JOURNAL OF ENVIRONMENTAL SCIENCES AND BUILT ENVIRONMENT RESEARCH (JESBER)
2026, Vol. 1, No. 2, pp. 265–282
Published by Faculty of Environmental Sciences, University of Calabar, Nigeria
Print ISSN: 3141-5547 | OPEN ACCESS

Review article

COMMUNITY PERCEPTIONS OF FLOOD INCIDENCE AND PERCEIVED CLIMATE-CHANGE LINKAGES IN SELECTED FLOOD-PRONE LOCAL GOVERNMENT AREAS (LGAS) OF GOMBE STATE, NIGERIA

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ABSTRACT
Flooding has become a recurrent environmental hazard in Gombe State, Nigeria, with increasing concerns over its linkage to climate change and changing rainfall characteristics. This study assessed community perceptions of flood incidences and their climate change linkages in Gombe State. A four-stage multistage sampling design, incorporating systematic random sampling at the household level, was employed to select 384 household heads across the four selected LGAs for questionnaire administration. Of these, 340 questionnaires were returned and analysed, yielding a response rate of 88.5%. Data were analyzed using descriptive statistics, while Pearson's Product Moment Correlation (PPMC) was used to test the hypothesis at the 0.05 level of significance. The findings revealed that 67.7% of the respondents were aware of climate change, while 32.3% had no awareness. Regarding flood occurrence, 69.0% perceived that flood events had slightly increased compared with twenty years ago, 9.0% reported a great increase, 16.0% perceived a slight decrease, 6.0% reported a great decrease, and 4.0% indicated that flood frequency had remained unchanged. Furthermore, 41.2% of the respondents perceived that rainfall events had become much more intense over the past decade, 23.5% believed rainfall had become slightly more intense, 25.0% perceived rainfall intensity had reduced, 4.5% observed no noticeable change, while 5.9% were uncertain. Spearman's Rank Correlation analysis revealed a statistically significant positive relationship between residents' awareness of climate change and perceived flood frequency ($r = 0.482$, $p < 0.05$), leading to the rejection of the null hypothesis. The study concluded that there is a statistically significant association between residents' awareness of climate change and their perceived flood-frequency changes; however, the findings reflect community perceptions rather than proof of climatic causation. Therefore, the results should be generalised to similar communities with caution. It recommends strengthening climate change awareness programmes, expanding community-based early warning systems, improving urban drainage infrastructure, enforcing land-use planning regulations, and integrating local knowledge into flood risk management and climate adaptation strategies in the study area.

KEYWORDS
Climate change, community perception, rainfall intensity, flood risk, Gombe State.

Introduction

Flooding has evolved from an occasional environmental hazard into a recurring socio-economic and humanitarian challenge across many parts of northern Nigeria, including Gombe State. Although Gombe State lies within the Sudan Savannah ecological zone where seasonal rainfall is relatively short, recent years have witnessed increasing occurrences of flash floods resulting from intense rainfall events, poor urban drainage systems, rapid population growth, encroachment on floodplains, and changing climatic conditions. These floods have caused widespread destruction of residential buildings, public infrastructure, agricultural lands, water facilities, and livelihoods, thereby increasing the vulnerability of households and undermining sustainable development. The recurrence of these flood events suggests that existing mitigation and adaptation measures have been inadequate in addressing the increasing risks posed by changing rainfall characteristics and climate variability (IPCC, 2023; World Meteorological Organization [WMO], 2024).

Community perception of flood incidences provides insight into how residents interpret environmental changes based on lived experiences accumulated over time. Comparing present flood occurrences with those experienced approximately

two decades ago enables researchers to understand whether residents perceive floods as becoming more frequent, more severe, or more destructive. Such perceptions are particularly valuable because they often reflect long-term environmental observations that complement meteorological records, especially in areas with limited historical climate data (IPCC, 2023). In many Nigerian communities, residents increasingly report that floods now occur more frequently than they did twenty years ago, a perception often linked to heavier rainfall, poor drainage systems, uncontrolled urban expansion, deforestation, and blockage of natural waterways (Ayanlade et al., 2022; NiMet, 2024).

Awareness of climate change has also play a major role in the response to floods among local populations due to repeated exposure to extreme weather events, media campaigns, government sensitization programmes, and personal experiences with changing environmental conditions. Many residents now associate observed changes in annual rainfall with broader climate change processes, particularly increases in rainfall variability, unusual rainfall timing, and prolonged extreme weather conditions (NiMet, 2024). Although scientific understanding of climate change varies among individuals, local observations frequently correspond with meteorological evidence indicating increasing rainfall extremes across many parts of Nigeria (IPCC, 2023; WMO, 2024). This growing awareness enhances community willingness to participate in climate adaptation and disaster risk reduction initiatives.

These observations are consistent with scientific evidence showing that climate change is increasing rainfall variability and altering intra-seasonal rainfall distribution across West Africa (IPCC, 2023; WMO, 2024). Consequently, examining community perceptions of these flood incidences and it linkages with climatic change provides valuable information for understanding local experiences of climate variability, strengthening climate adaptation policies, and improving flood risk management strategies. This study sets out to examine community perception of floods incidences and its climate change linkages in Gombe State, Nigeria.

Statement of the Problem

The flood situation in Gombe State has become increasingly alarming. According to the International Organization for Migration (IOM) Displacement Tracking Matrix, between 4 and 9 September 2024 alone, floods affected 14,910 people in 1,741 households across 42 communities in eight local government areas of the state. The assessment further revealed that 2,994 persons were displaced, 22% of affected houses were completely destroyed, 20% were partially damaged, while 38% required major repairs. Additionally, approximately 1,499 farmlands were damaged, 2,874 sanitation facilities were affected, and several water supply facilities became non-functional, exposing affected communities to increased health and livelihood risks (IOM, 2024). These figures demonstrate that flooding is no longer an isolated environmental event but a significant developmental challenge with direct implications for food security, public health, poverty, and human well-being.

Geospatial assessments conducted within Gombe State further indicate that physical environmental characteristics continue to heighten flood susceptibility. Using Geographic Information Systems (GIS) and remote sensing techniques, Abdullahi et al. (2024) identified extensive flood-prone zones within Gombe Local Government Area, showing that low-lying areas between 330 and 380 metres above sea level, together with high stream density and poorly drained soils, significantly increase flood risk. Likewise, a flood vulnerability assessment in Billiri Local Government Area revealed that approximately 34.4% of the study area falls within the highly vulnerable flood risk zone, largely due to topography, drainage characteristics, land-use changes, and rainfall patterns (Abubakar et al., 2024). These findings indicate that substantial portions of Gombe State remain physically exposed to recurrent flooding even under moderate rainfall conditions.

