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A Survey of Flood Early Warning Dissemination in Some Selected Communities in Kaduna State, Nigeria

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ABSTRACT

This study examines flood early warning dissemination, its effectiveness, and community preparedness in selected communities in Kaduna State, Nigeria, using a cross-sectional survey of 171 households. Descriptive and inferential statistics (Spearman correlation) were applied. Results show that while most respondents are aware of flood warning messages, many are dissatisfied with their effectiveness. The relationship between perceived usefulness of warnings and flood intensity was weak and not statistically significant. A majority of respondents reported inadequate guidance from local authorities, indicating low levels of preparedness. The findings highlight the need for improved communication strategies, greater inclusivity, and enhanced institutional support for effective disaster risk reduction.

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1.0 Introduction

Disasters are a recurring phenomenon that endangers the lives, property, and livelihoods of individuals and communities around the world (Cilliers, 2019). Flooding, particularly river flooding, is one of the world's most devastating natural catastrophes, killing more people and causing more property damage than any other natural phenomenon (Yin et al., 2021; Climate Risk Country Profile: Nigeria, 2023; Audu et al., 2024). Flooding is the most common natural hazard in Africa, with its effects exacerbated by climate change, which has increased weather variability and unpredictability (Echendu, 2020; International Labour Organization, 2022).

Nigeria is prone to natural catastrophes such as floods, droughts, and epidemics (Audu et al., 2024). According to the 2020 ND-GAIN Index, between 2011 and 2020, all 36 states in Nigeria experienced catastrophic flooding at least once, with Kaduna State among those hit by recurring disasters (Sule et al., 2016; Joshua et al., 2023). Despite repeated warnings, the 2022 floods exposed serious vulnerabilities in Nigeria's disaster management infrastructure. Early warning systems (EWS), which are widely acknowledged as critical to disaster risk reduction (DRR), are either poorly established or underused in Nigeria, leaving many communities vulnerable (International Labour Organization, 2022).

Early warning systems (EWS), which have evolved with technological advancements, are critical to disaster risk reduction (DRR) efforts, with the potential to save lives and reduce damage by 30% if activated 24 hours before a disaster (Jacob, 2018; International Telecommunication Union, 2019; International Labour Organisation, 2022). An important turning point in the history of disaster risk reduction occurred with the onset of the Industrial Revolution, which increased the frequency and severity of natural disasters (Wisner, Gaillard & Kelman, 2012). This contributed to the development of early warning systems in the late 19th century, which enabled communities to evacuate susceptible areas and become ready for disasters before they happened (Otuogha, 2024). Despite having extensive documentation in international contexts, these systems are still not widely used locally, especially in areas like Kaduna State. Their effectiveness is further undermined by inadequate resources, a lack of collaboration among stakeholders, and a failure to integrate indigenous knowledge systems (Joshua et al., 2023).

In general, the awareness of climate vulnerability in the majority of developing nations, and Kaduna Town specifically, has made it more necessary for information on flood early warning to be disseminated to avert adverse consequences of the disaster (Danladi et al., 2018; Cao et al., 2024). Given the increased probability of future floods in the state, efficient early warning dissemination is required for greater community preparedness. Thus, the objectives of this study are to: determine the frequency and intensity of flood occurrence in Kaduna State; identify the flood warning communication and dissemination channels used; examine the effectiveness of flood early warning dissemination; and examine factors inhibiting the ability to respond effectively to flood warnings in Kaduna State.

2.0 Materials and Methods

2.1 Study Area

Kaduna State is one of the seven states that constitute the North-Western region of Nigeria. Its population as of the last official census in 2006 ranked third among the sub-nations and the Federal Capital Territory (National Population Commission 2008). Three local government areas in Kaduna State, namely, Igabi, Kaduna North and Kaduna South, make up the study area. Figure 1 illustrates the administrative boundaries of the selected study areas. There are various land uses in the study area; the major ones are residential, agricultural, transportation, educational, administrative, and commercial.

