Climatic Observation Versus People Perception: A Case Study in the Ampesekrom Community Near Nkawkaw in the Kwahu West Municipal of Ghana.

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Abstract: This research examines community perspectives on climate change in Ampesekrom, near Nkawkaw, situated in Ghana's Eastern Region. The study employs a combined methodology that integrates meteorological data evaluation with community questionnaires (involving 100 participants) to explore trends in climate variability and adaptation strategies within forest-reliant communities. The meteorological evaluation identifies clear decade-by-decade temperature and precipitation trends across the three-decade timeframe. Peak temperatures show a general upward trajectory with significant variations, whereas precipitation patterns exhibit early decreases followed by more recent increases. A comparative evaluation with Abetifi, a neighbouring high-altitude station (positioned at 601m elevation compared to Nkawkaw's 275m), demonstrates varying climate effects associated with elevation and land use modifications. Precipitation patterns exhibited considerable variation, with significant decreases from the initial to the middle decade (roughly 15-25% reduction) before experiencing modest recovery during the final decade. Survey results indicated extensive recognition of climate change (98.5% confirmed that the climate is changing), accompanied by nuanced comprehension of the anthropogenic factors contributing to environmental transformation. Participants pinpointed forest clearing, farming intensification, vegetation burning, and urban development as key factors driving environmental transformation, revealing their understanding of connections between human actions and climatic conditions. The study recommends implementing community-focused educational programs that clarify climate change origins, indicators, and adaptation approaches through understandable terminology and contextually relevant illustrations. Additionally, it suggests enhancing agricultural advisory services that deliver technical guidance for climate adaptation, guaranteeing consistent interaction between agricultural advisors and farming communities, while improving climate information accessibility to support better agricultural planning and risk mitigation decisions.

Keywords: Climate Perception, Climate Change, Meteorological Observation, Indigenous Knowledge

I. Introduction

Climate change represents one of the most pressing challenges facing humanity in the 21st century, with disproportionate impacts on vulnerable populations in developing countries (Intergovernmental Panel on Climate Change [IPCC], 2021). Sub-Saharan Africa, despite contributing minimally to global greenhouse gas emissions, faces severe climate-related risks affecting agricultural productivity, water resources, and livelihoods (Niang et al., 2014). Ghana, located in West Africa, has experienced observable climatic shifts including increased temperatures, changing rainfall patterns, and increased frequency of extreme weather events (Asante & Amuakwa-Mensah, 2015).

Understanding the relationship between scientific climatological observations and community perceptions of climate change holds significant implications for policy development and adaptation planning. While meteorological data provide objective measurements of climatic parameters, local perceptions reflect lived experiences, traditional ecological knowledge, and immediate environmental interactions.

The convergence or divergence between these two knowledge systems can inform more effective and culturally appropriate climate interventions. Ghana has experienced measurable climatic changes over recent decades. Temperature records indicate a warming trend of approximately 1°C since 1960, with projections suggesting further increases of 1.5-5.2°C by 2100, depending on emission scenarios (Ministry of Environment, Science, Technology and Innovation [MESTI], 2015). Rainfall patterns have become increasingly variable, with some regions experiencing decreased annual totals while others face increased intensity but reduced frequency of rainfall events (Owusu & Waylen, 2009).

The Eastern Region, where Ampesekrom is located, falls within the semi-deciduous forest zone characterized by bimodal rainfall distribution with major and minor rainy seasons (Adu-Boahen et al., 2014). Historical analyses reveal shifts in rainfall onset and cessation dates, posing challenges for rain-dependent agricultural systems (Akpalu et al., 2008). Ampesekrom, a predominantly

agrarian community located approximately 15 kilometers from Nkawkaw in the Eastern Region of Ghana, provides an ideal setting for examining climate change impacts on rural livelihoods. The community's economy depends primarily on rain-fed agriculture, making residents particularly vulnerable to climatic variations (Fosu-Mensah et al., 2012). Understanding how local communities perceive climate change is crucial for developing effective adaptation strategies, as perceptions influence decision-making processes and adaptive behaviours (Mase et al., 2017).

While scientific evidence increasingly documents climate change through meteorological measurements, local communities often develop their understanding of climatic shifts through lived experiences and traditional ecological knowledge (Pearce et al., 2015). Discrepancies between scientific observations and local perceptions can lead to maladaptive responses, ineffective policy interventions, and missed opportunities for integrating indigenous knowledge with scientific approaches (Risiro et al., 2012). In Ampesekrom, anecdotal evidence suggests that farmers are altering their agricultural practices in response to perceived climate change, yet no systematic study has examined whether these perceptions align with actual meteorological trends. The forest belt of Ghana faces multiple concurrent stressors that exacerbate the impacts of climate change. Agricultural expansion, commercial logging, fuel wood collection, and urbanization have substantially degraded forest cover, potentially amplifying local climate effects through altered hydrological cycles and temperature regulation.

In African contexts, several studies have documented local perceptions of climate change. Maddison (2007) surveyed farmers across 11 African countries, finding widespread awareness of temperature increases and rainfall changes. However, Simelton et al. (2013) demonstrated that perceived changes often diverge from meteorological records, with farmers emphasizing recent extreme events over long-term trends.

However, the specific manifestations of these changes and their perception by local communities remain inadequately documented. Also, Agriculture, the primary livelihood activity in the study area, demonstrates particular sensitivity to climate variability. Changes in precipitation patterns, temperature extremes, and growing season length directly affect crop yields, food security, and household incomes. Understanding farmer perceptions of these changes and their adaptive responses is crucial for designing effective agricultural climate adaptation strategies.

