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SEASONAL WEATHER PATTERNS AND LIVELIHOOD SUSCEPTIBILITY IN ABUJA FCT, NIGERIA: CLIMATE INDICES TO SOCIO-ECONOMIC ACTIVITIES

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ABSTRACT
Seasonal weather patterns bring predictable changes in temperature, rainfall, and relative humidity that is experience throughout the year. These bring about change in climate and human comfort over time. There have been issues with seasonal weather worldwide, and in Nigeria, particularly in Abuja, where socio-economic activities are highly susceptible to it. This article examines the susceptibility of seasonal weather patterns to socio-economic livelihood activities in Abuja, the Federal Capital Territory (FCT) of Nigeria. A mixed-methods approach was applied, using NIMET long-term climate indices for Abuja (1990-2025) and household survey data from six municipal councils, with 384 participants. Findings were presented in graphical and descriptive-statistical formats, including mean annual temperature, the erratic onset and cessation of the rainy season, and moderate variations in thermal discomfort due to relative humidity. The study revealed profound effects on socio-economic livelihood activities, including agriculture, small enterprises, transport, employment issues, and vulnerable physical assets damaged by flooding. It therefore advocates climate-resilient infrastructure, livelihood diversification initiative and enhances the climate forecast information services that will fight against threats posed by climate variability in Abuja (FCT) of Nigeria

Keywords:
Livelihood, climate variables, seasonal-weather, socio-economics, susceptibility

INTRODUCTION

Seasonal weather change represents a pressing global issue, significantly altering the environment and reshaping ecosystems (Arora, 2019), and it is marked by rapid warming, with global temperatures expected to rise between 1.5^0 C and 4^0 C by 2100 (IPCC, 2024). Regions across the globe are experiencing more frequent heatwaves, prolonged warm seasons, and diminished cold seasons. The most vulnerable areas are Africa and Asia, bearing disproportionate impacts, compounded by limited resilience capacities (ND-GAIN, 2021). Nigeria ranks among the 10 most exposed countries to climate change, with nearly 6% of its land susceptible to extreme weather conditions (World Bank, 2019). Climate change is defined by long-term patterns in temperature, precipitation, and other environmental factors such as atmospheric pressure and humidity. Notable global and local effects of climate change include erratic weather patterns, rising temperatures resulting in the shrinking of ice sheets, and rising sea levels (Abbass, et al., 2022Alehile et al., 2022; Bulus & Maduene, 2022).

Rising urban temperatures generally result in adverse economic and environmental impacts locally, regionally and globally. Persistent rising temperatures increase demand for air conditioning, raise pollution levels, alter urban thermal environments, and eventually lead to thermal discomfort and other heat-related illnesses. (El-Bilali et al., 2020, Lawal, Adebosin & Ogunyomi-Oluyomi, 2022). With the recent rapid increase in population and buildings in urban areas, anthropogenic heat waste released from vehicles, air conditioners, power plants and industries which combine to heat the urban environment daily, temperatures in urban areas have increased steadily (Obada et al., 2024), creating situations which impact negatively on various aspects of human life, thus reducing the quality of life. Rising temperatures usually increase the demand for energy used for cooling, thus, more pressure will be added to the electricity grid because most buildings and houses run cooling systems, which help in reducing the air temperature indoors, particularly during extreme heat events (Ojha & Schofield, 2021).

Abuja, the Federal Capital Territory (FCT) in the North-Central region of Nigeria, experiences wet and dry seasons (April-September and December - March) due to tropical continental maritime air masses and large

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interannual variability in rainfall and temperature (Arogunade et al., 2024). There is a significant seasonal change altering weather patterns, the length and timing of rainy seasons, and extreme weather events in Abuja and its environs (Ani et al., 2021). With activities ongoing in FCT across economic diversification, construction, real estate, transportation, business, and agriculture, these sectors have contributed to the recent increase in climate risk, including temperature and rainfall variability. The significant seasonal weather-related challenges, including increased temperatures, flooding, and droughts, compromise the resilience of its real estate sector. Unplanned urbanisation and inadequate infrastructure development in the FCT amplify these vulnerabilities, posing substantial threats to property values, infrastructure integrity, and human well-being (Adeleke, 2016; Adewale, 2017; IPCC, 2021; UN-Habitat, 2016). The recent flooding incidents in Trademore and Efa estates (Omoera & Guanah, 2022; Ariemu, 2023) underscore the urgent need to adapt climate-resilient strategies to prevent recurrence in the environment.

