list of recommendations made by the researchers.

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INTRODUCTION

The climate crisis in the sub-Saharan region has transitioned from a localized environmental concern into a significant driver of hydrological instability, particularly within the Nigerian context. According to Adewole and Afusat (2017), climate change can be perceived as a change in the climate, which can be seen by changes in the variability of its properties, and that stayed for an extended period of time, simply decades or longer due to both anthropogenic and natural activities. In a similar vein, Okhakhu, (2019), & AMC, (2023), noted that climate change is the realistic increase in the average temperatures of the global environment (atmosphere, lithosphere, hydrosphere, biosphere, cryosphere) and other constituent elements of the Earth as a result of unguided human activities. Climate change is academically conceptualized as the persistent shift in global thermal and atmospheric patterns, predominantly characterized by the intensification of the greenhouse effect and the resulting disruption of the global water cycle (Ukhurebor & Azi, 2019). In Auchi, Edo State, the perceived evidence of these changes is manifest in the increasing frequency of extreme meteorological events, including prolonged heat-waves and high-intensity precipitation. The specific location of Auchi-situated on the undulating northern plateau of Edo State, renders it uniquely susceptible to these shifts. The terrain, defined by steep slopes and a rugged, hilly topography, dictates the movement of surface water and the eventual replenishment of groundwater. Groundwater refers to the freshwater stored in the saturated subsurface zones known as aquifers (Abulude *et al.*, 2023).

The interaction between climate-induced rainfall variability and the steep slope topography of Auchi creates a critical challenge for water security. While climate change often brings more frequent heavy downpours, the steep terrain of the Auchi area promotes rapid surface runoff, significantly reducing the residence time required for water to undergo infiltration (the process of water penetrating the soil surface to recharge the underlying aquifers). This often leads to a "recharge-runoff paradox" where, despite high total annual rainfall, the net groundwater recharge is diminished. Furthermore, the hydro-geological framework of Auchi consists of porous sedimentary formations that often lack significant aquifer protective capacity. This lack of a thick, impermeable overburden means that during the intense flooding events associated with current climatic trends, surface pollutants are easily transported into the groundwater, altering the hydro-geochemistry and compromising the safety of borehole water (Igelle *et al.*, 2024).

Ultimately, the vulnerability of the groundwater system in Auchi is exacerbated by the synergy of thermal stress and topographical constraints. Rising temperatures enhance potential evapotranspiration, which further depletes soil moisture and limits the volume of water available to maintain the static water level of local wells. As the West African Monsoon continues to display erratic behavior, traditional groundwater extraction methods are being stressed by the lowering of the water table and the threat of qualitative degradation. Addressing these impacts requires a sophisticated understanding of how the localized physical environment of Auchi interacts with broader global climatic stressors to ensure the continued availability of this vital resource (Ukhurebor *et al.*, 2020).

The perceived evidence of climate change and its multi-faceted effects on groundwater in Auchi, Edo State, Nigeria, represent a critical nexus between environmental science and socio-economic stability. In scholarly discourse, climate change is defined as the long-term, statistically significant shift in global or regional climatic patterns-primarily characterized by rising thermal indices and altered hydro-meteorological cycles, largely driven by anthropogenic greenhouse gas emissions and land-cover transformations (Ukhurebor & Azi, 2019). Within the specific geographical context of Auchi, a region defined by its rugged, undulating terrain and sedimentary lithology, this phenomenon manifests through "perceived evidence" such as increasing mean annual temperatures and the heightened frequency of extreme weather events. Longitudinal observations in the Auchi area have identified a consistent upward trend in temperature anomalies, with several years in the last decade exceeding historical benchmarks by as much as $0.40^\\circ C$ (Ukhurebor& Azi, 2019). This shift directly impacts groundwater, which refers to the water held within the saturated zone of the subsurface, occupying the voids, pores, and fractures of geological formations (Abulude *et al.*, 2023).