Beyond the physical exposure, empirical studies have shown that human activities substantially aggravate flood occurrence within Gombe metropolis. Thlakma et al. (2022), in a household survey involving 250 respondents, found that 52% of residents identified heavy rainfall as the principal cause of flooding, while 24% attributed flooding to poor waste management and 15% linked it to inadequate urban planning and drainage infrastructure. These findings suggest that flood disasters in the state result from the interaction between climatic factors and anthropogenic pressures

Despite the growing body of scientific evidence linking increasing rainfall variability and extreme precipitation to climate change, there remains limited understanding of how local communities in Gombe State perceive these changes and whether they associate recurrent flooding with climate change. Government agencies such as the Nigerian Meteorological Agency (NiMet) and the National Emergency Management Agency (NEMA) have consistently issued seasonal flood forecasts and early warning advisories for flood-prone communities in Gombe State, yet flood losses continue to occur almost annually, suggesting a possible disconnect between scientific information, local risk perception, and community preparedness (NiMet, 2024; NEMA, 2024). Indeed, NEMA identified several local government areas in Gombe State as

being at risk of moderate flooding during the 2024 rainy season and consequently intensified community-based early warning campaigns.

Furthermore, although numerous studies in Nigeria have focused on flood hazard mapping, hydrological modelling, vulnerability assessment, and climate projections, relatively few have examined how residents themselves perceive changes in flood frequency, rainfall intensity, delayed rainfall onset, shortened or prolonged rainy seasons, cessation patterns, and dry spells, particularly within Gombe State (Abdullahi et al., 2024; Effiom, 2024a; Abubakar et al., 2024). Community perceptions are important because they influence risk awareness, behavioural responses, adaptation decisions, acceptance of early warning information, and participation in climate change mitigation and disaster risk reduction programmes. Where public perceptions differ substantially from scientific evidence, adaptation policies may experience low acceptance and limited effectiveness. Conversely, understanding local perceptions can enhance the design of community-centred climate adaptation interventions that reflect local experiences and indigenous environmental knowledge. It is against this background that this study investigates community perceptions of flood incidences and their climate change linkages in Gombe State.

Research Questions

The study was guided by the following research questions:

i. What are the socioeconomic characteristics of respondents in flood-prone LGAs of Gombe State?
ii. How do communities perceive the characteristics and impacts of flood events in the study area?
iii. What is the level of awareness among residents regarding climate change and changes in annual rainfall patterns in recent years in the study area?
iv. How do residents perceive changes in rainfall intensity and extreme rainfall events over time in the study area?
v. What relationship exists between perceived rainfall intensity and flood occurrence in the study area?

Objectives of the Study

The specific objectives are to:

i. examine the socioeconomic characteristics of respondents in the study area.
ii. assess community perceptions of flood characteristics and their impacts.
iii. determine the level of awareness regarding climate change and perceived changes in annual rainfall patterns in recent years.
iv. examine community perceptions of changes in rainfall intensity and frequency of extreme rainfall events.
v. assess the relationship between perceived rainfall intensity and flood occurrence in the study area.

Materials and Methods

Study Area

The research was carried out in Gombe State, located in northeastern Nigeria between latitudes 9°30′ and 12°30′ N and longitudes 8°05′ and 11°45′ E. The state occupies a land area of about 20,265 km² (Figure 1) and shares borders with Borno, Yobe, Adamawa, Taraba, and Bauchi States. Gombe has a tropical climate characterized by two distinct seasons: a rainy season that extends from May to October and a dry season from November to April. Average annual temperatures generally range between 26°C and 30°C, with the hottest months typically being March and April (Odekunle, 2004). The state is situated within the Gongola River basin, where seasonal rainfall and an extensive river network frequently contribute to flooding across many communities (Adeoye, 2018; Effiom, 2026b). Owing to these climatic and hydrological conditions, Gombe State provides an appropriate setting for examining community perceptions of climate variability and flood-related risks.

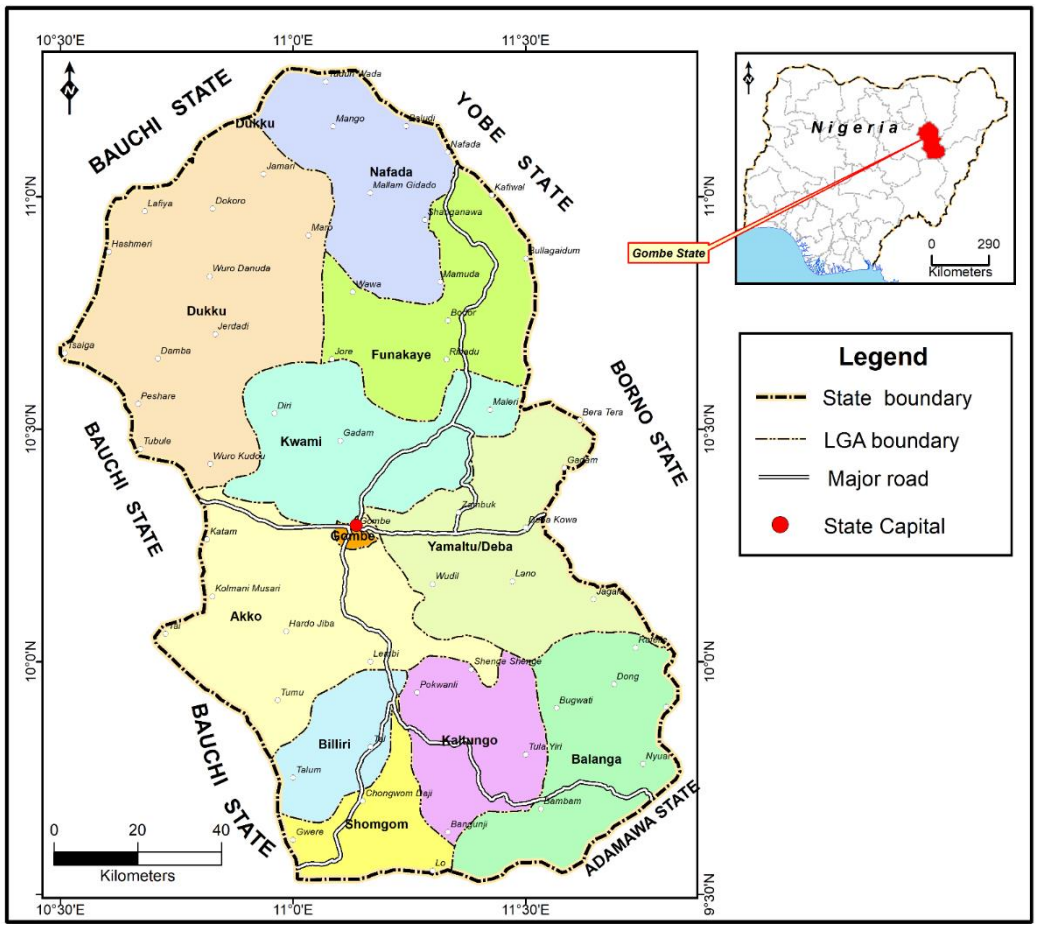

Figure 1. Gombe State – Study Area

Source: Gombe State Ministry of Lands and Urban Development, 2025

Agriculture remains the primary source of livelihood for most residents of Gombe State, with the majority of households relying on crop farming and livestock rearing for their income and sustenance (Yakubu et al., 2019; Aliyu et al., 2020; Adesiji et al., 2013). Because agricultural production is largely dependent on rainfall, households are particularly susceptible to the effects of climate variability and flooding. The state's population is mainly distributed across rural communities, where farming is the dominant economic activity, whereas urban areas are characterized by more concentrated settlement patterns (Adewuyi, 2018). These socioeconomic conditions guided the selection of households for the study and provide an essential basis for understanding local perceptions of climate variability and its associated flood impacts.