The socio-economic dimensions of climate change encompass the intricate interplay between societal structures, economic systems, and the impacts of climate change. These dimensions highlight how climate change exacerbates existing inequalities, disproportionately affecting vulnerable populations, particularly in developing countries with limited adaptive capacity (Ismail et al., 2019). Economic consequences include disruptions to agriculture, energy production, and infrastructure, reducing productivity and heightening poverty (Magaji & Musa, 2024). Socially, climate change intensifies health risks, displacement, and resource conflicts, requiring integrated policy responses that address environmental and socio-economic challenges. Area with weak healthcare system is ill-equipped to handle the increased burden of seasonal weather-related diseases. Inconsistent rainfall and water management issues affect water availability for domestic and industrial use (Ayanlade et al., 2022). The oil sector, a major source of revenue, is vulnerable to extreme weather events, which affect national income.

Despite the impact of seasonal weather change and its vulnerabilities in Abuja, only few studies connect seasonal weather indices of temperature and rainfall to socio-economic livelihood susceptibility. However, there remains a knowledge gap in the capital city of Abuja on seasonal weather patterns and derived climate indices that translate into differentiated livelihood susceptibility across urban, peri-urban, and rural socio-economic activities. This necessitated the study of seasonal weather change (Variability) on socio-economic activities of livelihoods in Abuja for the intended purpose to redesign climate information services and plan climate-smart development pathways that protect livelihoods.

METHODOLOGY

The Federal Capital Territory (FCT) Abuja, situated in central Nigeria, lying between latitude 80 25'and 90 25'North of the equator and longitude 60 45' and 70 45' east of the Greenwich meridian, spans 8,000 square kilometers and represents approximately 0.87% of the country's total area. It is bordered by Niger State to the west, part of Kaduna State to the north, and Nassarawa State to the east. The climate is characterized as tropical humid, with temperature variations significantly influenced by both cloud cover and elevation. Maximum temperatures during the dry season range from 30.1°C to 35.1°C, while they drop to 25.8°C and 30.2°C during the wet season (NIMET, 2024). FCT experiences two primary air masses: the tropical maritime air from the Atlantic, which is warm and moist, and the tropical continental air from the Sahara, which is dry and warm. The Intertropical Convergence Zone (ITCZ) plays a crucial role in seasonal weather patterns, with the rainy season typically commencing in April and concluding in October. Daily sunshine averages eight to ten hours during the dry season but can decrease to about four hours in the rainy months due to increased cloud cover. Relative humidity varies, being lower in the northern part of the FCT, particularly during the dry season, where it can drop to 20%. In contrast, it exceeds 50% in the rainy season. Rainfall begins in mid-March and lasts until early November in the south, with total annual precipitation ranging from 1,145mm to 1,631mm. The FCT's position on the windward side of the Jos Plateau leads to more frequent precipitation, characterized by squall lines, cumulonimbus cloud formation, and intense but short-lived downpours often followed by drizzles and clear skies. Overall, the FCT's climatic conditions demonstrate a complex interplay of geographical and meteorological factors that shape its seasonal weather characteristics.