The interaction between these climatic shifts and the local aquifer (a water-bearing geological unit of sufficient porosity and permeability to yield usable quantities of water), is complex and increasingly precarious. As

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temperatures rise, the rate of potential evapotranspiration accelerates, which can lead to a net reduction in the volume of water available for vertical percolation and subsequent recharge of the subsurface reservoirs. Furthermore, the changing precipitation profile in Edo State is characterized by shorter, more intense bursts of rainfall; while the total volume may remain high, the intensity often exceeds the soil's infiltration capacity, resulting in massive surface runoff and erosion rather than effective aquifer replenishment. This dynamic is exacerbated by the unique hydrogeological framework of the area, where the hydro-geochemistry (the study of the chemical signatures and mineral-water interactions within the water), reveals increasing susceptibility to external stressors. Recent studies indicate that when heavy precipitation events occur, they often facilitate the rapid transport of contaminants from the surface into shallow, unconfined aquifers, compromising the aquifer protective capacity and introducing hazardous elements such as heavy metals or organic pollutants into the local water supply (Igelle *et al.*, 2024).

Ultimately, the vulnerability of Auchi's groundwater resources-defined as the degree to which these systems are susceptible to, or unable to cope with, the adverse effects of climatic, and anthropogenic pressures, is at an all-time high (Igelle *et al.*, 2024). The reliance of the local population on untreated borehole water makes the intersection of climate-induced flooding and poor waste management practices a significant public health concern. As the West African Monsoon continues to exhibit erratic behavior, the traditional understanding of groundwater as a "buffered" or "infinite" resource is being challenged. This background necessitates a rigorous investigation into how the local population perceives these environmental shifts and the quantitative impact such changes have on the sustainability of the hydro-geological systems in Northern Edo State.

STATEMENT OF THE PROBLEM

Groundwater is the major source of domestic, agricultural, industrial and aesthetic water supply in many parts of Nigeria, including Auchi, Edo State, Nigeria. In recent years changes in climatic conditions such as irregular rainfall patterns, prolonged dry seasons, increasing temperatures, and drought episodes have raised concerns about the sustainability and availability of ground water resources. Studies have shown that climate change affects groundwater recharge, storage and overall water availability through changes in precipitation, and evapotranspiration patterns (Ukhurebor & Azi, 2019; Ukhurebor *et al.*, 2020; Abulude *et al.*, 2023).

In Auchi and its environs, residents largely depend on boreholes, hand dug wells, and springs for water supply due to insufficient public water infrastructure. However, many households have reported declining water levels in wells, seasonal dry up of boreholes, and increased difficulty in accessing potable water, especially during prolonged dry period. These observations suggest a possible relationship between climate variability and groundwater availability in the area. Despite these growing concerns, there is limited empirical research focusing specifically on the perceived impact of climate change on groundwater availability in Auchi, Edo State, Nigeria.

Most of the existing studies across Nigeria have focused on broader regional analyses or groundwater quality issues rather than the perceptions of communities and localized groundwater availability. In addition, inept knowledge on how the locals perceive climate change and tts associated effects on groundwater availability may hinder the development of effective water resource management, coping, adaptation, and intervention strategies (Edet, *et al.*, 2011; Aizebokhai, *et al.*, 2017 Aladejana, *et al.*, 2020).

Without sufficient data on community experiences, and perceptions, government, organizations, agencies, and policy makers would probably find it difficult to implement sustainable groundwater management practices capable of addressing future climate change-related water challenges (Aizebokhai, 2011; Aribisala, *et al.*, 2015; Shiru, *et al.*,, 2021).

Following the above, this current study aims to evaluate the perceived evidence of climate change and its effects on groundwater availability in Auchi, Edo State, Nigeria. Specifically, it focuses on understanding the experiences and perceptions of the locals, the major causes of climate change, the perceived evidence of climate change in relation to historical meteorological shifts; the factors influencing groundwater availability under changing climate patterns, the effects of climate change on groundwater resources, the coping and

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mitigating strategies in the face of climate change-induced stressors and providing apt actionable recommendations for sustainable groundwater management coping and mitigation strategies.

AIM AND OBJECTIVES OF THE STUDY

The primary aim of this research is to evaluate the interface between climatic variability and groundwater availability in Auchi, Edo State, Nigeria. The specific objectives are to:

i. examine the major causes of climate change in Auchi, Edo State, Nigeria;
ii. examine the perceived evidence of climate change in Auchi in relation to historical meteorological shifts;
iii. examine the factors influencing groundwater availability under changing climate patterns in Auchi;
iv. evaluate the effects of climate change on groundwater resources in Auchi; and
v. examine the coping and mitigating strategies in the face of climate-induced stressors.