Research on climate change perception has expanded significantly, revealing complex relationships between actual climatic changes and human understanding (Weber, 2010). Psychological factors, including cognitive biases, personal experiences, and cultural worldviews, influence how individuals interpret environmental changes (van der Linden, 2015).

This study aims to:

- To analyze meteorological data to identify trends and variability in temperature and rainfall patterns.

- To assess community awareness, understanding, and perceptions of climate change manifestations.

- Document local perceptions of climate change among Ampesekrom community members.

This research contributes to the growing body of literature on climate change perception in rural African contexts, providing empirical evidence from an underrepresented geographical area. The findings have practical implications for agricultural extension services, climate adaptation programming, and policy formulation in rural Ghana. By identifying perception-observation gaps, this study offers insights for designing more effective communication strategies that bridge scientific knowledge and local understanding.

Ghana has been the focus of several studies examining climate perception observation relationships. Fosu-Mensah et al. (2012) investigated farmers' perceptions in the Sekyedumase district, finding that 94% of respondents perceived increased temperatures over the past 20 years, partially corroborated by meteorological data showing warming trends. However, perceived rainfall patterns showed weaker correspondence with station records, particularly regarding seasonal distribution. Stanturf et al. (2011) examined forest-dependent communities in Ghana's transition zone, documenting that local perceptions of climate change were strongly influenced by deforestation and land-use changes, which communities often attributed to climatic shifts. Ghana has begun experiencing tangible climate change impacts including elevated temperatures, altered rainfall patterns, increased flooding, tidal waves, and coastal erosion (Quaittoo, 2014). These changes affect all sectors but particularly agriculture, water resources, and coastal infrastructure. Forest degradation compounds climate impacts through altered local hydrology and temperature regulation. The migration of herders from drought-affected northern regions to the south contributes to land degradation through overgrazing and increased fire frequency, effectively extending savanna vegetation southward into forest zones.

Understanding public perceptions of climate change has emerged as a critical research area over recent decades (Kempton, 1991; O'Connor et al., 1999; Leiserowitz, 2005, 2006; Brody et al., 2008; Agho et al., 2010). How people recognize, understand, and respond to climate risks influences public support for climate policies, individual adaptation behaviors, and collective action on mitigation. Cameron (2005) demonstrated that climate change perceptions significantly influence willingness to support climate policies. Viscusi and Zeckhauser (2006) found that Americans with higher perceptions of future temperature increases expressed greater willingness to pay for climate mitigation policies. These findings underscore the importance of understanding and potentially influencing climate perceptions for advancing climate action.

Research across sub-Saharan Africa consistently documents significant variations between meteorological records and farmer perceptions. Maddison (2007) conducted a comprehensive survey across 11 African countries, finding that while farmers widely perceive temperature increases and rainfall changes, these perceptions often exhibit spatial and temporal inconsistencies with climate station data. The study revealed that 65% of farmers perceived decreased precipitation, though meteorological records showed more complex patterns. In West Africa specifically, Mertz et al. (2009) demonstrated that Sahelian farmers' perceptions of climate trends frequently aligned with broad directional changes but diverged regarding magnitude and timing. Their research emphasized that perception-observation gaps do not indicate "incorrect" local knowledge but rather reflect different observational scales, relevant indicators, and the integration of climate factors with socioeconomic changes.

The study of climate perception versus observation draws heavily from several theoretical traditions. Social constructivism provides a foundational understanding that human perception of environmental change is mediated through cultural, social, and experiential filters (Berkes, 1999). Communities construct knowledge about climate through lived experiences, traditional knowledge systems, and social learning processes that may diverge from scientific measurements (Agrawal, 1995). The Theory of Planned Behavior (Ajzen, 1991) offers insights into how perceptions influence adaptive behaviours, suggesting that subjective assessments of climate risks, regardless of their alignment with meteorological data, directly shape community responses. Additionally, the Local Ecological Knowledge (LEK) framework recognizes that indigenous and local knowledge systems represent valid, though different, epistemological approaches to understanding environmental change (Berkes et al., 2000).

Multiple factors contribute to discrepancies between climate perceptions and observations. Psychological research demonstrates that availability heuristics lead individuals to overweight recent extreme events (Kahneman & Tversky, 1974), potentially explaining why communities may perceive increased climate variability even when statistical trends are ambiguous. Weber (2010) extended this work to environmental risk perception, showing that personal experience with extreme events shapes climate perceptions more powerfully than statistical information. Socioeconomic factors significantly mediate climate perception. Deressa et al. (2011) found in Ethiopia that education level, farming experience, and access to climate information influenced perception accuracy. However, Roncoli et al. (2009) cautioned against interpreting formal education as automatically improving perception accuracy, noting that indigenous knowledge systems often capture climate nuances missed by sparse meteorological networks. In Ghana, traditional environmental knowledge has been documented by several researchers. Gyampoh et al. (2009) recorded indigenous climate indicators in Ghana's forest-savanna transition zone, including flowering patterns of specific trees, migration timing of birds, and changes in water body levels. Communities demonstrated detailed ecological observations that, while not meteorologically standardized, provided actionable climate information.

Gender significantly influences climate perception and knowledge. Kristjanson et al. (2017) documented in East Africa that men and women often perceive different aspects of climate change due to gendered livelihood activities and decision-making roles. Women, more engaged in water collection and small-scale agriculture, frequently showed greater sensitivity to precipitation changes and water availability. Carr and Thompson (2014) emphasized that aggregating community perceptions without attention to gendered knowledge can obscure important insights and reinforce power inequalities. Their research suggested that women's climate observations, though sometimes marginalized in community discussions, often align closely with localized impacts measured through agricultural and water data. The relationship between climate information access and perception accuracy presents complex findings. Patt and Gwata (2002) found in Zimbabwe that access to seasonal forecasts did not necessarily improve perception accuracy or agricultural decision-making, due to issues of trust, relevance, and integration with existing knowledge systems.

