



Indigenous early warning systems and community resilience in flood-prone areas

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Received Date: November 2, 2025

Revised Date: February 18, 2026

Accepted Date: February 23, 2026

ABSTRACT

Background: The hazard of flooding is an annual phenomenon that has displaced millions of people over the years worldwide and claimed lives and properties. This study examined indigenous – based early warning method for flood prevention in Ayetoro and its environs in Ilaje Local Government Area, Ondo State, Nigeria. **Methods:** The study employed descriptive survey design using systematic sampling techniques to select 309 respondents to investigate indigenous based early warning method and flood prevention in Aiyetoro and its environs in Ilaje Local Government Area of Ondo State, Nigeria. Four research questions were raised and answered using descriptive statistics. **Findings:** The result revealed that there was moderate level of indigenous knowledge (grand mean = 3.00, above the standard mean of 2.50) which suggested that Ayetoro and its environs maintains traditional practices for flood prediction and mitigation of respondents on the effectiveness of Indigenous – based Early Warning Method (IEWM), supported by the grand mean value of 3.49 which indicated that the communities finds these methods highly reliable for flood mitigation, because of the timeliness and reliability of the information and trust in the accuracy of predictions. The result also indicated that majority of respondents (53.9%) supported the integration of indigenous knowledge with modern technology, with a grand mean of 3.49. This reveals the community's recognition of the limitations of indigenous methods and the potential benefits of combining them with technological advancements. The result further shows that (94.8%) of the respondents consenting the statements indicated that there were high challenges and barriers to the development and implementation of indigenous – based early warning method in the study area. **Conclusion:** The study concluded that communities highly value the accuracy and reliability of traditional methods, but the need for modernization is evident to sustain long-term flood management efforts. **Novelty/Originality of this article:** This study established shortfall in dependability of indigenous methods commonly adopted in the observed communities in the study. Modern technological tools of flood prediction combined with traditional knowledge will help to create a comprehensive and robust flood management system in the study area.

KEYWORDS: early warning method; flood prediction; flood prevention; indigenous-based; modern technology.

1. Introduction

The hazard of flooding is an annual phenomenon that has displaced millions of people every year worldwide and claimed lives and properties. Looking at river flooding specifically, the World Resources Institute (2015) has observed that this hazard affects 21 million people around the world every year and that in 2030, that number could rise to 54 million per year; with ongoing urbanization and climate change impacts. Floods pose a

Cite This Article:

Olabode, A. D., & Ogayemi, E. (2026). Indigenous early warning systems and community resilience in flood-prone areas. *Journal of Disaster Management and Community Resilience*, 3(1), 42-58. <https://doi.org/10.61511/jdmcr.v3i1.3317>

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recurrent threat to both urban and rural areas in Nigeria, as highlighted (Mfon et al., 2022). According to Umar & Gray (2023) and Ologunorisa et al. (2022), Nigeria encounters annual floods, particularly flash floods and dam-related floods, during the rainy season. However, each occurrence appears to exacerbate, causing more significant impacts than its predecessor. In a related report, by National Emergency Management (2012) submitted that floods, displaced over 2.1 million Nigerians and rendering them homeless. The intensity of the floods resulted in substantial loss of life and property, with hundreds of thousands of hectares of farmland washed away. The northern regions of Nigeria bore the brunt of the disaster, particularly states like Ondo, Kogi, Rivers State that are traversed by major rivers and communities situated along riverbanks, which were entirely submerged.

Indigenous knowledge encompasses the methods and practices honed by a community through generations of inhabiting a specific area, as defined (Iloka, 2016). This form of knowledge stands apart from other types as it arises within the community itself, transmitted through informal channels, collectively owned, and continuously evolving through adaptation. It is deeply ingrained in the community's way of life, serving as a means of survival and promoting well-being. Matsika (2012) further characterizes indigenous knowledge as the traditional wisdom developed by local communities in managing the challenges they face in daily life. This knowledge is built upon the experiences, relationships between society and nature, and communal practices and institutions, persisting over time and transmitted across generations (Sillitoe, 2000).