THE STUDY AREA

The study area is Auchi and it comprises of all the 25 communities of Auchi. According to Ogboi, & Odeh, (2012), and Ajayi, Ibrahim, Brai, & Seghosime (2019), the Communities are: Usogun, Akpekpe, Igbei, Ikelebe, Oshiomole, Ughidane, Egelesor, Osomeke, Oki, Idaniyeluwa, Oluedide, Omemi, Idanilesi, Isami, Aleogbomi, Osuali, Oguokhai, Akharuma, Ozomode, Okilokhai, Igieboi, Aimanesi and Utsokwili, Imeke, and Iyakpi. Auchi is a very important settlement in Edo State, Nigeria. It is the administrative headquarters of Etsako-West LGA, Afemai Ethnic group and Edo North Sentorial District. The town of Auchi is located within Latitudes $6^{o}48'$N and $7^{o}12'$ of the Equator and Longitudes $6^{o}11'$E and $6^{o}24'$E of the Greenwich Meridian. It is borderded by; Uzauire (Imeke and Jattu); Ibie-Nafe:; Sabo-Iyakpi; Aviele; Ivbiaro; Warrake and Ikpeshi (Orji & Ologunorisa, 2016; Ajayi, Ibrahim, Brai, & Seghosime, 2019).The study area serves as a strategic gateway between Southern and Northern Nigeria. Its topography is characterized by the rugged Kukuruku Hills, which contribute to high velocity runoff during rainfall events. Historically, the region was dominated by lush rainforests; however, it has transitioned into a derived savanna characterized by sparse tree cover and dominant grass species, a primary indicator of land degradation and encroaching aridity (Orji & Ologunorisa, 2016; Ajayi, Ibrahim, Brai, & Seghosime, 2019). See Figs 1and 2 for further elucidation on the study area.

THEORETICAL, AND CONCEPTUAL FRAMEWORKS, AND LITERATURE REVIEW

This section presents the theoretical and conceptual frameworks and a review of related and relevant literature.

Theoretical Framework

Hydrological Sensitivity Theory

The Hydrological Sensitivity Theory serves as the primary mechanism for understanding the non-linear relationship between climatic forcing and aquifer response. This theory suggests that the terrestrial water balance is highly sensitive to even marginal shifts in meteorological parameters.

Thermal Forcing and Evapotranspiration: In the context of Auchi, Ukhurebor and Azi (2019) identified a significant thermal variability, specifically a 0.40^{o}C mean temperature anomaly. This increase in thermal energy directly accelerates Potential Evapotranspiration (PET). According to Ukhurebor *et al*., (2020), such thermal fluctuations in tropical environments like Edo State create a "recharge deficit," where a greater proportion of incident rainfall is returned to the atmosphere before it can percolate into the soil.

Precipitation Elasticity**:** Supporting this, Aremu and Sule (2022) argued that in Nigerian sedimentary basins, groundwater levels exhibit "high elasticity" to rainfall intensity. This means that as climate change causes rainfall to become more erratic, a phenomenon observed locally, the aquifers do not respond linearly; instead,

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they show rapid depletion during dry spells that is not immediately compensated for by heavy, short-duration storms.

The Infiltration-Runoff Nexus: Irumhe *et al.,* (2022) further expanded this by noting that the sensitivity is heightened by Auchi's undulating terrain. The theory predicts that on steep slopes, the "time of concentration" for surface water is reduced, meaning that the geological sensitivity to climate change is compounded by topographical constraints.

Vulnerability Assessment Framework (VAF)

The Vulnerability Assessment Framework (VAF) provides a structured approach to quantifying the risk posed to Auchi's groundwater. Within this framework, vulnerability is defined as a function of three distinct components: Exposure, Sensitivity, and Adaptive Capacity.

Exposure (The Climate Hazard)**:** This refers to the frequency and intensity of climatic stressors. In Auchi, exposure is manifested through increased flooding and prolonged heat. Igelle *et al.,* (2024), apply this to show that the "exposure" of Northern Edo to erratic West African Monsoons creates a high-pressure environment for subsurface resources.

Sensitivity (The Hydro-geological Factor)**:** This component evaluates the internal characteristics of the system that make it susceptible to the hazard. Isikhueme and Omorogieva (2015), noted that the sedimentary formations in Southern and Central Nigeria (including the Anambra Basin which influences Auchi) have high porosity but often lack thick, impermeable overburden. This "intrinsic sensitivity" means that when climate-induced flooding occurs, contaminants are easily transported into the saturated zone.