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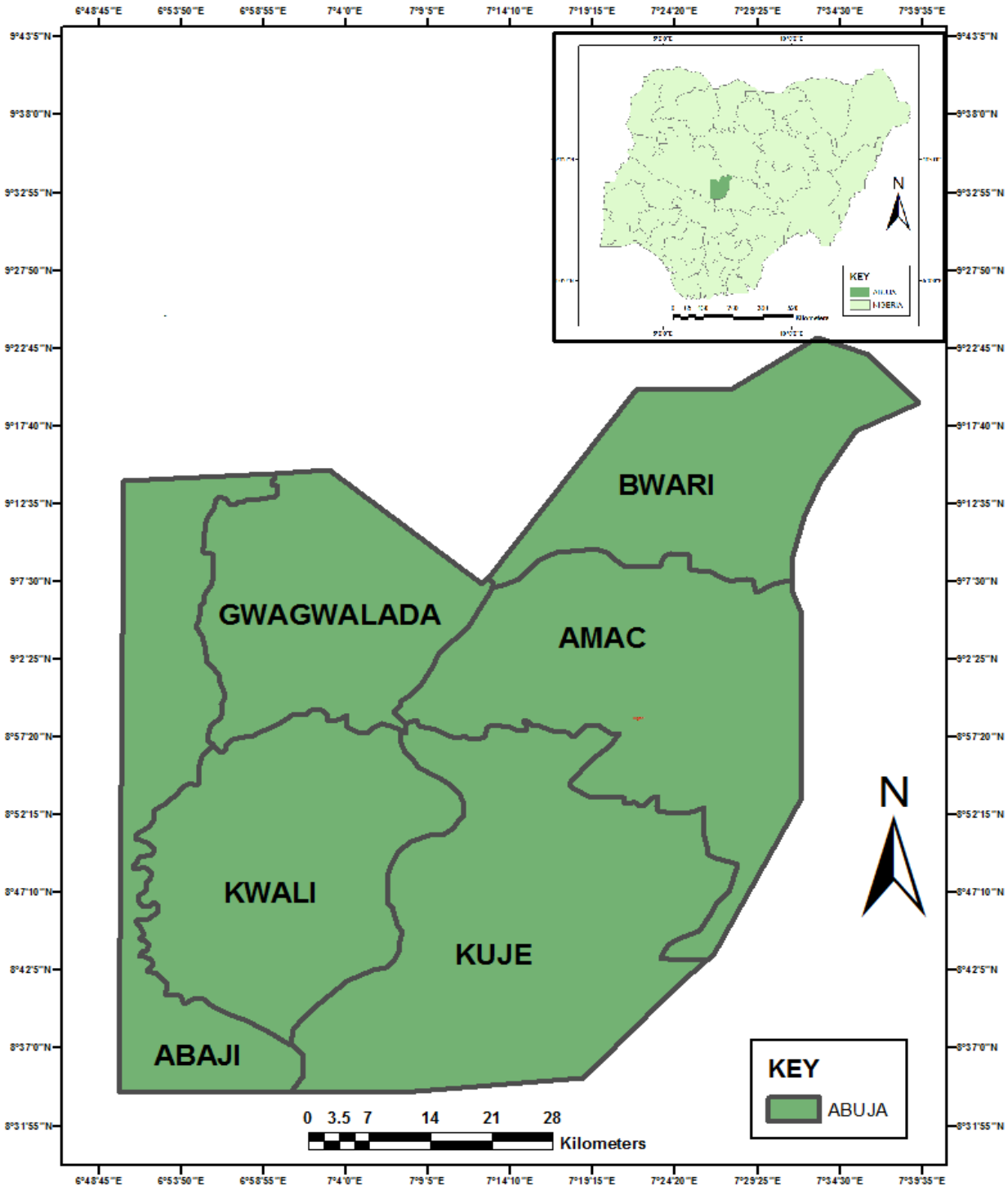

Figure 1: Map of FCT Showing the Study Area.
Source: GIS LAB. University of Abuja(2025)

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The study adopted a mixed-methods approach, relying on both primary and secondary quantitative data. The analytical methods and techniques adopted in this study are the most suitable because they aim to investigate issues in depth rather than provide a superficial description. The researcher compiled daily rainfall, temperature, and relative humidity records of the Federal Capital Territory (FCT) for 35 years (1990-2025) compiled by meteorologists of the Nigerian Meteorological Agency (NIMET). This data was collected regularly from the NIMET synoptic station in Abuja, using hourly instrumental observations of the weather variables in question. Each variable was calculated as a yearly average to understand changes over the 35-year period, and the results were used to observe seasonal weather events in line with World Meteorological Organization (WMO) standards. Temperature, rainfall, and relative humidity were measured in degrees Celsius, millimetres, and percentages, respectively. The qualitative and primary data were collected using a Likert-scale measure among residents of the Abuja FCT, which comprises all six municipal area councils (Bwari, Gwagwalada, Amac, Kwali, Kuje, and Abaji). According to the Federal Republic of Nigeria Official Gazette (2019), it is 4,392,360 (World Population Review). The study population is therefore 1,406,239. The sample size for the study is three hundred eighty-four (384) respondents. The sample size was determined using Cochran's formula. Cochran (as cited in Asemah 2013) developed a statistical formula for determining sample size. A random sampling strategy was adopted to ensure unbiased coverage of the municipal council and all aspects of livelihoods. The mean and standard deviation were used to examine participants' responses.