Methods

A four-stage multistage sampling approach was employed to select respondents from flood-affected and flood-prone communities across Gombe State. In the first stage, the eleven Local Government Areas (LGAs) in the state were grouped based on their levels of flood vulnerability using information obtained from the Gombe State Emergency Management Agency (SEMA). The LGAs were subsequently categorized into high-, medium-, and low-flood-risk groups to reflect differences in exposure to flood hazards across the state. During the second stage, four LGAs such as Gombe, Yamaltu/Deba, Billiri, and Nafada were purposively chosen due to their history of repeated flood occurrences and their classification as high-risk areas by SEMA. This selection strategy enabled the study to focus on communities with direct and substantial experiences of flooding. Therefore, the findings are interpreted within the context of perceptions among residents of these high-risk LGAs. The third stage involved identifying flood-prone communities within the selected LGAs for inclusion in the study (insert names of sampled communities). With the support of community leaders, a household register was developed and used as the sampling frame. Households were then selected through a systematic random sampling procedure. A starting household was randomly chosen in each community, followed by the selection of every third household until the desired sample size was achieved. In situations where a selected household was unavailable, lacked an eligible respondent, or declined participation, the next suitable household was selected while maintaining the established sampling interval.

In the final stage, one respondent was selected from each sampled household. Eligible participants included household heads or adult household members aged 18 years and above who had lived continuously in the community for a minimum of five years. This criterion ensured that respondents possessed adequate knowledge of local climatic conditions and previous flood experiences. Where multiple eligible adults were available within a household, the household head was prioritized for interview; however, in cases where the household head was unavailable, another informed adult member was selected.

Krejcie and Morgan (1970) formula was used to determine the sample size from the population of the four LGAs, thus:

$$S = \frac{X^2 \,.\, N.\, P.\, (1\text{-}P)}{d^2.\, (N-1) + X^2.\, P.\, (1-P)}$$

Where:

S = required sample size

X^2 = table value of chi-square for 1 degree of freedom at confidence level (3.841 for 95%)

N = Population size

P = Population proportion (assumed to be 0.5 for maximum sample size)

d = degree of accuracy expressed as a proportion (0.05)

Using the combined population size of the four selected LGAs (1,449,100 persons), a minimum sample size of 384 respondents was determined. Population figures were adopted as the basis for proportional sample allocation because up-to-date and reliable household population data for the selected communities were not available. However, official population estimates existed for all LGAs and provided a uniform and consistent reference for distributing the sample across the study areas (Creswell & Creswell, 2018; Israel, 1992). Based on this approach, 384 questionnaires were proportionally allocated and administered across the four selected LGAs (Table 1). Of these, 340 properly completed questionnaires were retrieved and used for analysis, resulting in an overall response rate of 88.5%. The distribution of completed questionnaires across the LGAs is presented in Table 1.

Table 1. Proportional Distribution of Sample Size

LGA	Population	Questionnaires Administered	Questionnaires Returned
Gombe	446,800	118	104
Yamaltu/Deba	428,200	114	101
Billiri	339,400	90	80
Nafada	234,700	62	55
Total	1,449,100	384	340

Data were collected through a structured questionnaire designed to examine respondents' perceptions of flood characteristics, their level of awareness regarding climate change, changes in rainfall patterns, and the effects of flooding within the study area. The questionnaire included both closed-ended and open-ended questions and was divided into sections that corresponded with the specific objectives of the study. Some perception-based questions were measured using a five-point Likert scale, ranging from strongly disagree to strongly agree. This method is widely applied in social science research for assessing attitudes, perceptions, and personal experiences (Creswell & Creswell, 2018). Additional categorical questions were used to collect information on respondents' demographic and socioeconomic backgrounds.

Prior to the main survey, a pilot study was carried out with 30 respondents in Herwagana community, Gombe City. The community was selected due to its vulnerability to flooding and its similarity to the study areas in terms of environmental conditions and socioeconomic characteristics. The purpose of the pilot exercise was to assess the clarity, relevance, and overall completeness of the questionnaire, as well as to identify any unclear or ambiguous questions that needed modification before the final survey. Pilot testing is an important stage in survey research because it helps improve the quality and reliability of research instruments by revealing potential weaknesses before large-scale data collection (Kothari, 2004; Saunders et al., 2019).

The content validity of the questionnaire was assessed through expert evaluation by the researcher's supervisor and the Director of the Gombe State Ministry of Environment, Gombe. Their feedback was used to determine whether the questionnaire items sufficiently captured the study objectives and accurately reflected the major concepts being investigated (Polit & Beck, 2006).

The reliability of the questionnaire was tested using Cronbach's alpha, which yielded a coefficient value of 0.62. Cronbach's alpha is a commonly used statistical measure for assessing the internal consistency of multiple-item scales

(Cronbach, 1951). Although the reliability coefficient did not indicate a very high level of consistency, it was considered acceptable for an exploratory study focusing on community perceptions and environmental experiences (Tavakol & Dennick, 2011). Following the pilot test, necessary adjustments were made to improve the wording, sequence, and clarity of the questionnaire items before the final data collection exercise.

The questionnaire was initially prepared in English and translated into Hausa and Fulfulde where necessary to enhance respondents' understanding and participation. To minimize translation errors and maintain consistency of meaning, the translated versions were back-translated into English and compared with the original instrument before field deployment. Back-translation is a commonly recommended procedure in cross-language survey research to ensure conceptual equivalence between the original and translated versions of research instruments (Brislin, 1970; Sousa & Rojjanasrirat, 2011).

The study relied on respondents' assessments of changes in flood conditions over an approximate 20-year period; therefore, the findings may be influenced by recall limitations. This issue is particularly important among younger participants, including those within the 20–30-year age group, who may have drawn on both personal experiences and shared memories from households or communities when describing long-term environmental changes. Accordingly, the results should be understood as reflecting community perceptions of climate variability and flood trends rather than as direct measurements of climatic change or evidence of causal relationships.

Ethical considerations were maintained throughout the entire data collection process. Before participating in the survey, respondents were informed about the purpose of the research, the voluntary nature of their involvement, the type of information required, and their right to refuse participation or withdraw at any point without any consequences. Participants were assured that all information provided would remain confidential and would only be used for academic purposes. Informed consent was obtained from all respondents before the administration of the questionnaire, either verbally or in writing. No identifying personal information was collected, and completed questionnaires were securely stored to safeguard respondents' privacy. These procedures are consistent with established ethical standards for research involving human participants, particularly the principles of autonomy, informed consent, and confidentiality (World Medical Association, 2013).