Despite substantial research, several gaps remain relevant to the Ampesekrom context. Few studies have focused specifically on Ghana's Eastern Region, where distinct climatic, topographic, and socioeconomic conditions may produce unique perception-observation relationships. The Nkawkaw area's position in the transition between forest and savanna zones creates particular climate sensitivities poorly documented in existing literature. Additionally, most studies employ cross-sectional designs that capture perceptions at single time points. Longitudinal research tracking how perceptions evolve in relation to observed climate trends remains limited, particularly in West African contexts.

II. Materials and Methods

Study Area and Size

Ampesekrom is located approximately 6 kilometers east of Nkawkaw in the Kwahu West Municipality of Ghana's Eastern Region. The district represents one of the newly created administrative units established to enhance local governance and development. Geographically, Kwahu West is situated between latitudes 6°30' and 7°15' North and longitudes 1°00' West and 0°15' East, encompassing approximately 414 square kilometers. Nkawkaw, the municipal capital, lies approximately 241 kilometers northwest of Accra, Ghana's national capital, making it accessible yet distinctly rural in character. The municipality exhibits diverse topography, positioned at the foothills of the Kwahu Mountains, which rise prominently to the north and east. The district is bounded by several neighbouring administrative units: Kwahu South District to the north, Asante Akim South District to the west, Fanteakwa District to the east, and Birim North and Atiwa Districts to the south. This location positions the district within Ghana's transitional forest zone, where forest ecosystems transition toward savanna vegetation to the north.
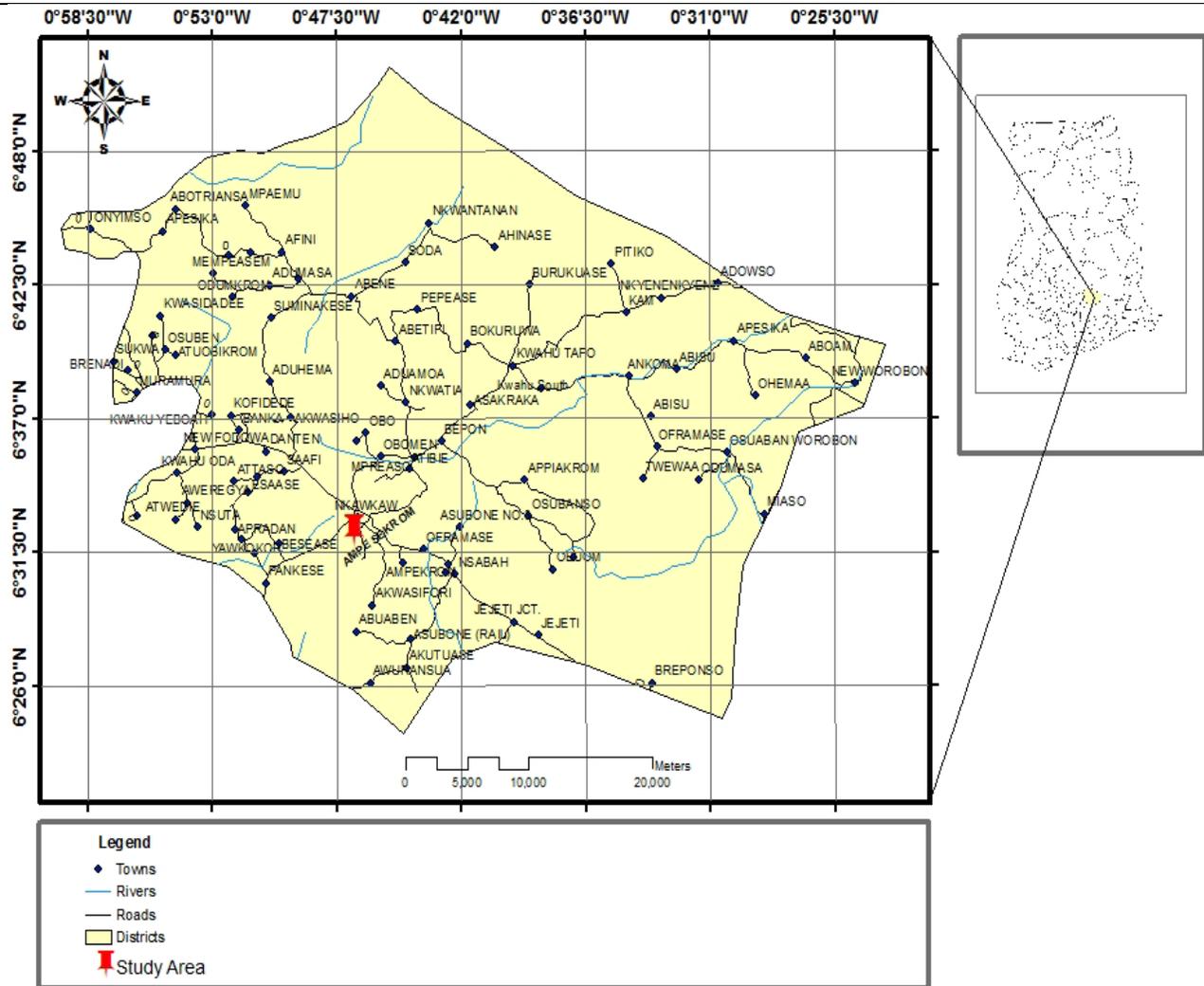
Figure 1: Map of the study area.