2.2 Ethics Statement

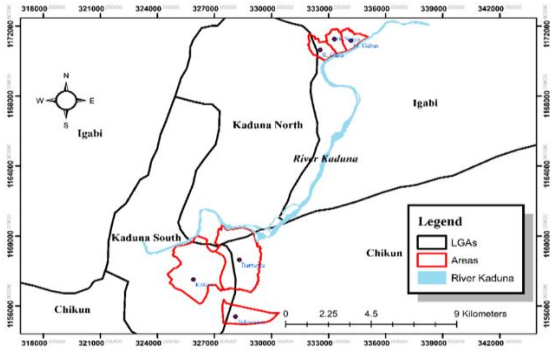
Standard ethical procedures were followed. The survey's purpose was clearly stated on the questionnaire. Second, the respondents were asked for consent and told their responses and identities were confidential. Only willing participants were included in the survey.

2.3 Participants and Sampling Technique

A survey research design was adopted in this study, using multi-stage sampling techniques for

the collection of data. The first stage was the selection of the local government areas, which make up the study area. While the state has twenty-three local government areas, three local governments (Igabi, Kaduna North and Kaduna South) were purposively selected for the study. The three local government areas purposefully selected for the study are some of the ones that are flood-prone in the state. The second stage of the sampling process was the selection of neighbourhoods among the chosen local governments. Six neighbourhoods were randomly selected: Rafin Guza, Hayin Naíya, Malalin Gabas, Barnawa, Kakuri, and Television.

Figure 1
Administrative Map of the Study Area



The third and final stage of the sampling was the selection of households, where a representative of the household was administered the questionnaire. With no official records documenting the number of households in the wards, systematic random sampling was adopted, with an interval of 10. All respondents residing in the selected neighbourhoods have experienced similar floods over time.

2.4 Data Collection Method

The questionnaire administration method adopted was a direct one-to-one administration. This ensured a high rate of return since the questionnaires were delivered directly by hand to the respondents and taken back immediately upon completion. This approach ensured a 100% retrieval rate in this study, as incentives were also provided for some households, thus increasing their readiness to answer the questionnaire.

2.5 Data Analysis

The collected data were analysed using the Statistical Package for the Social Sciences (SPSS). Both descriptive and inferential statistics were used in the study. The descriptive analysis was used to summarise and simplify the data collected. Frequencies and percentages were the measures of descriptive statistics used in determining the frequency of flood occurrence, identifying the flood warning communication and dissemination channels, and determining factors inhibiting the ability to respond effectively to flood warnings in the study area. To test the correlation between respondents' perceptions of the helpfulness of early warning dissemination and the intensity of floods, an inferential test—the Spearman rank correlation test—was conducted.

3.0 Results

3.1 Frequency and Intensity of Flood Occurrence

Table 1 highlights the occurrence and severity of floods in the study area. The occurrence of flooding is a widely experienced disaster in the study area, with the majority of respondents (78.4%) affirming its occurrence with varying levels of frequency annually. The findings indicate varying levels of severity of the flood when it occurs. Mild and moderate flooding jointly accounted for more than four-fifths of the floods experienced by the respondents.

Table 1
Frequency and Intensity of Floods

Variable	Responses	Frequency	Percent
The frequency of flood annually	Never	37	21.6
	Rarely (once every few years)	33	19.3
	Occasionally (1-2 times a year)	70	40.9
	Frequently (several times a year)	15	8.8
	Very frequent	16	9.4
	Total	**171**	**100**
Severity of flooding when it occurs	Very mild (Flood does not go beyond curb height)	81	47.4
	Moderate (water spills from drainages, no property damage)	62	36.3
	Severe (damage to properties)	24	14
	Extreme (significant damage to properties, infrastructure and livelihood)	4	2.3
	Total	**171**	**100**

3.2 Flood Warning Communication and Dissemination Channels

The results of this study in Table 2 show the use of varying media for disseminating flood warnings in the study area. Over 74% affirm that they are aware of flood warning messages in their communities. These findings indicate that not all residents can access the disseminated messages. The responses to the channels of communicating flood warning messages in the communities varied. The major channel was mobile alerts, with 45% reporting accessing flood warning messages through it.