Before the commencement of fieldwork, research assistants received training to ensure consistency and accuracy during data collection. The training covered the objectives of the study, ethical responsibilities, interpretation of questionnaire items, interview procedures, and the appropriate use of response scales. Data were collected through face-to-face interviews, allowing respondents to seek clarification where necessary and helping to reduce misunderstandings and inconsistencies during the interview process (Creswell & Creswell, 2018).

A purposive sampling approach was used to select key informants with relevant knowledge of flooding, environmental management, and flood-risk issues in Gombe State. The interviewed categories included community leaders/traditional representatives, officials from the Gombe State Ministry of Environment, technical officers from the Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) project, and other relevant stakeholders involved in flood management and environmental planning.

A semi-structured interview guide was developed based on the study objectives and covered issues related to changes in flood frequency, causes of flooding, drainage challenges, urban development pressures, and adaptation responses. Interviews were conducted face-to-face, with informed consent obtained before participation and audio recording. The interviews were transcribed verbatim and translated where necessary while maintaining the original meaning of responses.

The qualitative data were analysed through thematic coding. Emerging themes related to flood trends, environmental changes, drainage problems, and institutional responses were identified and compared with survey findings. The quotations presented in the findings section were selected from recurring themes identified during the interview analysis and were used to complement and explain the quantitative results.

All completed questionnaires were checked daily to ensure accuracy and completeness. During the data analysis stage, missing responses were managed using listwise deletion, where questionnaires containing missing data for variables required in particular statistical analyses were excluded from those specific analyses (Hair et al., 2019).

The data collected from the field was analysed using a combination of descriptive and inferential statistical techniques. Descriptive statistics such as frequency, simple percentages, charts, graphs and tables were used to summarize and present the data. This study used Spearman's rank-order correlation coefficient (Spearman's rho, r_s) to assess the strength and direction of the relationship between residents' awareness of climate change occurrence and their perceived changes in flood frequency. Spearman's rho was considered appropriate because the variables did not satisfy the assumptions required for Pearson's Product Moment Correlation. In this study, climate-change awareness was measured as a binary variable, coded as aware (1) and not aware (0), while perceived changes in flood frequency were measured using an ordinal scale based on respondents' reported experiences and perceptions. Therefore, a non-parametric correlation technique was applied because it is suitable for analysing ordinal data and does not require the assumption of normally distributed continuous variables. The formula is typically stated as:

$$r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

Where:

r_s = Spearman's rank-order correlation coefficient

Σd^2 = the sum of the squared differences between the ranks of the two variables

d = the difference between the paired ranks of each observation

n = the total number of paired observations (sample size)

In this study, r_s represents the strength and direction of the association between residents' awareness of climate change and their perceived frequency of flood incidences. The value of r_s ranges from −1 to +1:

+1 indicates a perfect positive association,

−1 indicates a perfect negative association, and

0 indicates no association between the variables.

The level of significance for the analysis was set at $\alpha = 0.05$. Before conducting the test, relevant assumptions were considered, including the independence of observations, correct coding of the binary awareness variable, and the ordinal nature of the perceived flood-frequency measure.

Results and Discussion

Socioeconomic Characteristics of Respondents

The results in figure 2 show that 153 respondents (45%) were within the 20-30-year age group, 108 (32%) were between 31 and 40 years, 39 (11%) were aged 41–50 years, 30 (9%) were between 51 and 60 years, and 10 (3%) were 61 years or older (Figure 4.2). This indicates that the majority of respondents were relatively young adults. Younger individuals are generally more active in economic activities such as farming, trading, and transportation, which may expose them directly to flood impacts. They may also be more aware of climate change issues through education, media, and social networks. However, older respondents often possess valuable historical knowledge of environmental changes and long-term flood patterns. Studies such as Smit & Wandel (2006) emphasize that older community members can provide insights into historical climate variability and local adaptation practices. The relatively smaller proportion of elderly respondents in this study may therefore limit the depth of historical perspectives on flood trends in Gombe State.

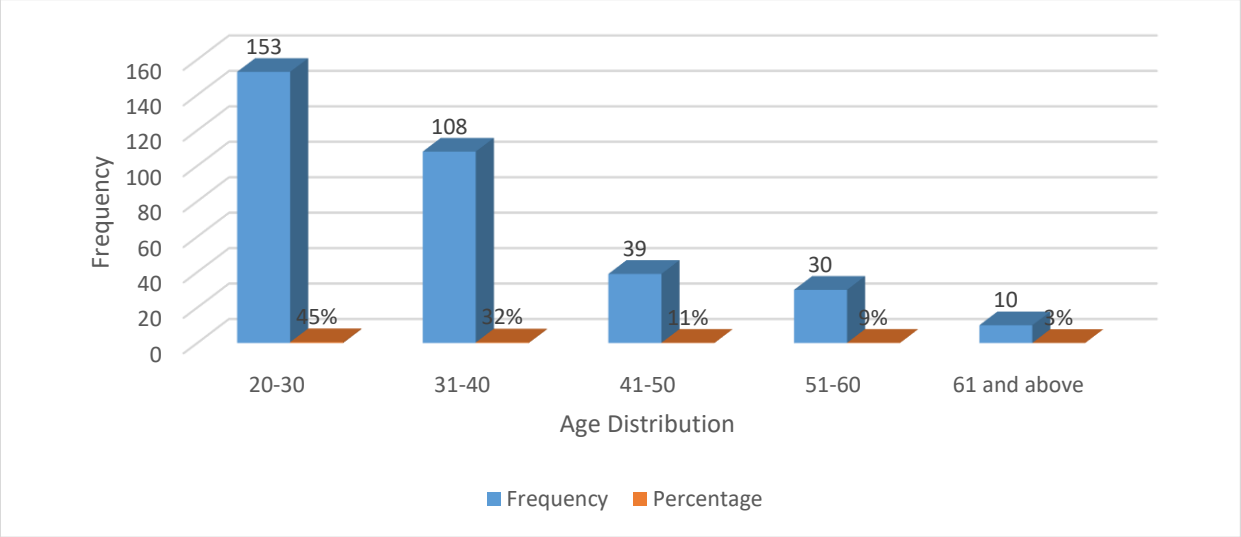

Figure 2. Distribution of Respondents by Age

Source: Field Survey, 2025

The results of the analysis in Table 2 reveals that a substantial proportion of the respondents fall within the lower income group. Among the 340 respondents surveyed, 124 respondents (36.5%) indicated that they earned less than ₦30,000 per month, while another 124 respondents (36.5%) reported a monthly income ranging from ₦31,000 to ₦50,000. Together, these two income categories represent 73.0% of the total respondents, suggesting that most households in the study area have relatively low levels of income.

A total of 70 respondents (20.6%) reported earning between ₦51,000 and ₦70,000 per month. However, participation declined considerably among the higher-income categories, with only 16 respondents (4.7%) earning between ₦71,000 and ₦90,000, and just 6 respondents (1.8%) reporting monthly earnings above ₦90,000. This distribution indicates that respondents were largely concentrated within the lower- and middle-income groups, with very few households represented among the higher-income categories.