Climate and Vegetation

Kwahu West Municipal experiences a wet semi-equatorial climate characterized by bimodal rainfall distribution, a pattern typical of Ghana's forest and transitional zones. The primary rainy season occurs from May to August, followed by a shorter rainy season from September to October. Average annual rainfall ranges between 1,700 and 2,000 millimetres, providing substantial moisture for agricultural activities and forest ecosystem maintenance. Relative humidity varies seasonally, ranging between 75% and 80% during rainy seasons, creating conditions favourable for agriculture but also conducive to certain agricultural pests and diseases. Mean monthly temperatures exhibit seasonal patterns, reaching highs of approximately 30°C during the hot dry season (March-April) and declining to approximately 26°C during the major rainy season (August).The district's climate is influenced by two principal air masses: the tropical maritime (mT) air mass originating from the Atlantic Ocean, bringing moisture during rainy seasons; and the tropical continental (cT) air mass from the Sahara Desert, creating hot, dry conditions during the Harmattan season (November-March). The seasonal migration of the Inter-Tropical Convergence Zone (ITCZ) drives these air mass movements, producing the characteristic bimodal rainfall pattern. Vegetation in Kwahu West District belongs to the semi-deciduous forest zone, specifically the Antiaris-Chlorophora association. This forest type is characterized by dense canopy cover comprising economically valuable timber species including Odum (Milicia excelsa), Wawa (Triplochiton scleroxylon), Mahogany (Khaya species), Cinderella (Cinderella erythrophlei), Ceiba (Ceiba pentandra), and Sapele (Entandrophragma cylindricum). The forest structure exhibits three distinct layers: an upper canopy reaching 30-40 meters, a middle canopy of 15-25 meters, and an understory layer. Many species in the upper and middle layers display deciduous characteristics, shedding leaves during the dry season (November-March) as a water conservation strategy. Unfortunately, extensive human activities including commercial logging, subsistence agriculture, fuelwood collection, and bush burning have substantially degraded virgin forest cover. Much of the original climax vegetation has been replaced by secondary forest and bush, representing significantly altered ecosystem structure and composition. Three forest reserves persist in the district: Kade Bepo, Nkawanda, and a third reserve, collectively covering approximately 15,460 hectares or 171.56 square kilometers.

Research Design

This study employed a mixed-methods research design integrating quantitative meteorological data analysis with qualitative and quantitative survey approaches. The triangulation of multiple data sources enhances research validity by enabling cross-verification of findings and providing complementary perspectives on climate change manifestations and community responses.

- The research design incorporated three principal components:

- *Quantitative climatological analysis:* Time series analysis of meteorological parameters (temperature, rainfall, relative humidity, sunshine hours) spanning 30 years (1984-2013)

- *Community survey:* Structured questionnaire administration to assess climate change awareness, perceptions, impacts, and adaptation strategies

- *Comparative analysis:* Integration of meteorological observations with community perceptions to identify convergence and divergence

This design addresses both descriptive and analytical objectives, documenting what climate changes have occurred while examining how communities perceive and respond to these changes. The comparative component between Nkawkaw adds spatial dimension to the analysis, revealing how local topography and land use influence climate manifestations.

Data Sources

Both Primary and Secondary Data were used on Ampesekrom community using structured questionnaires addressing: Demographic and Socioeconomic Characteristics (gender, age, occupation, education), Climate change awareness and understanding, Perceived changes in temperature, rainfall, and other environmental parameters etc. Secondary data included the monthly meteorological data for Nkawkaw were obtained from the Ghana Meteorological Agency. The dataset includes: Maximum and minimum temperatures (°C), Rainfall (mm), and Relative humidity (%) - limited availability

Sampling Technique and Sample Size

Simple random sampling was employed to select survey respondents, ensuring each community member had equal selection probability and minimizing sampling bias. The sample size was determined using the formula:

$n = N / [1 + N(\alpha)^2]$

Where:

- n = sample size

- N = total population

- α = margin of error (0.1 or 10%)

Given the community population (N = 536) and desired margin of error (α = 0.1):

$n = 536 / [1 + 536(0.1)^2]$ n = 536 / [1 + 536(0.01)] n = 536 / 3.36 n ≈ 160

However, due to practical constraints including respondent availability and time limitations, 100 questionnaires were successfully administered and completed, representing approximately 64% of the total population. This sample size remains sufficient for descriptive analysis and identifying dominant patterns within the community.

Data Collection Procedures & Data Analysis

Questionnaire Administration: The researcher personally administered questionnaires to ensure consistency in question delivery, clarify ambiguities, and maximize response rates. Questionnaires incorporated both closed-ended questions (providing predetermined response options) and open-ended questions (allowing respondents to express views in their own words). *Observation:* Direct field observations supplemented questionnaire data, providing contextual information on environmental conditions, agricultural practices, forest conditions, and community infrastructure. Observations were recorded through field notes and photographs (where permitted).

Microsoft Excel was used for data organization, calculation of descriptive statistics, and graph generation. Trend lines were fitted to identify overall patterns across the 30-year period. For each meteorological parameter, the following analyses were conducted: Decadal mean values for each month, overall monthly means across all years. Questionnaire data were coded and entered into Statistical Package for Social Sciences (SPSS) for analysis. Analysis procedures included: Descriptive statistics: Frequencies, percentages, and cross-tabulations for demographic variables and response patterns

III. Results and Discussion

Temperature Trends in Nkawkaw

Analysis of 30-year temperature data reveals complex patterns with both long-term trends and decadal variability. The data were analysed in three ten-year periods to identify shifts in temperature patterns over time.