RESULTS AND DISCUSSION

The study indicates substantial seasonal weather variability in FCT, as reflected in its effects on livelihoods. With 35 years of climatic data from 1990- 2025 and household survey data collected, the findings reveal a clear upward trend in the mean annual temperature in Abuja, FCT, over the 35-year period (Figure 2). The highest average temperature was recorded in 2000 with about 32.2^0C whereas the lowest average recorded was 29.98^0C. According to Ahmed et a.,(2020) The minimum temperatures occur in January and December, averaging approximately 20.47°C and 20.82°C, respectively. The interannual temperature trend from 1982 to 2022 reveals a consistent increase of roughly 0.0299°C annually, culminating in a total rise of nearly 1.196°C during the 40-year span. Although short-term fluctuations are evident, the long-term pattern indicates progressive warming, particularly pronounced since the early 2000s. This trend confirms intensifying thermal stress in the FCT, consistent with broader regional climate change patterns reported for North-Central Nigeria. Rising temperatures exacerbate heat stress, increase energy demand for cooling, and reduce outdoor productivity, especially for informal sector workers whose livelihoods depend on daily physical activity. This variability disrupts the traditional onset and cessation of the rainy season, which respondents strongly acknowledged (Mean = 1.71). Such inconsistency undermines agricultural planning, increases the risk of crop failure, and intensifies flood exposure during high-rainfall years(Ahmed et al., 2020). The findings reinforce the argument that climate risk in Abuja is not defined solely by declining rainfall but by increasing rainfall uncertainty and intensity. Otaru (2020) concurred that for over five years, certain areas of the Federal Capital Territory (FCT), Abuja, have been profoundly afflicted by flooding, an ordeal that would persist as a haunting memory for the impacted citizens for an extended period. Locations such as Karu, Lokogoma, Galadimawa, Giri, Gwagwalada, Trade More Estate, and various other areas of the capital city frequently experience severe flooding. The relative humidity trends in Figure 5 show moderate but persistent fluctuations over the study period, humidity was 77.6% at its peak in 1995, while the lowest humidity was 59% in 1990. There is less dramatic than changes in temperature and rainfall, humidity interacts with heat to intensify thermal discomfort. High humidity limits evaporative cooling, increasing vulnerability to heat-related illnesses. These supports concerns raised in the discussion on environmental stress and declining comfort levels in urban and peri-urban Abuja.