Adaptive Capacity (The Socio-Technical Factor)**:** This relates to the ability of the community and infrastructure to adjust to climate shifts. Efe (2021), in a study on water security in the Niger Delta and surrounding Edo regions, points out that the adaptive capacity in towns like Auchi is often "low to moderate" due to the reliance on shallow, privately-owned boreholes that lack sophisticated filtration or climate-resilient engineering.

Conceptual Issues

The conceptual framework for understanding climate change impacts in Northern Edo State is defined by the following nuanced dimensions, supported by local empirical evidence and hydro-geological theory.

The Recharge-Runoff Paradox

This concept challenges the simplistic assumption that increased precipitation automatically correlates with increased water availability. In the unique geographical context of Auchi, climate change manifests as a shift toward high-intensity, short-duration storm events.

The Relief Factor: Because Auchi is characterized by a high-relief, undulating terrain, the gravitational force acting on surface water during these intense storms significantly outweighs the soil's hydraulic conductivity.

Loss of Residence Time**:** As Irumhe *et al.,* (2022), conceptualized, the "residence time"-the duration water remains in contact with the land surface is drastically reduced. Instead of providing a steady supply for infiltration, the water is converted into high-velocity surface runoff. This results in the paradox of a "dry aquifer" occurring within a "wet season," as the subsurface reservoirs are bypassed by the very water intended to replenish them.

Erosion and Siltation: Olorunfemi and Jimoh (2021), observed that this runoff in Northern Edo (including Auchi) often leads to severe gully erosion and the siltation of natural infiltration basins, further sealing off the pathways to the aquifer.

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Aquifer Protective Capacity (APC)

Conceptually, the safety and resilience of groundwater are dictated by the Aquifer Protective Capacity, which refers to the ability of the overlying geological strata to attenuate or filter pollutants before they reach the water table.

Lithological Sensitivity**:** In the Auchi hydro-geological model, the subsurface is dominated by porous sedimentary formations that often lack a thick, impermeable clay capping (a confining layer). As a result, the aquifer is classified as unconfined or semi-confined.

The Pathway of Vulnerability**:** Igelle *et al.*, (2024), conceptualize this lack of protective overburden as a "direct pathway" for climate-induced hazards. During the intense flooding events perceived by the locals, the Aquifer Protective Capacity (APC) is insufficient to prevent the rapid vertical migration of pathogens and chemical leachates. This makes the groundwater system highly vulnerable not only to quantitative depletion but to qualitative degradation, as the "natural filter" of the earth is too thin to manage the increased pollutant load associated with climate-driven urban flooding.

Empirical Review

Empirical studies in Auchi and the wider Edo State provide verifiable evidence of these theoretical and conceptual claims:

Meteorological Trends: Ukhurebor and Azi (2019), conducted a longitudinal study on temperature variability in Auchi, and they noted that 60% of the years studied were significantly warmer than normal. This empirical data confirms the local "perception" of a warming climate. Similarly, Ukhurebor *et al.*, (2020), empirically demonstrated that weather variables (specifically temperature and pressure) have a direct, measurable influence on the fluctuations of the groundwater level in tropical environments.

Groundwater Quality and Contamination**:** Abulude *et al.*, (2023), empirically assessed groundwater across three Nigerian states, including Edo State. They noted that physicochemical characteristics are increasingly reflecting surface stress. Their data showed that shallow wells are particularly prone to "climate-induced leachate migration," where heavy rains wash surface pollutants into the water table.

Hydro-geological Vulnerability**:** Research by Irumhe *et al.*, (2022), specifically focused on the Auchi Polytechnic campuses, providing empirical evidence that the local aquifer potential is highly sensitive to the topographical relief. Their findings suggest that the hilly nature of Auchi makes the groundwater recharge zones highly localized and easily disrupted by land-use changes and climate-driven erosion.

Regional Comparisons**:** Empirically, Igelle *et al.*, (2024), and Isikhueme and Omorogieva (2015), revealed that in the Niger Delta and Eastern Nigeria, the qualitative degradation of groundwater (e.g., the presence of heavy metals or nitrates) is accelerating due to the increased frequency of flooding events, which are direct consequences of the current climatic regime.