Maximum Temperature

Mean monthly maximum temperatures for Nkawkaw demonstrate an overall increasing trend across the study period, with notable inter-decadal variations. The first decade (1984-1993) established baseline temperature conditions, while the second decade (1994-2003) showed elevated maximum temperatures across most months. The third decade (2004-2013) presents a mixed pattern, with some months showing slight cooling compared to the second decade while others maintain elevated temperatures.

The annual temperature cycle exhibits predictable seasonal patterns, with peak maximum temperatures occurring during March-April (reaching approximately 32-33°C) coinciding with the pre-monsoon hot dry season. Minimum maximum temperatures occur during the major rainy season (July-August, approximately 28-29°C) when cloud cover and precipitation moderate temperatures.

Statistical analysis reveals that mean maximum temperature increased by approximately 0.8-1.2°C between the first and second decades, with the most pronounced warming occurring during the dry season months (December-March). However, the third decade shows evidence of stabilization or slight cooling, particularly during mid-year months. This pattern suggests complex interactions between regional climate drivers, local land use changes, and natural climate variability.

The slight temperature decline in the most recent decade, despite continued global warming, may reflect several factors: increased cloud cover from altered regional circulation patterns, local afforestation efforts that enhance evaporative cooling, or natural decadal oscillations in regional climate. Further investigation with higher temporal resolution data would be needed to definitively attribute these patterns.
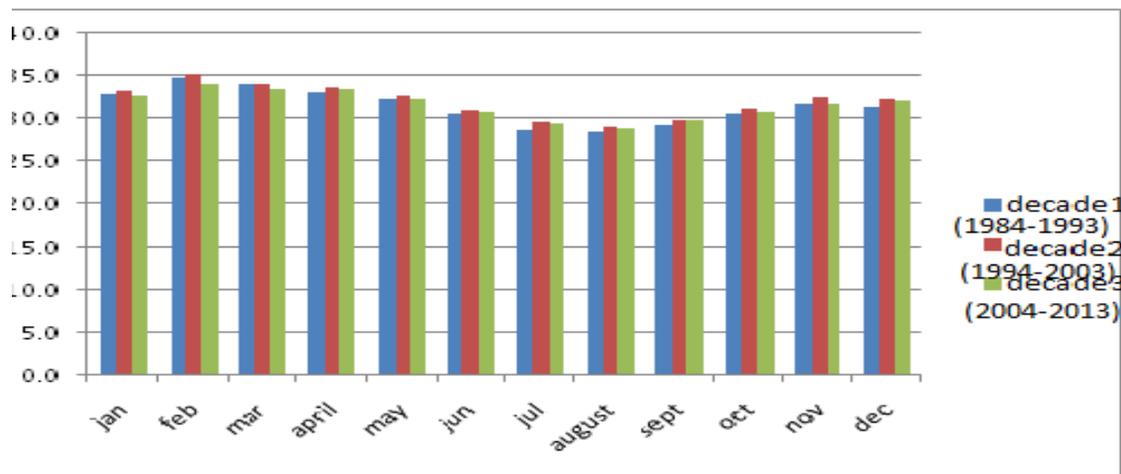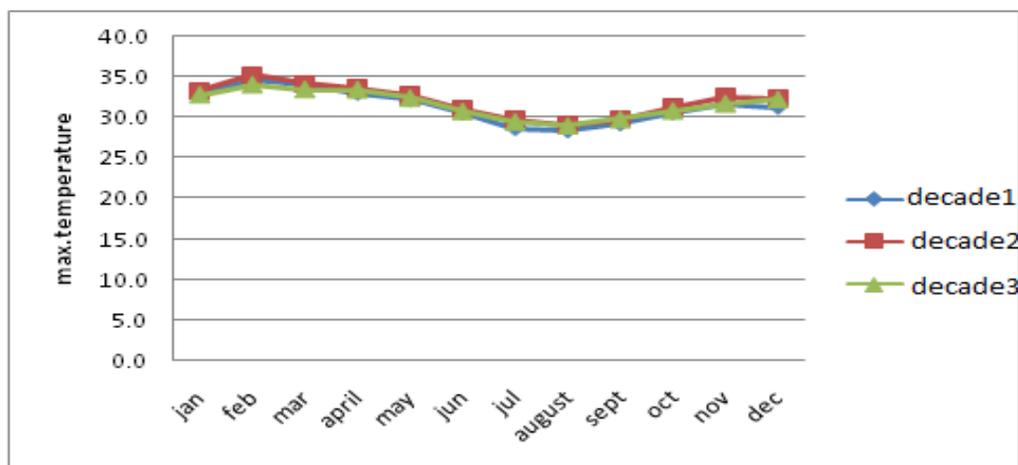