Table 2. Distribution of Respondents according to Income

Income	Frequency	Percentage (%)
< ₦30,000	124	34.0
₦31,000–₦50,000	124	34.0
₦51,000–₦70,000	70	24.3
₦71,000–₦90,000	16	5.6
> ₦90,000	6	2.1
Total	340	100.0

Source: Field Survey, 2025

The most common income categories were those earning below ₦30,000 and those earning between ₦31,000 and ₦50,000, with each accounting for 36.5% of the sample. Since nearly three-quarters of respondents fall within these two groups, the findings indicate that the average household in the study area operates with limited financial resources. The median income category was also ₦31,000–₦50,000, implying that at least half of the respondents earned within or below this income range. The dominance of low-income households among the respondents has significant implications for flood vulnerability and the ability of communities to adapt to flood risks in Gombe State. Households with limited financial resources may face challenges in adopting protective measures, such as improving the quality of housing structures, investing in drainage improvements, purchasing insurance, or relocating to less flood-prone areas. Consequently, the findings highlight the important role of economic status in shaping households' capacity to prepare for, respond to, and recover from flood events.

Community Perception of Floods Characteristics

Perceived Frequency of Flood Events compared to 20 years ago

Table 3 presents respondents' perceptions of how the frequency of flood events in Gombe State has changed compared to 20 years ago. The results reveal that 31 respondents (9%) believe the frequency has greatly increased, while 224 respondents (69%) think it has slightly increased. Ten respondents (3%) reported no change, whereas 55 respondents (16%) and 20 respondents (6%) indicated that the frequency has slightly or greatly decreased, respectively. Interviews with key informants supported the perception that flood events have become more frequent in recent years. A community leader in Gombe Metropolis stated that flooding has increased compared to previous decades due to rapid urban development and inadequate drainage systems (Yerima of Gombbe Interview 2025). Similarly, an official from the Ministry of Environment observed that rainfall events have become more intense and concentrated, resulting in more frequent flood occurrences across the state. "Many of the drainage channels originally designed to convey storm water are now blocked by waste and unplanned structures, increasing the frequency of urban flooding" (Chief Engineer ACReSAL, Interview 2025).

Table 3. Distribution of Respondents by Perceived Frequency of Flood Events Compared to 20 Years Ago

Response option	No. of respondents	Percentage (%)
Greatly increased	31	9.1
Slightly increased	224	65.9
Remained about the same	10	2.9
Slightly decreased	55	16.2

Response option	No. of respondents	Percentage (%)
Greatly decreased	20	5.9
Total	340	100.0

Source: Field Survey, 2025

Perception of Seasonal Pattern of Flooding in Recent Years

Table 4 presents respondents' perceptions of the seasonal pattern of flooding in recent years in Gombe State based on responses from 340 participants. The results show that the majority of respondents, 52.9%, indicated that flooding occurs throughout the rainy season without a clear pattern. This represents more than half of the sample population, suggesting that flooding is widely perceived as increasingly irregular and prolonged. Furthermore, 22.1% of respondents reported that flooding occurs earlier in the year than before, indicating a noticeable shift in the timing of flood events. In contrast, only 2.9% believed that flooding occurs later in the year, making it the least reported perception.

Table 4. Distribution of Respondents by Perception of the Seasonal Pattern of Flooding in Recent Years

Options	No. of Respondents	Percentage (%)
Flooding occurs earlier in the year than before	75	22.1
Flooding occurs later in the year than before	180	52.9
Flooding occurs throughout the rainy season without a clear pattern	10	2.9
No noticeable change in seasonal pattern	40	11.8
Unpredictable and erratic	35	10.3
Total	340	100

Source: Field Survey, 2025

Additionally, 10.3% of respondents described flooding as unpredictable and erratic, while 11.8% reported no noticeable change in the seasonal pattern. When responses indicating change (earlier flooding, flooding throughout the rainy season, later flooding, and unpredictable flooding) are combined, they account for 88.2% of the total responses, suggesting a strong statistical perception that flood patterns have changed. These findings are consistent with studies in Bangladesh and Ghana by Ahmed & Mirza, (2000) and Douglas et al., (2008) where communities similarly reported increasing variability and unpredictability in flood timing due to changing rainfall patterns associated with climate change. Table 5 shows respondents' views on the changes observed in seasonal flooding patterns over recent years. Among the 340 respondents surveyed, 70 individuals (20.6%) agreed, while 190 respondents (55.8%) strongly agreed that seasonal flooding patterns have changed or become more severe in recent years. This reflects a considerable level of agreement among respondents, suggesting that many people perceive an increase in the occurrence or intensity of seasonal flooding. In contrast, 8 respondents (2.4%) expressed a neutral opinion, while 50 respondents (14.7%) disagreed and 22 respondents (6.5%) strongly disagreed with the statement. Overall, the combined percentage of respondents who agreed and strongly agreed was 76.5%, indicating a broad recognition that seasonal flooding patterns have intensified in recent years. The findings highlight a strong level of public awareness regarding changes in flood behaviour and suggest that respondents associate these changes with possible climate-related influences affecting flood occurrence within the study area.

Table 5. Distribution of Respondents by Perception of the Seasonal Pattern of Flooding in Recent Years

Options	No. of Respondents	Percentage (%)
Agree	70	20.5
Strongly Agree	190	55.8
Neutral	8	2.4
Disagree	50	14.8
Strongly Disagree	22	6.5
Total	340	100

Source: Field Survey, 2025

Reason for Perceived Increase in Flood Incidents

Table 6 shows that 45.0% of respondents perceive urban expansion without proper drainage and poor land-use practices as the main reason for increased floods. 29.5% (n = 100) attributed it to increased rainfall intensity, while 11.7% cited a combination of factors. Deforestation (8.8%, n = 30) and river overflow (3.5%) were less commonly perceived causes. This result implies that anthropogenic factors (urbanization, land use, deforestation) account for 65.5% of responses, exceeding natural causes (rainfall, river overflow, 33%). This aligns with findings in Bangladesh and India by World Bank, (2019); IPCC, (2021) where urban growth and poor planning drive flood risk, and in the UK, where extreme rainfall interacts with urbanization to increase flooding.

Interview with key informants largely attributed the increase in flood incidents to rapid urban expansion, blockage of drainage channels, and poor land-use planning. An urban planner noted that many residential developments have encroached on natural drainage routes and floodplains, thereby increasing flood vulnerability. Environmental officers also emphasized that poor waste disposal practices contribute significantly to drainage blockage and urban flooding.