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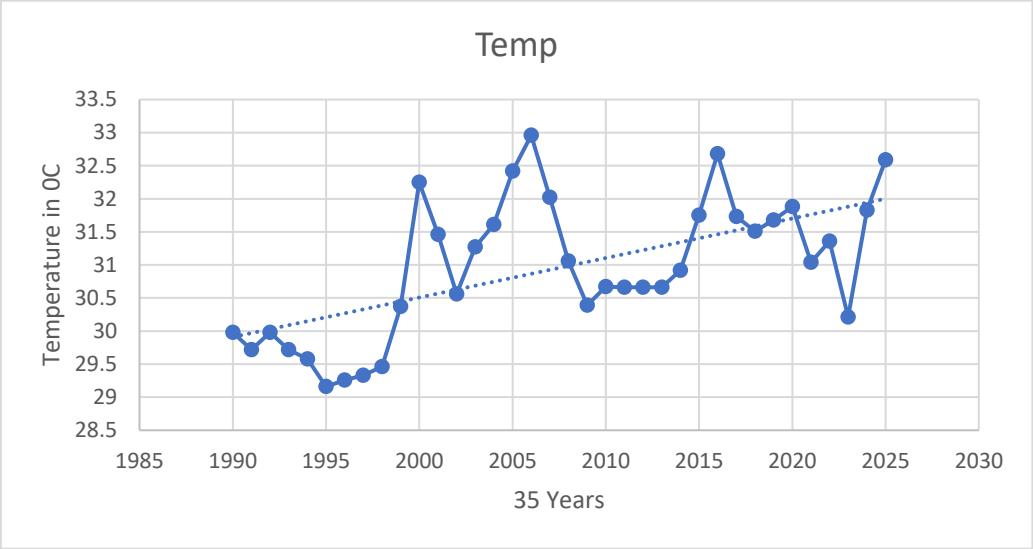
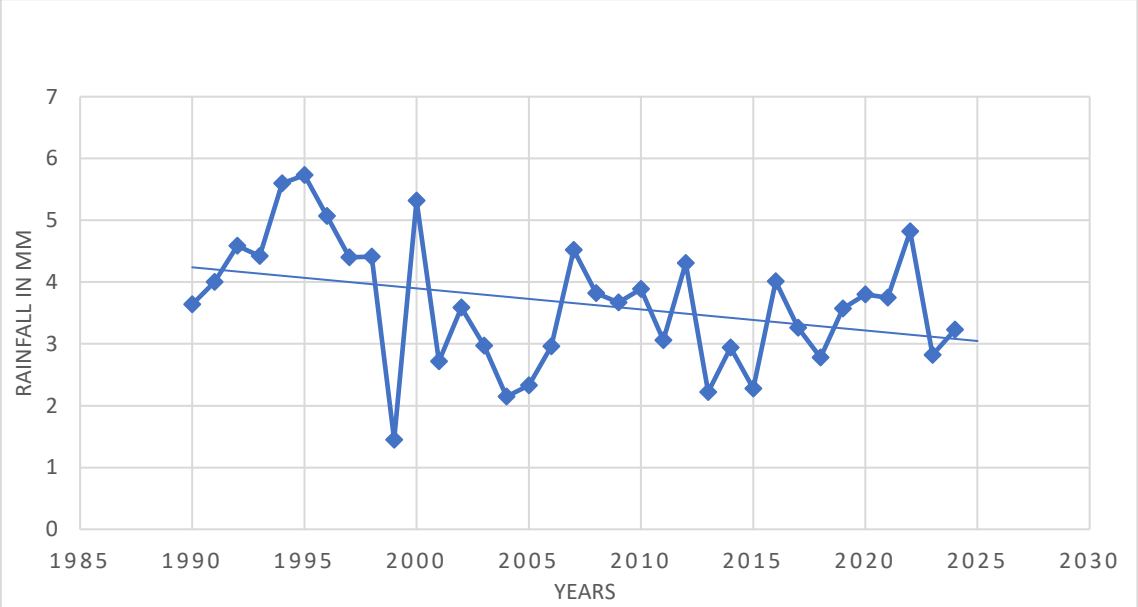


Source: MiNET, 2026

Figure 2: Temperature Variation from 1990-2025 of Abuja FCT



Source: NiMET, 2026

Figure 3: Rainfall Pattern Variation from 1990-2025 in Abuja FCT, Nigeria

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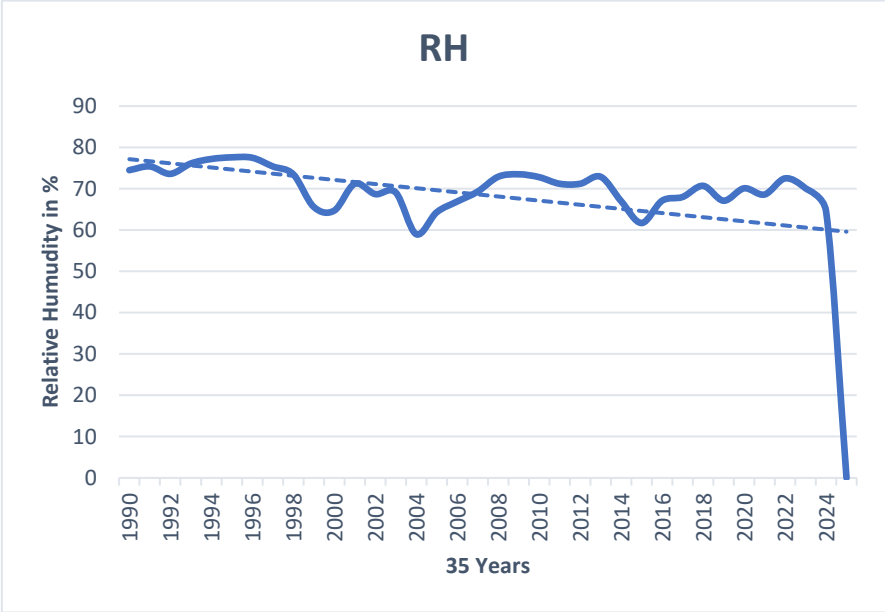