Figure 1 Maximum Temperature trend

Figure 2 Maximum Temperature trend

Minimum Temperature

Minimum temperature trends largely parallel maximum temperature patterns, showing overall warming across the 30-year period with similar decadal variations. Mean monthly minimum temperatures range from approximately 20°C during the coolest months (July-August) to 23-24°C during the warmest periods (March-April). The first to second decade transition showed clear warming of minimum temperatures (approximately 0.5-1.0°C), indicating reduced overnight cooling. This pattern is consistent with increased atmospheric moisture and greenhouse gas concentrations, which reduce radiative heat loss at night. The third decade maintains elevated minimum temperatures relative to the first decade, though with slight moderation compared to the second decade in some months. Warming of minimum temperatures often exceeds maximum temperature warming in global datasets, a pattern partially reflected in this local data. This asymmetric warming has significant implications for agriculture, as many crops require cool night temperatures during critical growth stages. Elevated nighttime temperatures can reduce yields in crops such as rice and maize by accelerating respiration rates and reducing net photosynthetic gain.
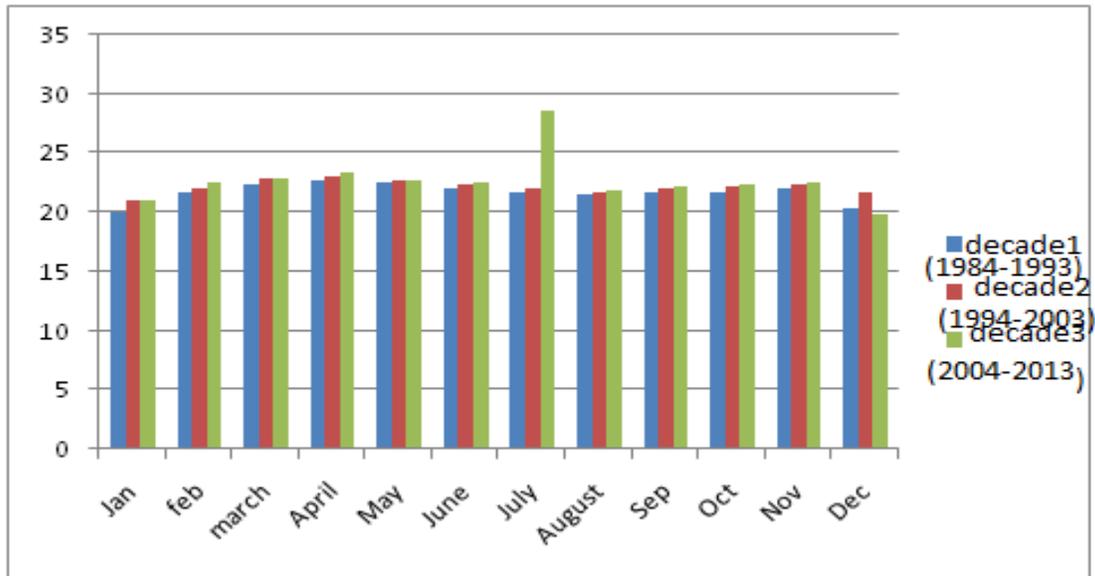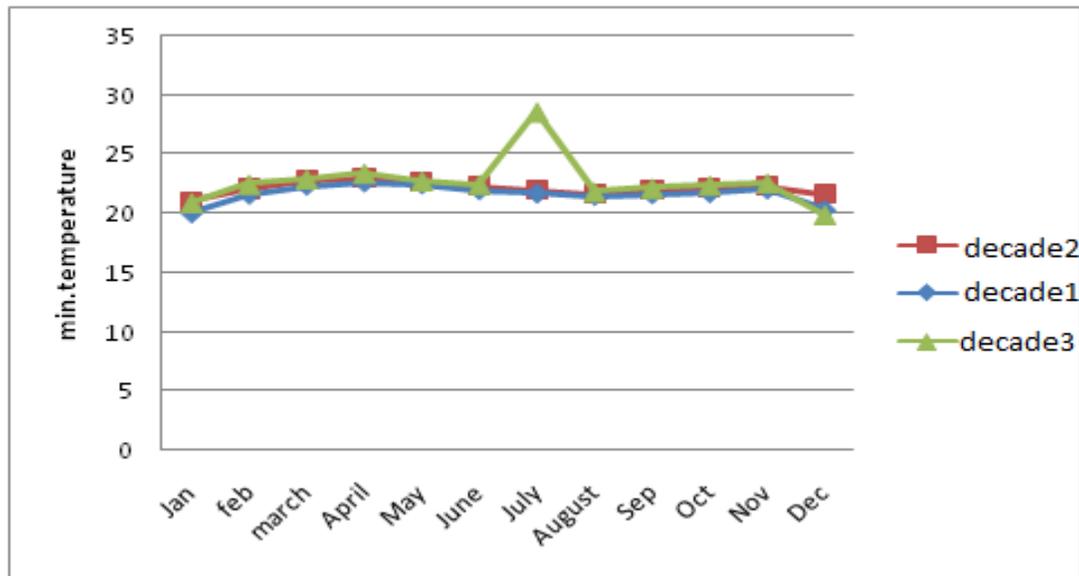

Figure 3 Minimum Temperature trend

Figure 4 Minimum Temperature trend

Rainfall Trends

Mean annual rainfall shows a notable declining trend from the first to second decade, with the first decade (1984-1993) experiencing the highest rainfall totals. The second decade (1994-2003) represents the driest period, with reduced precipitation across most months. The third decade (2004-2013) demonstrates partial recovery, with rainfall increasing compared to the second decade though not fully returning to first decade levels. Monthly analysis reveals that rainfall reductions were most pronounced during the major