Table 6. Distribution of Respondents by Reason for the Perceived Increase in Flood Incidents

Options	No. of Respondents	Percentage (%)
Increased rainfall intensity	100	29.5
Urban expansion without proper drainage and Poor land-use practices	158 12	45 3.5
Deforestation	30	.2
Combination of several factors	40	11.7
Total	340	100

Source: Field Survey, 2025

Awareness of Existence of Climate Change and Annual Rainfall Change in Recent Years

The finding in Table 7, which shows that 230 respondents (67.7%) were aware of the existence of climate change while 110 respondents (32.3%) were not aware, indicates a relatively high level of climate change awareness among residents of the study area. This suggests that climate change has become a recognised environmental issue among many households in Gombe State, possibly due to increased exposure to climate-related events such as flooding, irregular rainfall patterns, and changing weather conditions. The findings also correspond with evidence from Turkey, where Anılan et al. (2024) reported that flood-prone communities showed considerable awareness of flood risks and the importance of incorporating public perceptions into disaster risk management. Their study emphasised that communities experiencing recurrent flooding are more likely to develop stronger perceptions of environmental risks because repeated exposure increases their understanding of hazards and their potential consequences. This supports the argument that the relatively high climate change awareness recorded in Gombe State may be partly associated with residents' experiences of recurring flood events.

Table 7. Distribution of Respondents According to Awareness of the Existence of Climate Change in Gombe State

Response option	No. of respondents	Percentage (%)
Yes	230	67.7
No	110	32.3
Total	340	100.0

Source: Field Survey, 2025

Regarding annual rainfall trends in Table 8, 35.4% reported a significant increase, 27.9% a slight increase, 25% a slight decrease, 5.8% no change, and 5.8% a significant decrease. This result implies that 63.3% of respondents perceived an increase in rainfall, indicating that a majority recognize changes consistent with climate change. The finding that many respondents observed an increase in rainfall suggests that they are aware of changes in climatic conditions occurring in their environment.

Table 8. Distribution of Respondents According to Perceived Changes in Annual Rainfall Patterns in Gombe State in Recent Years

Response option	No. of respondents	Percentage (%)
Significantly increased	120	35.3
Slightly increased	95	27.9
Remained about the same	20	5.9
Slightly decreased	85	25.0
Significantly decreased	20	5.9
Total	340	100.0

This perception is consistent with scientific reports of the IPCC, (2021) and UNDRR, (2020), which indicated that climate change is increasing rainfall intensity and variability in many regions of the world. Similar perceptions have been reported in studies conducted in India and Kenya, where local communities observed heavier rainfall events, more unpredictable rainfall patterns, and increased flooding. Therefore, the respondents' observations in Gombe State reflect a growing awareness of climate change and its effects on local rainfall characteristics. This is where climate change awareness is linked to perceived changes in local rainfall, such as in India and Kenya, where increasing rainfall intensity and variability are reported in surveys. Interviews revealed that most stakeholders Gombe State were aware of changing climatic conditions. According to officials from the Ministry of Environment, rainfall patterns have become increasingly unpredictable, with heavier rainfall occurring within shorter periods. Community leaders also reported noticeable changes in seasonal rainfall distribution compared to previous decades. "Residents are increasingly aware that rainfall patterns have changed compared to twenty years ago, but awareness alone is not enough without adequate preparedness measures" (Director of Information Gombe State Ministry of Environment, Key Informant Interview, 2025).

This analysis used Spearman's rank-order correlation coefficient (Spearman's rho, r_s) to assess the strength and direction of the relationship between residents' awareness of climate change occurrence and their perceptions of changes in flood frequency. Spearman's rho was considered suitable because the data did not satisfy the assumptions required for Pearson's Product Moment Correlation. Climate-change awareness was represented as a binary variable, where respondents were classified as either aware (1) or not aware (0), while perceived changes in flood frequency were measured using an ordinal scale based on participants' reported views. Therefore, a non-parametric correlation method was applied because it is appropriate for analysing ordinal data and variables that do not require normally distributed continuous measurements.

The analysis was conducted at a 5% level of significance ($\alpha = 0.05$). The assumptions underlying the test included the independence of observations, correct classification and coding of the climate-change awareness variable, and the ordinal measurement of perceived flood-frequency changes. To examine the research hypothesis, Spearman's rank-order correlation analysis was performed. The findings presented in Table 9 showed a moderate positive and statistically significant relationship between residents' awareness of climate change occurrence and their perception of flood frequency changes in Gombe State ($r_s = .482$, $p < .001$, $N = 340$, 95% CI [insert confidence interval]). The positive correlation coefficient suggests that respondents who were aware of climate change were more likely to perceive an increase in flood occurrences compared with twenty years earlier. In contrast, individuals with lower levels of climate-change awareness were less likely to report that flood frequency had increased.

The result demonstrates an association between climate-change awareness and perceived changes in flood frequency; however, it does not imply that awareness of climate change directly causes changes in flood perceptions. The coefficient of determination ($r^2 = 0.232$) indicates the extent of shared variation between the two variables and should not be interpreted as the proportion of flood-frequency perceptions caused by climate-change awareness. Other influencing factors, including previous flood experiences, location within flood-prone areas, environmental conditions, drainage systems, land-use activities, educational attainment, and access to climate-related information, may also shape residents' perceptions. Because the probability value was below the 0.05 significance threshold ($p < .001$), the null hypothesis was rejected. The study therefore concludes that a statistically significant relationship exists between residents' awareness of climate change occurrence and their perceived frequency of flood incidences in Gombe State.

The result is consistent with studies that have shown that individuals with higher levels of climate change awareness are generally more likely to recognize increases in extreme weather events, including flooding, and are more willing to support adaptation and disaster risk reduction measures (Intergovernmental Panel on Climate Change [IPCC], 2023; Nigerian Meteorological Agency [NiMet], 2024; World Meteorological Organization [WMO], 2024).

Table 9. Spearman's Rank-Order Correlation between Residents' Awareness of Climate Change and Perceived Frequency of Flood Incidences

Variables	Awareness of Climate Change	Perceived Frequency of Flood Incidences
Awareness of Climate Change	1	.482**
Perceived Frequency of Flood Incidences	.482**	1
N	340	340
Sig. (2-tailed)	< .001	< .001

Correlation is significant at the 0.01 level (2-tailed).

Perceived Changes in the Intensity of Rainfall Events

Changes in the Intensity of Rainfall Events over the Past Decade

Table 10 shows that 41.2% of respondents perceived rainfall events as much more intense over the past decade, while 23.5% reported they have become slightly more intense. Only 4.5% observed no noticeable change, 25% felt rainfall is less intense, and 5.9% were uncertain. Statistically, 64.7% of respondents perceived an increase in rainfall intensity, suggesting a majority recognize a trend toward heavier precipitation. This aligns with observations in other developing countries like Bangladesh, India, and Kenya, where urban areas are experiencing more frequent and intense downpours, increasing flood risk (IPCC, 2021; UNDRR, 2020). The results indicate that both climate change awareness and perceived rainfall intensification are consistent with global patterns of extreme precipitation, highlighting the need for adaptive flood management strategies.