Perception versus Empirical Reality

The conceptualization of "perceived evidence" is a critical socio-scientific bridge in climate research. In Auchi, the human experience of environmental change often acts as a precursor to formal instrumentation.

Anecdotal Indicators**:** The locals frequently cite "hotter nights" and the premature "drying of shallow wells" as primary evidence. Abulude *et al.*, (2023), argued that these perceptions are not merely subjective but are early warning indicators of a shifting baseline.

The Signal-to-Noise Challenge**:** A significant conceptual hurdle is distinguishing between "weather noise" (natural seasonal variability like a particularly harsh Harmattan) and "climate signal" (long-term permanent shifts). Ukhurebor and Azi (2019), noted that while residents perceive the climate as "changing," scholarly rigor is required to map these perceptions against decadal meteorological data to ensure that coping and

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adaptation strategies address permanent trends rather than temporary fluctuations.

MATERIALS AND METHODS

The data required for this paper were collected from primary and secondary sources of data. The primary source formed the major source of data needed for this paper. The primary data were collected by the use of structured questionnaire administration and personal observation in the field. At present (2026), the population of the study area (Auchi) at 2.8% projection is 255,600 people (after, NPC, 2006). Out of this projected population figure, 400 respondents which represent 0.16% (zero point one six percent) of the population in the study area were considered. Following the above, four hundred questionnaires were administered in the study area. The preliminary and actual field surveys revealed that there are 25 communities in the study. The recognizance and actual field surveys also affirm that the population is not evenly distributed across the 25 communities in the study area. Following the above observation, the questionnaires were distributed in the various communities in this order: Usogun (20), Akpekpe (18), Igbe (18) , Ikelebe (28), Oshiomole (20), Ughidane (14), Egelesor (14), Osomeke (14), Oki (16), Idaniyeluwa (14), Oluedide (12), Omemi (14), Idanilesi (14), Isami (16), Aleogbomi (14), Osuali (16), Oguokhai (18), Akharuma (18), Ozomode (14), Okilokhai (12), Igieboi (14), Aimanesi (16), Utsokwili (14), Imeke (18), and Iyakpi (22). All the four hundred questionnaires were retrieved with passion and perseverance and used for the study. Random sampling techniques were used to select the respondents for interview. Questions were asked on the major causes of climate change, the perceived evidence of climate change in Auchi in relation to historical meteorological shifts, the factors influencing groundwater availability under changing climate patterns in Auchi, evaluate the effects of climate change on groundwater resources in Auchi, and the coping and mitigating strategies in the face of climate-induced stressors.

The secondary data used in this paper include textbooks, internet, articles in journal publications, newspapers, magazine, gazetteers, conference papers, and inaugural lecture pamphlets. The data collected were carefully collated and analysed using apt tables, frequencies and percentages.

RESULTS AND DISCUSSIONS

The recognizance and actual field surveys carried out on the impact of climate change on groundwater availability in Auchi, Edo State, Nigeria, shows that climate change has a marked impact on groundwater availability in the study area. It further reveals that the impacts are multifaceted; critical on water in terms of quantity and quality, infrastructure, settlement, agricultural productivity, and the overall socio-economic development of the locals and the general environment in Auchi, Edo State, Nigeria.

The Major Causes of Climate change in Auchi, Edo State, Nigeria

Table 1 reveals the major causes of climate change in Auchi, Edo State, Nigeria. It reveals that burning of fossil fuels with 188 (47.00%) respondents ranked highest among the major causes of climate change in Auchi and it is followed by industrial activities which recorded 68 (17.00%) respondents of the sample population in the study area. Deforestation recorded 50 (12.50%) respondents, use of fluorinated gases was next in the ranking and it recorded 32 (8.00%) respondents of the sample population in the study area. The others are agricultural activities with 22 (5.50%) respondents, bush burning which recorded 21 (5.25%) respondents, emissions from dump sites recorded 9 (2.50%) respondents, heat from concrete floors had 6 (1.50.2%) respondents, and finally, the least in the ranking which is heat from roof tops recorded 4 (1.00%) respondents of the sample population in the study area, Auchi, Edo State, Nigeria.