rainy season (May-July), the period most critical for rain-fed agriculture. The minor rainy season (September-October) showed relatively less decline, suggesting differential impacts on the bimodal rainfall pattern. The substantial rainfall declines between the first and second decades (approximately 15-25% reduction in total annual rainfall) corresponds with regional drought patterns observed across West Africa during the 1990s and early 2000s. This period coincided with severe food security challenges across the Sahel and Guinea Savanna zones.
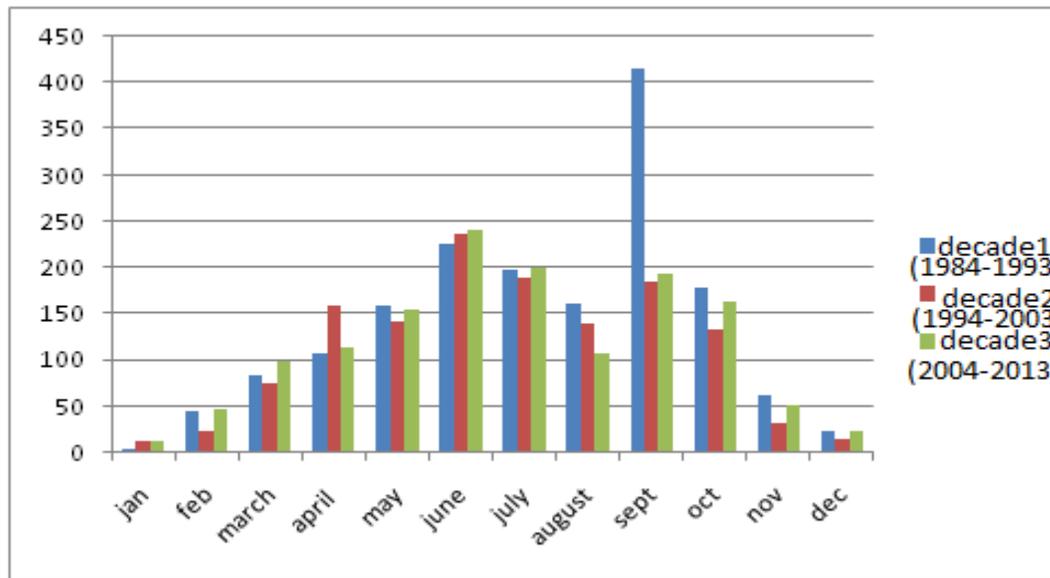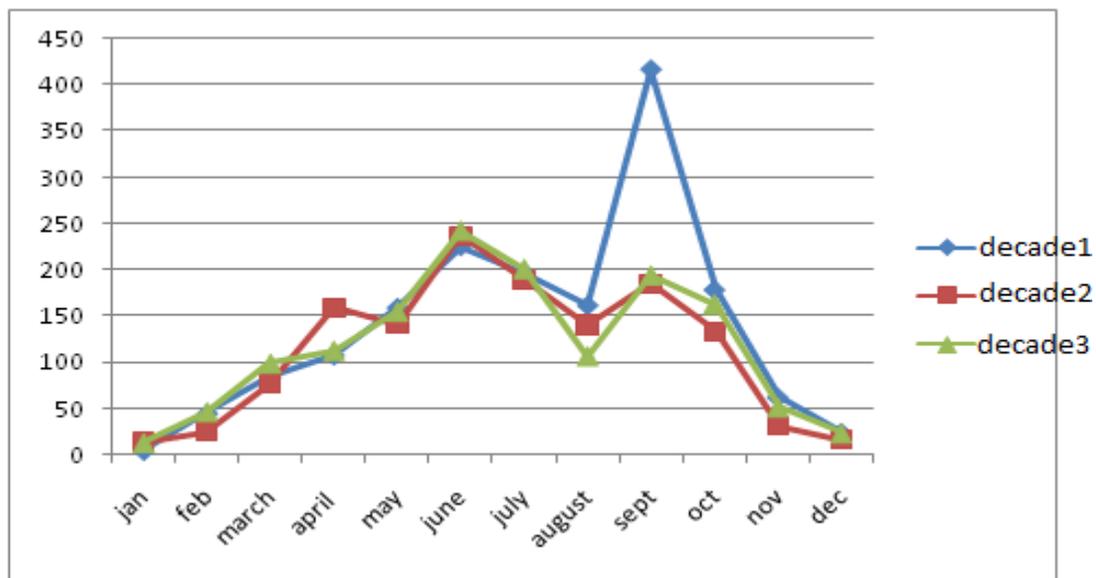

Figure 5 Annual Rainfall

Figure 6 Rainfall Trend in Decade

Recent Rainfall Recovery

The third decade's rainfall increase represents a positive trend from agricultural and water resource perspectives. Several factors may contribute to this recovery:

- Regional climate oscillations: West African rainfall exhibits multi-decadal variability linked to Atlantic and Pacific Ocean temperature patterns

- Forest conservation initiatives: Increased awareness and conservation efforts may enhance local moisture recycling through evapotranspiration

- Afforestation programs: Tree planting initiatives reported by community members could contribute to local rainfall enhancement

- Regional land use changes: Broader landscape modifications across the region may influence atmospheric moisture and circulation patterns

However, increased rainfall also presents challenges, including flooding, soil erosion, crop waterlogging, and increased disease pressure. Communities must develop adaptation strategies that address both drought and flood risks.

Community Perceptions of Climate Change

Demographic Characteristics

The survey sample (n =100) comprised 56% males (n=64) and 44% females (n=36), reflecting gender imbalances in household decision-making and potentially in survey participation. Future research should ensure more balanced gender representation to capture diverse climate perceptions and vulnerabilities. The observed gender skew likely reflects entrenched patriarchal structures within the study community, where males predominantly occupy positions of authority in household decision-making processes. This demographic pattern mirrors broader trends documented across rural agrarian societies in sub-Saharan Africa, where gender norms frequently relegate women to subordinate roles in formal consultative processes, despite their substantial contributions to agricultural production and climate adaptation strategies (Doss et al., 2018; Kristjanson et al., 2017). The underrepresentation of women in the sample presents a significant methodological limitation, as gendered experiences of climate change impacts, adaptive capacities, and vulnerability dimensions remain inadequately captured.