Table 2
Channels of Flood Warning Dissemination

Variable	Responses	Frequency	Percent
Existence of Flood Warning Alerts and Messages	Yes	128	74.9
	No	36	21.1
	Not Sure	7	4.1
	Total	171	100
Mobile Alert	No	94	55
	Yes	77	45
	Total	171	100
Radio Broadcast	No	100	58.5
	Yes	71	41.5
	Total	171	100
TV Broadcast	No	139	81.3
	Yes	32	18.7
	Total	171	100
Community Meeting	No	165	96.5
	Yes	6	3.5
	Total	171	100

3.3 Effectiveness of Early Warning Messages Disseminated

Disaster risk reduction can be optimised when vulnerable people are well-informed about risks through effective early warning dissemination. The study's findings in Table 3 illustrate the usefulness of flood early warning messages as a significant component of flood early warning systems (FEWSs). Regarding the usefulness of the flood warning messages and notices, the results indicate that many respondents (56.2%) believed the information disseminated was only slightly beneficial. The Spearman correlation test was conducted to assess the relationship between the respondents' perceptions of the helpfulness of the warning messages and the intensity of the flood. Table 4 shows a weak negative correlation between respondents' perceptions of the helpfulness of the early warning issued and the intensity of the flood. However, this relationship was not statistically significant ($p = 0.407$), an indication that as the intensity of the flood increased, the helpfulness of the early warnings decreased.

Table 3
Respondents' Perceptions of the Effectiveness of Flood Early Warning Messages

Variable	Responses	Frequency	Percent
The effectiveness of a warning provides sufficient notice before a flood	Yes	29	17
	No	47	27.5
	Not Sure	95	55.5
	Total	171	100
Helpfulness of flood warning messages in responding to flood situations	Not helpful at all	40	23.4
	Slightly helpful	96	56.2
	Moderately helpful	31	18.1
	Very helpful	3	1.8
	Extremely helpful	1	0.6
	Total	171	100
Satisfaction with flood warning messages	very dissatisfied	62	36.3
	Dissatisfied	34	19.9
	Neutral	51	29.8
	Satisfied	17	9.9
	Very satisfied	7	4.1
	Total	171	100

Table 4

Spearman Rank Correlation Test between Helpfulness of Warning Dissemination and Flood Intensity

			Intensity of Flood	Helpful Early Warning Dissemination
Spearman's rho	Intensity of Flood	Correlation Coefficient	1.000	-.066
		Sig. (2-tailed)	.	.407
		N	168	168

3.4 Inhibitors to an Effective Response to Flood Warning

Table 5 presents the different factors that hindered people's capacity to successfully respond to flood warnings in the study area. A lack of information was one of the most common problems that came up. Most of the people who answered (80.7%) said they didn't have enough information to get ready for and deal with floods. One supporting factor in promoting early warning dissemination is the communication infrastructure. This essential infrastructure was found to be among the significant factors (30.4%) that hampered response to flood warnings. The federal, state and local governments are instrumental in managing disasters; in particular, the state and local governments play a crucial role, as they provide grassroots engagement with inhabitants. In Table 6, the majority of the respondents (64.9%) said their local authority (local government and the state emergency management agency [SEMA]) did not provide appropriate instructions on how to prepare for floods, with "No" being the most common response. In terms of the adequacy of local authority methods in disseminating early warning, the findings show that more than half (53.8%) of the respondents were uncertain about the adequacy of the local authority's methods to disseminate the message required.

Table 5

Factors Limiting the Ability of Respondents to Respond Effectively to Flood Warnings

Variable	Responses	Frequency	Percent
Lack of information	No	33	19.3
	Yes	138	80.7
	Total	171	100
Inadequate transport to evacuate	No	129	75.4
	Yes	42	24.6
	Total	171	100
Poor communication infrastructure	No	119	69.6
	Yes	52	30.4
	Total	171	100
Lack of financial Resources to prepare	No	165	96.5
	Yes	6	3.5
	Total	171	100
No designated Place to evacuate to	No	156	91.2
	Yes	15	8.8
	Total	171	100

Table 6

Respondents' Perception of the Regulatory Role of the Local Authority's Assessment

Variable	Responses	Frequency	Percent
Local authority provision of guidance on how to prepare	Yes	45	26.3
	No	111	64.9
	Not Sure	1	0.6
	Not Indicated	14	8.2
	Total	171	100
Adequacy of Local Authority methods in disseminating early warning	Yes	36	21.1
	No	43	25.1
	Not Sure	92	53.8
	Total	171	100
Any improvement in Flood Management in the last few years?	Yes	25	14.6
	No	55	32.2
	Not Sure	91	53.2
	Total	171	100

4.0 Discussion

A significant proportion of the respondents reporting frequent occurrences of floods is likely due to the study area being in a region with a relatively high amount of rainfall in August and September. The risk of the disaster is further heightened because some of the communities are largely in low-lying areas, close to rivers that overflow their banks at the peak of the wet season. The findings on the frequency of flood occurrence are consistent with prior research that found similar flooding frequencies in similar places (Smith, 2018). Johnson (2019) points out that even occasional flooding can have a big impact on local communities and ecosystems.