Table 7.1: The Major Causes of Climate Change in Auchi, Edo State, Nigeria

The Causes of climate Change in Auchi	Frequency	Percentage (%)
Burning of fossil fuels	188	47.00
Deforestation	50	12.50
Industrial activities	68	17.00

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Use of fluorinated gases	32	8.00
Agricultural activities	22	5.50
Bush burning	21	5.25
Emissions from dump sites	9	2.25
Heat from concrete floors	6	1.50
Heat from roof tops	4	1.00
Total	400	100

Source: Field survey, 2026

The Perceived Evidence of Climate Change in Auchi in Relation to Historical Meteorological Shifts

Table 2 shows the perceived evidence of climate change in Auchi, Edo State, Nigeria in relation to historical meteorological shifts. From Table 2, it is crystal clear that early cessation of rainy season with 86 (21.50%) respondents of the sample population ranked highest. The Table further reveals that delayed dry season with 78 (19.50%) respondents was next on the ranking, erratic rainfall recorded 70 (17.50%) respondents, and excessive temperature recorded 64 (16.00%) respondents of the sample population in the study area. Others are destructive thunderstorms with 32 (08.00%), strong and desiccating winds, which recorded 28 (7.00%) respondents, disappearance of August Break recorded 24 (6.00 %) respondents, cloudless skies recorded 14 (3.50%) respondents and finally, brighter lightning and deafening thunderstorm recorded 04 (01.00%) respondents of the sample population in the study area, Auchi, Edo State, Nigeria.

Table 2: The Perceived Evidences of Climate Change in Auchi, Edo State, Nigeria in Relation to Historical Meteorological Shifts

The major The Perceived Evidences of Climate Change in Auchi, Edo State, in Relation to Historical Meteorological Shifts	Frequency	Percentage (%)
Erratic rainfall	70	17.50
Excessive temperature	64	16.00
Early cessation of rainy season	86	21.50.
Delayed dry season	78	19.50
Strong and desiccating winds	28	07.00.
Destructive thunderstorms	32	08.00
Disappearance of August Break	24	6.00
Cloudless skies	14	3.50
Brighter lightning and deafening thunder	04	01
Total	400	100.00

Source: Field survey, 2026

The Factors Affecting Groundwater Availability under Changing Climate Patterns in Auchi, Edo State, Nigeria

Table 3 shows the perceptions of the locals in Auchi on the factors affecting the efficiency of groundwater availability under changing climate patterns. The table further shows that 62 (15.50%) respondents are of the perception that reduced rainfall ranked foremost among the factors influencing groundwater availability under changing climate patterns in Auchi. Increased temperature ranked second, because 51 respondents which represent 12.75% of the sample population in the study area are of the perception that increased temperature is one of the factors affecting groundwater availability under changing climate patterns in Auchi. The table further reveals that reduced relative humidity and increased evaporation/evapotranspiration recorded 40 (10.00%) respondents each, deforestation and urbanization recorded 38 (9.5%) respondents each, industrialization recorded 36 (9.00%) respondents, agriculture recorded 33 (8.50%) respondents, while the least perceived among the factors affecting groundwater availability under changing climate patterns in Auchi are population growth and topography and they recorded 32 (8.00%) respondents each of the sample population in the study area, Auchi, Edo State, Nigeria.

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Table 3: The Factors Influencing Groundwater Availability under Changing Climate Patterns in Auchi

Factors Influencing Groundwater Availability under Changing Climate Pattern in Auchi	Frequency	Percentage (%)
Reduced rainfall	62	15.50
Increased temperature	51	12.75
Reduced relative humidity	40	10.00
Increased evaporation/evapotranspiration	40	10.00
Deforestation	38	9.50
Population growth	32	8.00
Agriculture	33	8.25
Industrialization	36	9.00
Topography	32	8.00
Urbanization	38	9.50
Total	400	100.00

Source: Field survey, 2026

The Effects of Climate Change on Groundwater Availability in Auchi

Table 4 reveals the opinions of the respondents as regards the effects of climate change on ground water availability in Auchi. The table further reveals that shortage of water with 114 (28.50%) respondents ranked highest of the sample population, and so the most worrisome of the effects in the study area. Shortage of food ranked second as it recorded 71 (17.75%) respondents of the sample population in the study area. Other effects of climate change on ground water availability in Auchi are increased cost of water with 45 (11.25%) respondents, decline in agricultural yields recorded 44 (11.00%) respondents, use of water from random sources recorded 36 (9.00%) respondents, emergence and spread of water borne diseases recorded 26 (6.50%) respondents, discrimination against residences recoded 22 (5.50%), death of some plants and animals recorded 18 (4.50%) respondents, unkempt environment recorded 14 (3.50%), and migration which is the least of all the factors recorded 10 (2,50%) respondents of the sample population in the study area. .