Climate Change Awareness

Virtually all respondents (98.5%) acknowledged that climate is changing, demonstrating widespread awareness of environmental change in the community. This high awareness level contrasts with some western populations where climate change scepticism remains significant, suggesting that populations directly experiencing climate impacts develop strong awareness regardless of formal climate education. *One responded said it used to rain from June to July each year when we were young but now it doesn't rain this time the weather keeps changing and it is causing a lot of problem*. Most respondents attributed climate change primarily to human activities rather than natural causes, demonstrating understanding of anthropogenic influence. Regarding temperature changes, 67.6% of respondents (combining "strongly agree" 13.2% and "agree" 54.4%) perceive increasing temperatures, while 28.9% disagree and 4.4% express uncertainty. This majority perception of warming aligns broadly with meteorological observations showing overall warming across the 30-year period, though the observational data show recent stabilization not captured in perceptions. Respondents attributing temperature increases cited multiple causal factors:

- Deforestation and forest clearing (most commonly cited)

- Farm expansion and agricultural extensification

- Bush burning for land clearing

- Urbanization and increased construction

- Reduced tree cover and shade

These causal explanations demonstrate sophisticated understanding of linkages between land use changes and local climate, recognizing that human activities affect temperature conditions. Farmers particularly emphasized how forest loss has reduced shade and increased heat in farming areas. The significant minority disagreeing with temperature increase (28.9%) may reflect several factors: temporal focus on recent years showing stabilization, spatial variation in temperature changes within the community, or different reference baselines for comparison. Some older respondents recalled specific hot years in the past, potentially perceiving no increase when comparing to these extreme years rather than average conditions.

When asked whether climate change results from human or natural causes, 63% attributed it primarily to human activities while 37% considered it natural. *One respondent said We are part of the problems regarding climate change in our environment, we keep on cutting a lot of trees and polluting our environment with car tyres which even affect our health*. This reveals substantial awareness of anthropogenic influence, though a significant minority views climate change as a natural phenomenon beyond human control.

Rainfall Perceptions

Rainfall perceptions show stronger consensus than temperature perceptions, with 94.2% of respondents (combining "strongly agree" 47.1% and "agree" 47.1%) perceiving decreased rainfall in recent years. Only 4.4% disagree and 1.5% strongly disagree. This strong perception of rainfall decrease aligns well with meteorological data showing rainfall recovery in the third decade (2004-2013) compared to the dry second decade (1994-2003*). One respondent said it doesn't rain off late and it is affecting our crop*. Respondents' perceptions likely reflect their experiences over the past 10-15 years, corresponding to the third decade when rainfall

increased compared to the previous decade. Respondents consistently expressed that a decrease in rainfall affects their farming activities by: Reducing sufficient moisture for crop growth and affecting multiple cropping cycles

The strong emphasis on afforestation as a driver of increased rainfall demonstrates community understanding of forest-rainfall relationships. Whether local afforestation actually drives rainfall increases remains scientifically uncertain, though forests do contribute to moisture recycling. Regardless of causation, this belief may motivate continued tree planting efforts, providing co-benefits even if rainfall attribution is oversimplified.

IV. Conclusion

Meteorological analysis revealed significant climate variability and change across the study period: Both maximum and minimum temperatures demonstrated overall warming trends across the 30-year period, with increases of approximately 0.8-1.2°C for maximum temperatures and 0.5-1.0°C for minimum temperatures between the first (1984-1993) and second (1994-2003) decades. However, the third decade (2004-2013) showed evidence of stabilization or slight cooling compared to the second decade, suggesting complex interactions between regional climate drivers and local factors.

Rainfall patterns showed marked variability, with a substantial decline from the first to second decade (approximately 15-25% reduction) followed by partial recovery in the third decade. This pattern reflects broader West African climate variability while also potentially indicating influences of local land use changes on precipitation. Systematic comparison between Nkawkaw (275m elevation) and Abetifi (601m elevation, 13.9 km distant) revealed differential climate trends. While both locations showed temperature increases, Nkawkaw experienced more pronounced warming, potentially reflecting greater urbanization and deforestation impacts.

Survey findings demonstrated widespread climate change awareness (98.5% acknowledging climate is changing) with a sophisticated understanding of human contributions to environmental change. Respondents identified deforestation, agricultural expansion, bush burning, and urbanization as primary drivers of environmental change, demonstrating recognition of linkages between human activities and climate conditions. Community perceptions aligned strongly with meteorological observations for rainfall (94.2% perceiving increases, matching observed third-decade recovery) but showed partial alignment for temperature (67.6% perceiving increases despite recent stabilization). This pattern reveals that communities develop accurate understandings of climate parameters directly affecting their livelihoods through daily environmental interaction, while longer-term or subtler trends may be less accurately perceived.

While climate change awareness is high, understanding of specific trends, future projections, and effective adaptations requires enhancement. Recommended interventions include: *Climate literacy programs:* Develop community-based education initiatives explaining climate change causes, manifestations, and adaptation strategies using accessible language and local examples. *Extension service enhancement*: Strengthen agricultural extension services providing technical support for climate adaptation, ensuring regular contact between extension agents and farming communities. Improving access to climate information enhances decision-making for agriculture and risk management: Develop and disseminate seasonal rainfall forecasts, helping farmers make informed decisions about planting timing, crop selection, and input investments. Ensure forecasts reach rural communities through radio, extension agents, and community meetings, with an explanation of probabilistic information

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