Table 10. Distribution of Respondents by Changes in the Intensity of Rainfall Events over the Past Decade

Options	No. of Respondents	Percentage (%)
Rainfall events have become much more intense	140	41.2
Rainfall events have become slightly more intense	80	23.5
No noticeable change in rainfall intensity	15	4.5
Rainfall events have become less intense	85	25
Don't know	20	5.9
Total	340	100

Source: Field Survey, 2025

Perceived Changes in Number of Months Rainy Season Last each Year

The result of Figure 3 shows that 52.9% of respondents perceived the rainy season as slightly longer, and 11.9% as much longer, while 8.8% reported it has become much shorter, 20.5% slightly shorter, and 5.9% observed no significant changes. Overall, 64.8% of respondents perceived an extension in rainy season duration, indicating a trend toward prolonged rainfall periods. Similar perceptions were reported in developing countries like Kenya, India, and Bangladesh, where climate change has altered seasonal patterns, increasing both rainfall duration and intensity, which exacerbates flood risks (IPCC, 2021; UNDRR, 2020). These findings suggest that residents in Gombe State are aware of changes in rainfall patterns, mirroring global trends in climate-affected regions.

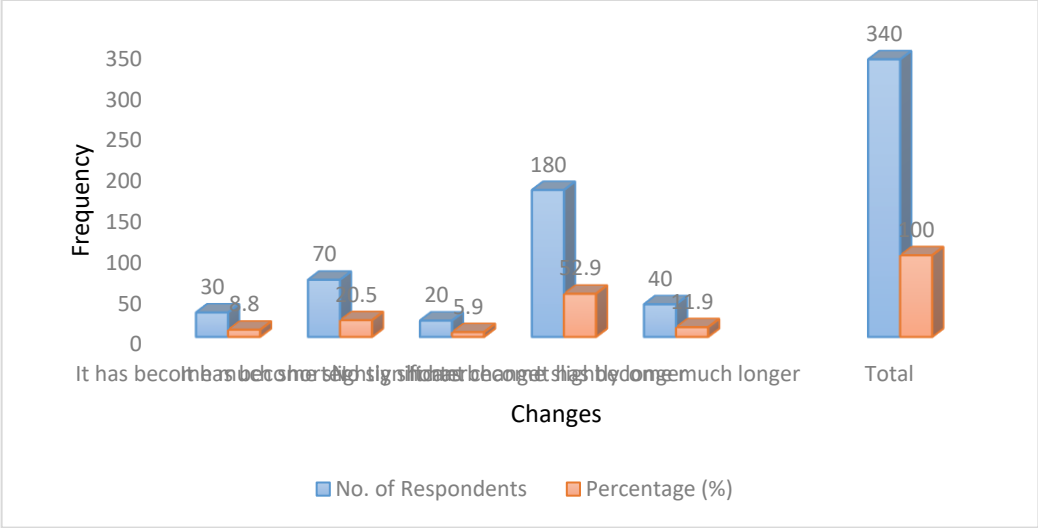

Figure 3. Distribution of Respondents by Changes in the Number of Months the Rainy Season Lasts Each Year. Source: Field Survey, 2025.

Perceived Changes in the onset (beginning) of the Rainy Season in Recent Years

Table 11 shows that 29.5% of respondents reported the rainy season onset has become much earlier, 25% slightly earlier, 27.9% slightly delayed, 10.2% much delayed, and 7.4% saw no change. Statistically, 54.5% perceive an earlier onset, while 38.1% perceive a delayed onset, indicating considerable variability in seasonal timing. Such shifts in rainfall patterns are consistent with findings in other developing countries like India, Bangladesh, and Kenya, where climate change has altered the timing and intensity of rainy seasons, increasing flood vulnerability (Huq & Reid, 2007).). These results suggest that Gombe residents are aware of climate-induced variability in rainfall onset, reflecting broader global trends in hydrological changes.

Table 11. Distribution of Respondents by Perceived Changes in the Onset (Beginning) of the Rainy Season in Recent Years

Options (Perception)	Change in Months (Shift in Onset)	No. of Respondents	Percentage (%)
It has become much earlier	Earlier by 3 months or more	100	29.5
It has become slightly earlier	Earlier by 1–2 months	85	25.0
No significant change	0 month difference	25	7.4
It has become slightly later	Later by 1–2 months	95	27.9
It has become much later	Later by 3 months or more	35	10.2
Total	—	340	100

Source: Field Survey, 2025

Perceived Cessation of Rainy Season

Table 12 presents respondents' perceptions of the influence of climate change on the timing of the end of the rainy season in recent years in Gombe State. The results indicate that 90 respondents (26.5%) believed that the rainy season now ends much earlier than it did in the past, while 65 respondents (19.1%) reported that it ends slightly earlier. Additionally, 90 respondents (26.5%) perceived that the rainy season ends at approximately the same time as it did in previous years. Conversely, 85 respondents (25.0%) indicated that the rainy season now ends slightly later than before, while 10 respondents (2.9%) stated that it ends much later. These findings demonstrate differences in respondents' perceptions regarding shifts in the timing of rainy-season cessation. However, the proportion of respondents who perceived an earlier end to the rainy season (45.6%) was greater than those who observed a later cessation (27.9%). This suggests that a larger number of residents perceive a reduction in the duration of the rainy season in recent years. The perception of an earlier end to the rainy season has significant implications for agricultural practices, water resources, and local hydrological conditions. A shortened rainfall period, especially when accompanied by variations in rainfall intensity and distribution, may affect runoff processes and increase the likelihood of flooding during episodes of heavy rainfall. Therefore, the findings suggest that changes in rainfall timing represent a key component of community perceptions of climate variability and its impacts in Gombe State.

Table 12. Distribution of Respondents by Perceived Changes in the Cessation (End) of the Rainy Season

Options (Perception)	Change in Months (Shift in Cessation)	No. of Respondents	Percentage (%)
It ends much earlier than before	Earlier by 3 months or more	90	26.5
It ends slightly earlier	Earlier by 1–2 months	65	19.1
It ends around the same time	0 month difference	90	26.5
It ends slightly later	Later by 1–2 months	85	25.0
It ends much later	Later by 3 months or more	10	2.9
Total	—	340	100

Source: Field Survey, 2025

Perceived Rainfall Intensity and Flood Events

Relationship between Rainfall Intensity and Flood Occurrence

Table 12 presents respondents' perceptions of the relationship between increased rainfall intensity and flood occurrence. The results indicate that 35.3% of respondents perceive a strong relationship between intense rainfall and increased flooding, while 26.5% perceive a moderate relationship. Conversely, 17.6% believe there is little or no relationship, 13.3% stated that rainfall intensity has decreased and flooding has decreased, and 7.3% were not sure. The combined proportion of respondents acknowledging either a strong or moderate relationship is 61.8%, which represents a clear majority. This indicates that most residents associate increased rainfall intensity with the rising incidence of floods. This perception is consistent with hydrological theory, which shows that intense rainfall events increase runoff rates, reduce soil infiltration capacity, and overwhelm drainage channels, thereby triggering floods.