Source: MiNET, 2026

Figure 4: Relative Humidity Variation from 1990- 2025 in Abuja FCT, Nigeria

The survey results indicate that seasonal weather variability significantly disrupted livelihood stability. One aspect of the seasonal weather was that temperature increase weather stress to the livelihood (mean = 2.04) with (SD = 1.072) was strongly agreed. According to Effiong et al., (2024) Harsh weather brings stress to human comfort and Tanko & Mohammed (2024), added that increasing temperatures typically lead to detrimental economic and environmental consequences at local, regional, and global levels. Continually escalating temperatures heighten the demand for air conditioning, elevate pollution levels, alter urban thermal environments, and ultimately result in thermal pain and other heat-related ailments (Tanko & Mohammed, 2024). Respondents agreed that changes in seasonal patterns undermine long-term livelihood planning (Mean = 1.54) with (SD =0.804) significant and negatively affect households during prolonged dry seasons (Mean = 2.02) with (SD =1.032) significant. These results highlight the erosion of predictability, which is critical for both farming and non-farming livelihoods. The instability forces households to resort to short-term coping strategies rather than sustainable planning, thereby increasing economic vulnerability. Regarding environmental conditions, the strongest agreement in the table 1 relates to rainfall intensity affecting soil productivity (Mean = 3.17) with (SD = 0.960). Flooding during rainfall season damage physical assets with a (mean = 2.08) and a (SD = 1.072) and prolong dry season spells reduce vegetation cover and natural resources (mean = 2.60 and SD = 1.227) and seasonal weather indices influence timing to farming and non-farming activities (mean = 2.53 and SD = 1.034). These findings indicate that extreme rainfall events contribute to soil erosion, nutrient loss, and declining agricultural yields. Additionally, prolonged dry spells reduce vegetation cover (Mean = 2.60), further weakening ecosystem services that support livelihoods such as fuelwood collection, grazing, and water availability. This dual pressure of floods and droughts reflects a climate stress trap that disproportionately affects low-income households. Livelihood susceptibility indicators reveal high sensitivity of household income to seasonal weather changes (Mean = 2.58 and 1.100) and increased livelihood insecurity due to weather-related shocks (Mean = 2.68 and 1.153). Employment opportunities are also influenced by climate variability (Mean = 2.59 and SD = 1.100), particularly in sectors such as agriculture, construction, transportation, and informal trade. These findings confirm that climate change functions as an economic risk multiplier, amplifying existing socio-economic inequalities in Abuja FCT. The socio-economic livelihoods of households are negatively affected by seasonal weather changes, which disrupt small-scale businesses (Mean = 2.12 and SD = 0.850) and disrupt transportation during heavy rainfall (Mean = 1.91 and 1.073). Flooded roads, traffic congestion, and damaged infrastructure reduce mobility and productivity. Educational activities are also disrupted during extreme weather events (Mean = 1.62 and SD = 0.918), indicating broader social consequences beyond income loss. Climate variability was found to increase the cost of living (Mean = 1.80 and 0.936), reflecting higher food, transportation, and energy costs. Ucheje et al., (2024), Magari &Musa, (2024), & Ucheje & Chukwueloka, (2024) agreed that seasonal weather considerable affects socio-

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economics on local communities, especially on marginalised people. Mitigating these repercussions necessitates a comprehensive strategy, encompassing the broadcast of climate knowledge, the implementation of climate-resilient projects, and the establishment of social protection program. Ahmed, 2020; Chauhan et al., 2023; Klassert et al., 2023 and Magaji et al., 2025, in their views that rising production costs and diminishing productivity may result in decreased economic growth and development. Small enterprises, which are the foundation of the local economy, are especially susceptible. The financial pressure on these enterprises may result in layoffs, shorter working hours, and, in certain instances, business closures. In the livestock sector, diminished production may result in increased costs for meat and dairy products, so impacting food security and nutrition. The results establish a strong linkage between observed climatic trends and livelihood vulnerability in Abuja FCT. Rising temperatures, erratic rainfall, and fluctuating humidity interact with rapid urbanization and weak infrastructure to heighten exposure and reduce adaptive capacity (Abugu et al., 2025). The alignment between meteorological data and household perceptions strengthens the validity of the findings and underscores the urgency of integrating climate information into urban planning, livelihood diversification, and climate-resilient development strategies. Improve the dissemination of climate information and early warning systems; Support initiatives for climate-resilient agriculture and livelihoods; Promote climate-sensitive social protection programs; Enhance access to climate finance and adaptation resources; Encourage community-led adaptation and resilience-building initiatives. There is a significant reduction in water availability, erratic rainfall patterns, and an increase in extreme weather events, all of which complicate agricultural planning and food security.