The variability of rainfall amounts in the wet seasons in Nigeria contributes to varying levels of flooding. The onset of rainfall in the study area typically has low rainfall when soils are not saturated and drainage could accommodate the rains, but as the wet season progresses, the increase in rainfall could translate to floods of varying intensity. This discovery is consistent with previous research that has demonstrated the heterogeneity of flooding patterns between regions (Lee, 2020). The fact that a sizable proportion of respondents reported very mild or moderate flooding shows that the study area is prone to occurrences that, while not catastrophic, still pose major dangers to people, properties, and infrastructure. Patel (2019) pointed out the necessity to take flooding severity into account when developing risk assessments and management methods.

The relatively high number of respondents accessing warning messages via mobile alerts is consistent with earlier studies emphasising the use of mobile technology in disaster communication (Kavitha et al., 2024). Alsabhan and Dudin (2023) observed that mobile alerts are increasingly being used, especially in poor nations, making them an effective medium for delivering crucial information such as flood warnings. A similar observation was seen in the study area; however, the system is more accessible to smartphone users, and those without these kinds of phones may only hear of such through a third party. The choice of language in message transmission is another factor that could influence access levels when sending mobile alerts. The English language, which is incomprehensible to individuals with limited formal education, is the most common language used to pass information through this channel, thus omitting some classes of people in the study area.

In contrast, media alerts, radio broadcasts, TV broadcasts, and community meetings had less coverage for disseminating flood warnings, with the majority of respondents indicating "No" to receiving warnings through these channels. These findings are consistent with studies (e.g., Norris & Stevens, 2016) that have highlighted the limits of traditional media, such as radio and television, in reaching vulnerable people. Television and radio largely run on electricity, and in Nigeria, many communities face erratic power supply; thus, flood warnings aired on these media channels could be missed.

Communities have various levels of leadership and associations, which are veritable tools in disseminating early flood warning in community gatherings, but their potential has not been effectively harnessed in the study area. The existing structures in the communities are not given importance by the state agencies and are often left out as agents that could be used for early warning dissemination. The low usage of community gatherings as a medium for spreading flood warnings is also consistent with Haynes and Tanner's (2015) research, which emphasises the necessity for more targeted and personalised communication tactics. The variation in access to flood warning messages across the different media emphasises the need for a multi-channel approach to flood warning distribution. According to Kreps (2017), flood warning systems can be made more successful and inclusive by combining the strengths of several mediums such as mobile technology, media warnings, and community interaction.

In the study area, a lack of clarity may explain why the warning dissemination is perceived as only slightly helpful. It is common to see warning dissemination containing general information without specifics on which neighbourhoods would be most affected. The United Nations Office for Disaster Risk Reduction (2024) emphasised the importance of early and accurate warnings in minimising flood risk. Studies have shown that effective FEWS can cut flood-related deaths and damage by as much as 90% (IFRC,

2012). In the study, the proportion of respondents that affirm that the warning disseminated was either very advantageous or extremely helpful accounts for less than 2%, indicating that there is a great opportunity for improvement.

The respondents were largely unsatisfied with the warning dissemination, with many reporting that they were very dissatisfied or dissatisfied. This high level of dissatisfaction could be linked to the minimal inclusion of the affected people in decision-making and community interaction on the disaster. This is similar to earlier research that has emphasised the significance of community interaction and participation in the establishment of EWS (Sufri et al., 2020). To reduce the risk of vulnerable people to floods, early warning is expected to convey the right message to aid preparation and possible evacuation from affected areas. When recipients of such information consider the message as lacking in clarity or wrongly timed, and they are left exposed to grave negative consequences, the early warning would be considered generally unhelpful.