Table 4: The Effects of Climate Change on Groundwater Resources in Auchi

The Effects of Climate Change on Groundwater Resources in Auchi	Frequency	Percentage
Shortage of water	114	28.50
Shortage of food	71	17.75
Decline in agricultural yields	44	11.00
Increased cost of water	45	11.25
Death of some plants and animals	18	4.50
Unkempt environment	14	3.50
Migration	10	2.50
Discrimination against residence	22	5.50
Use of water from random sources	36	9.00
Emergence and spread of water borne diseases	26	6.50
Total	400	100

Source: Field survey, 2026

The Coping and Mitigating Strategies in the Face of the Effects of Climate Change on Groundwater Availability in Auchi, Edo State, Nigeria

In Auchi (the study area), the coping and mitigating strategies adopted in the face of the effects of climate change on groundwater availability in Auchi are multifarious and multifaceted. Specifically, the coping strategies adopted are rain water harvesting, artificial recharge, modern drilling techniques and technologies,

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green building initiatives and water conservation/storage practices. The mitigation strategies adopted by the locals are regulated sinking of bore holes, controlled deforestation, prohibition of laws against uncontrolled bush burning, regulated land use, and planting of special trees (gmelina, teak, ducanut, neem, moringa, and amongst others).

RECOMMENDATIONS

This paper examined the impact of climate change on groundwater availability in Auchi, Edo State, Nigeria. Water is very essential to all living organisms. So, constant and adequate availability of water is indispensable to all living things. The threat arising from the impact of climate change on groundwater availability in Auchi is leaving the inhabitants with a growing concern daily. This is because, from historical perspective, Auchi depends completely on groundwater for all its water needs. Today, the case is different. Auchi has recorded water challenges in terms of quantity and quality. The locals through this research and possibly others have expressed that they have perceived that the natural environmental factor behind this challenge is climate change. Based on the findings of this paper, the following actionable policy recommendations are made: regular creation of awareness, orientation and sensitization on the evidence of climate change that can impact groundwater availability in Auchi Edo State, Nigeria; introduction and practicing of current coping and mitigation strategies to alleviate the effects of climate change on groundwater availability; measures should be put in place to help modify climatic conditions in order that the temperature near the earth surface can be moderated to avoid excessive heat, evaporation/evapotranspiration, and reduced relative humidity; sustainable practices to help in treating water against water borne diseases without harming the environment should be emphasized; and governments at all levels (federal, state and local) should as a matter of great concern and urgency work out actionable modalities to make groundwater available to the locals all year round in Auchi, Edo State, Nigeria.

CONCLUSION

The effects of climate change on groundwater availability in Auchi are evident in changing climate patterns: early cessation of rainy season, delayed dry season, erratic rainfall, excessive temperature, destructive thunderstorms, strong and desiccating winds, disappearance of August Break, cloudless skies, and brighter lightning and deafening thunderstorm. All these reduce surface water flows, and increase the pressure on the already strained groundwater availability and consequently, the overall supply systems. These changes have significant implications for agriculture, food supply, public health, and the general socio-economic well-being in the study area. Adaptation strategies which include rainwater harvesting, artificial recharge techniques, adoption of modern techniques and technologies for digging/sinking boreholes/wells, green building initiatives, water conservation/storage practices, and improved water resource management are essential to mitigate the adverse impacts of climate change on groundwater availability in Auchi, and similar climes in southern Nigeria. Further research and policy interventions from governments, corporate bodies, organizations and public spirited individuals are necessary to ensure the sustained availability of groundwater and overall water systems in the face of climate change-induced stressors.

LIMITATIONS

This paper is questionnaire-based. Questionnaire-based perception data may be subjective. For instance, 2026 population is a projection, not actual population figures from real population census. In addition, no groundwater sample or remote sensing data were collected and analyzed independently to validate the authenticity of the perceived effects of climate change on groundwater availability in Auchi, Edo State, Nigeria. Finally, no inferential statistical technique was adopted in the course of analyzing the data.

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