Table 12. Distribution of Respondents according to Perceived Relationship between Rainfall Intensity and Flood Occurrence

Perceived Relationship Category	Description of Relationship	No. of Respondents	Percentage (%)
Strong positive relationship	Higher rainfall intensity leads to more flooding	120	35.3
Moderate positive relationship	Some increase in flooding with higher rainfall	90	26.5
Weak or no relationship	Little or no observable association	60	17.6
Negative relationship	Decreased rainfall intensity linked to less flooding	45	13.3
Not sure	Unable to determine relationship	25	7.3
Total	—	340	100

Source: Field Survey, 2025

Delayed Onset of Rainfall and Flood Events

Findings as shown in Figure 4 highlights perceptions of the impact of delayed onset of rains on flood events in the context of climate change. The results reveal that a majority of respondents, 58.9%, believe that delayed rains reduce flooding. In contrast, 8.8% believe that delayed rains lead to more intense rainfall and increased floods, while 14.7% perceive no effect on flooding. Additionally, 7.3% stated that the timing of rainfall onset is unpredictable, and 10.3% were not sure. The dominant perception that delayed rainfall reduces flooding suggests that many respondents believe shorter rainy seasons lead to less cumulative rainfall, thereby reducing flood risk. However, a smaller but significant proportion of respondents perceive the opposite effect, suggesting that delayed rains may lead to sudden heavy rainfall events, which can increase flooding.

By implications, while delayed rainfall may reduce total seasonal precipitation in some cases, it can also produce high-intensity storms occurring within shorter periods, potentially increasing flash floods. Similar mixed perceptions have been observed in Kenya where delayed rainfall onset has been associated with both reduced seasonal flooding and sudden heavy storms that trigger flash floods (Ratnaweera, et al., 2022). Similarly, in the Philippines, studies have shown that variations in monsoon behaviour, including irregular rainfall patterns and extreme precipitation events, contribute to increased flood risks in vulnerable areas (Olaguera et al., 2023). These comparisons show that the perceptions of respondents in Gombe State are consistent with global experiences of climate variability.

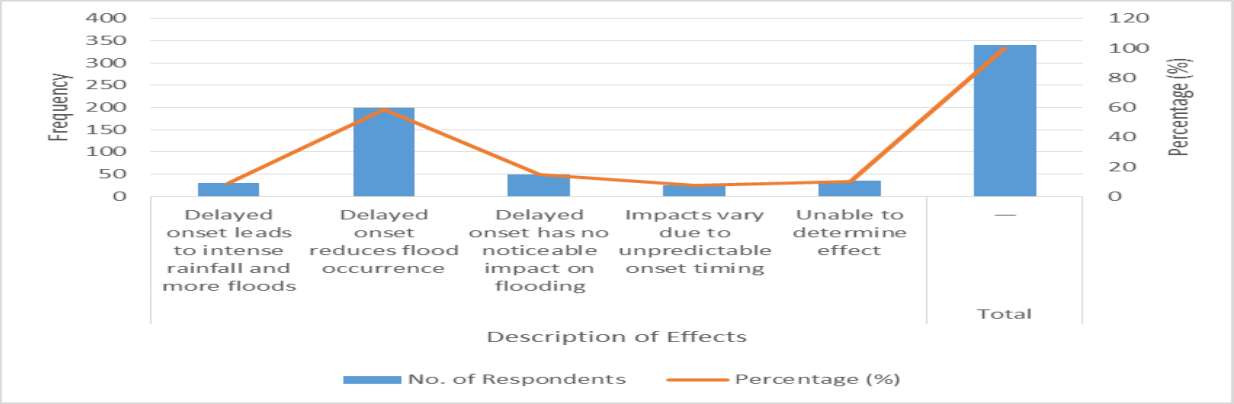

Figure 4. Distribution of Respondents by Delayed Onset of Rainfall and Flood Events
Source: Field Survey, 2025.

Changes in Dry Spell Patterns

Table 14 presents respondents' observations regarding changes in the pattern of dry spells during the period of climate change. The results indicate that 26.4% of respondents reported that dry spells have become more frequent and longer, while 19.3% observed that dry spells have become slightly more frequent. Similarly, 26.4% stated that there has been no noticeable change in dry spells. In contrast, 25% perceived that dry spells have become shorter or less frequent, while 2.9% were not sure. The combined proportion of respondents indicating increased frequency of dry spells (45.7%) suggests that nearly half of the respondents perceive greater variability in rainfall distribution. Increased dry spells during the rainy season may lead to intermittent rainfall patterns, which can affect soil moisture, crop productivity, and runoff processes.

By implications, longer dry spells can harden soil surfaces, reducing infiltration capacity. When rainfall eventually occurs, especially in intense bursts, surface runoff increases, thereby raising the potential for flooding. Consequently, alternating dry spells and intense rainfall events may exacerbate flood risks in affected communities. Comparable patterns have been documented in Ethiopia, where increased dry spells during rainy seasons have been linked to erratic rainfall and sudden floods (Gebremichael et al., 2022). Similarly, in Brazil, climate variability has resulted in alternating drought and heavy rainfall events, contributing to both water scarcity and flooding in vulnerable regions (Silva et al., 2022). These international comparisons reinforce the significance of changing dry spell patterns as an indicator of climate variability.

Table 14. Distribution of Respondents by Changes in Dry Spell Patterns

Options	No. of Respondents	Percentage (%)
Dry spells have become more frequent and longer	90	26.4
Dry spells have become slightly more frequent	65	19.3
No noticeable change in dry spells	90	26.4
Dry spells have become shorter or less frequent	85	25
Not sure	10	2.9
Total	340	100

Source: Field Survey, (2025)

Conclusion and Recommendations

This study examined community perceptions of flood incidences and their climate change linkages in Gombe State, Nigeria. The findings revealed that residents have a high level of awareness of climate change and generally perceive that flood incidences have increased over the past two decades. Most respondents associated the increasing occurrence of floods with changes in rainfall characteristics, particularly increasing rainfall intensity, delayed onset of the rainy season, irregular cessation of rainfall, and changing dry spell patterns. These perceptions are consistent with recent climatic observations that indicate increasing rainfall variability and the occurrence of more frequent extreme weather events in many parts of Nigeria. Based on the findings of this study, the following recommendations are made:

Since 32.3% of the respondents were not aware of climate change, the Gombe State Government, the Nigerian Meteorological Agency (NiMet), and other relevant stakeholders should intensify climate change education and public

sensitization programmes to improve awareness and understanding of its effects on flooding. As 78.0% of the respondents perceived that rainfall events have become more intense over the past decade, government should strengthen flood forecasting and early warning systems and ensure that timely weather information reaches communities before periods of heavy rainfall. Given that 69.0% of the respondents perceived that flood events have increased compared with twenty years ago, the Gombe State Government should prioritize the construction, rehabilitation, and regular maintenance of drainage systems and other flood control infrastructure in flood-prone communities. Since respondents reported changes in the onset and cessation of the rainy season as well as increasing dry spell variability, relevant agencies should incorporate seasonal climate forecasts into community awareness programmes to support timely preparedness and adaptation measures, particularly for farming households. In view of the significant positive relationship between climate change awareness and perceived flood frequency, policymakers should integrate community perceptions and local experiences into flood risk management and climate change adaptation policies to improve their effectiveness and public acceptance.

DECLARATIONS

Funding
The authors received no specific funding for this study.

Conflict of interest
The authors declare no conflict of interest.

Author contribution
All the authors contributed to the conception, literature synthesis, framework development, drafting and critical revision of the manuscript.

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