Table 1 Seasonal Weather Changes on Livelihoods in Abuja FCT, Nigeria

Description	Mean	SD	Decision
Seasonal Weather Variability			
Temperature increase has intensified seasonal weather stress	2.04	1.072	Significant
Onset and cessation of the rainy season have change over the years	1.71	0.872	Significant
Dry seasons affect households negatively	2.02	1.032	Significant
Seasonal weather variability disrupts long-term planning of livelihood activities	1.54	0.804	Significant
Seasonal Weather Influence on Environmental Conditions			
Changes in rainfall intensity affect soil productivity	3.17	0.960	Significant
Flooding during rainfall season damages physical assets used for livelihoods	2.08	1.072	Significant
Prolong dry spells reduce vegetation cover and natural resources	2.60	1.227	Significant
Seasonal climate indices influence the timing of farming and non- farming activities	2.53	1.034	Significant
Livelihood Susceptibility on seasonal weather change			
Seasonal weather changes highly sensitive to household income	2.58	1.100	Significant
Weather related shocks have increased livelihood insecurity.	2.68	1.153	Significant
Seasonal weather changes influences pattern of employment opportunities	2.59	1.000	Significant
Food availability in households is affected by seasonal weather changes	3.13	1.062	Significant
Seasonal Weather Change on Socio-economic Activities			
Small-scale businesses are negatively affected by extreme seasonal weather change.	2.12	0.850	Significant
Transportation is disrupted during the heavy rainfall period	1.91	1.073	Significant
Seasonal weather conditions influence the daily economic activities of households.	1.37	0.654	Significant

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Climate variability increases the cost of living for households	1.80	0.936	Significant
Educational activities are disrupted during extreme weather changes	1.62	0.918	Significant

Source: Field survey 2025

CONCLUSION

This study analysed long-term seasonal weather patterns and their effects on livelihood vulnerability in Abuja, FCT, utilising 35 years of meteorological data and household-level views. The results indicate that Abuja has experienced a persistent rise in temperature, notable rainfall unpredictability, and inconsistent relative humidity, all of which have substantially transformed environmental conditions and socio-economic activity. The observed climate changes validate previous research in Nigeria and Sub-Saharan Africa, which identifies increasing temperatures and unpredictable rainfall as significant factors contributing to livelihood risk, especially in increasingly urbanising areas. The findings indicate that seasonal weather fluctuations hinder livelihood planning, reduce agricultural output, damage physical assets from flooding, and exacerbate household income volatility. Food availability, job prospects, transportation systems, and educational activities are all negatively affected, demonstrating that seasonal weather change is a systemic threat that goes beyond environmental limits and directly jeopardises socio-economic stability. Aligning long-term climatic data with residents' views enhances the validity of the findings and underscores the lived experiences of climate stress in Abuja. The study concludes that in the absence of intentional climate adaptation and risk-aware development planning, seasonal weather variability will exacerbate livelihood instability and socio-economic inequality in the Federal Capital Territory.

RECOMMENDATIONS

There is an urgent need to integrate climate risk factors into urban and regional planning in Abuja FCT, under the following recommendations:

- Emphasis should be placed on developing climate-resilient infrastructure, such as improved drainage systems and flood-control measures, to reduce damage from heavy rainfall in places that were not available, not neglecting slum communities.
- Enhance climate information services and early warning systems will help households and businesses plan in strategies schedules of their activities.
- Promote livelihood diversification and climate-smart agriculture is vital, especially in peri-urban and rural areas, to lessen dependence on climate-sensitive income sources.
- Design supportive policies for small-scale enterprises during weather disasters, such as microcredit and insurance, would ease economic impacts.
- Additionally, public awareness efforts and investments in health, transportation, and education are essential to address the broader socio-economic consequences of weather variations. Long-term climate adaptation strategies should be woven into FCT development programs for sustainable growth.

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