The negative relationship between the respondents' perceptions of the helpfulness of the warning messages and the intensity of the flood is an indication that as the floods intensified, respondents felt the early warning issued was unhelpful. Early warning is meant to adequately prepare affected communities and reduce the risk experienced, but with the losses suffered by communities increasing as floods intensify, the general feeling about the helpfulness of early warning decreases. Respondents are largely left less prepared, and recurring losses and personal suffering that attend affected communities as the disaster intensifies are common features. This shows a lack of positive experiences resulting from the early warning disseminated.

Different factors were found that hindered people's capacity to successfully respond to flood warnings. One of the most common being a lack of information, with the majority of respondents (80.7%) stating that they did not have enough information to prepare and respond to floods. This finding is consistent with prior research, which has highlighted the importance of timely and correct information in disaster response (Glago et al., 2019). According to Fernández-Nóvoa et al. (2024), a lack of information might make individuals and communities more vulnerable to flood risk.

Another big concern noted was a lack of transportation to evacuate, with about one-quarter of respondents stating that they did not have reliable transportation. This finding is consistent with previous studies emphasising the importance of evacuation routes and transportation in disaster response (Parajuli et al., 2023). Thapa et al. (2022) state that a lack of suitable transportation can severely restrict citizens' ability to escape safely and speedily. The findings also show that poor communication infrastructure was found to be among the significant factors (30.4%) that hampered response to flood warnings. While some of the communities in Kaduna State are well served by communication infrastructure, there are places where the provision of the infrastructure is not adequate. In addition, it is not uncommon to have the efficiency of the infrastructure lowered at the time of the occurrence of a flood. The lack of financial resources to prepare was also among the factors that hampered the response to flood warnings. These findings are consistent with earlier studies highlighting the relevance of communication infrastructure and financial resources in disaster response (Smith, 2013). Lack of financial resources to prepare and the inability of official authorities to designate a location of evacuation also hampered response to flood warnings. Zhang and Prater (2014) observed that the provision of evacuation shelters and designated evacuation points in disaster response promotes better response to the risk.

JosèMoisès et al. (2023) highlighted the need for clear guidelines and communication from local authorities in flood risk management, as communities may be more vulnerable to flood risk if local authorities do not provide adequate guidelines. Local government, an important segment of a local authority in Nigeria, has had issues with funding and relevance many times. While the staff of the local government are inhabitants of various communities in the state and could make for easy engagements, much is not achieved because of limited funds and the downgrading of their roles by state and national agencies. About one-fifth of the respondents

believe that the local authorities are sufficiently adequate in disseminating early warnings to communities at risk of floods. Shah et al.'s (2023) study emphasised the issues that local governments face when addressing flood risk, such as limited resources and ability. Krasiewicz and Wierzbicki (2023) opine that the perceived incompetence of local authorities can weaken trust and confidence in flood risk management.
Respondents were uncertain about whether flood control has improved in their area in recent years. The most common response was "Not sure", followed by "No" and "Yes". This finding is consistent with previous research that has emphasised the importance of continuing evaluation and enhancement of flood risk management measures (Pham et al., 2024). Parkoo et al. (2022) argue that the perceived lack of improvement in flood control can perpetuate vulnerability and risk.

5.0 Conclusion

This study provides useful information about flood early warning dissemination in some communities in Kaduna State. Mild and moderate flood events are the most frequently reported in the study area. Dissemination of warning is a crucial part of early warning systems, but residents feel the information put out is not sufficient and is also regarded as ineffective in most cases when it is disseminated. Local government and the state emergency management agency, which are the primary responders, have not sufficiently performed well in the dissemination of messages that could help residents prepare and respond to the disaster.

6.0 Recommendation

The necessity for better engagement between the local authority and communities is apparent. To foster this engagement, community leaders should be more involved in the dissemination of early warnings, as their influence is extensive in local settings. The effectiveness of the early warning will be enhanced through the dissemination of clearer information and communication in English and indigenous languages. Investing in facilities and systems that make for better information coverage and inclusivity and customising flood warning systems to the individual requirements and settings of vulnerable people would promote better responses to the early warning and reduce the effects of the disaster.

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9.0 Declaration of Conflicting Interests

The authors declare no conflict of interest.

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