Every community naturally engages in efforts to prevent and minimize potential losses when faced with hazards. Many vulnerable communities possess extensive experience in monitoring environmental shifts and have developed rich knowledge and practices in this direction (Aksa, 2020). Within their knowledge systems lie components focused on disaster prevention, risk awareness, and preparedness. These communities also employ sophisticated methods to address, manage, and recover from the effects of hazards (Timilsena & Devkota, 2022). Such traditions and practices significantly shape how local communities anticipate and adjust to extreme weather events and other threats (Lambert & Scott, 2019).

The significance of indigenous knowledge in Disaster Risk Reduction (DRR) from an African standpoint is emphasized in the study, contending that relying solely on scientific knowledge in Africa has not yielded satisfactory outcomes due to the neglect of local perspectives and dynamics (Iloka, 2016). The study advocates for the incorporation of indigenous knowledge as a fundamental aspect in DRR programming and the formulation of local policies. A notable investigation in Africa conducted by the United Nations Environment Programme (2018) explored the utilization of indigenous knowledge in disaster management across Kenya, Swaziland, South Africa, and Tanzania. The findings highlighted indigenous knowledge as a valuable asset enabling communities to establish their own forecasting and early warning methods. Furthermore, based on these methods, communities developed various coping mechanisms and strategies for food management. Examples included the observation of animal behaviour (such as birds and insects), plant and tree species, meteorological indicators, and celestial bodies.

Furthermore, the significance of this research extends beyond the local confines of Ondo State. As climate change exacerbates the frequency and severity of extreme weather occurrences worldwide, there is an increasing acknowledgment of the value of indigenous knowledge in bolstering adaptive capacity and promoting sustainable resilience. In Nigeria, there are currently upsurge in flood occurrences due to climate change majorly in riverine communities (Echendu, 2020; Buba et al., 2021). Between 1960 and 2006, Nigeria experienced an increase of 0.8°C in its average annual temperature, with a steep increase occurring since 1980 and the greatest increase occurring in the northern region. In the same period, the country also experienced a decrease in precipitation of 3.5mm per month per decade. Additionally, Nigeria's climate is expected to continue to change. The mean annual temperature is projected to increase by 1.1 to 2.5°C by 2060, with an extreme increase expected in the north of Nigeria. Increased variability in rainfall and extreme rainfall events is expected across most of the country, as well as a rise in sea level of 0.4 to 1.0 m by 2100

(USAID, 2019). Through documentation and recognition of indigenous methodologies in managing flood risks, this study contributes to broader dialogues on climate adaptation, disaster risk reduction, and the collaborative generation of knowledge among diverse stakeholders. Essentially, this research emerges from the intersection of environmental challenges, cultural heritage, and the necessity for inclusive and sustainable development. By bridging the divergence between tradition and modernity, it aims to pave the way for more resilient and culturally attuned approaches to flood prevention in Ondo State and beyond.

Ayetoro community and its environs in the Ilaje Local Government Area of Ondo State, are located in southwestern Nigeria, grapples with persistent flooding issues, posing significant threats to the lives, livelihoods, and infrastructure of its residents (Olorunlana, 2024). Despite the implementation of modern EWM, efforts to prevent and mitigate floods remain largely ineffective. EWM initiatives typically adopt a top-down approach, neglecting to adequately involve local communities and integrate their perspectives, needs, and indigenous knowledge into flood risk management strategies (Muhammed et al., 2024). Ondo State boasts a wealth of indigenous knowledge methods that have traditionally guided communities in comprehending and adapting to environmental changes, including floods (Hiwasaki et al., 2014). However, there is a notable absence of incorporation of this traditional wisdom into modern EWM, resulting in a disconnect between scientific methodologies and local realities. Although modern EWM technologies are available, they often lack adaptation to local contexts and fail to recognize the subtle signs of impending floods acknowledged by indigenous communities. Consequently, there are delays in issuing warnings and ineffective communication of risk to vulnerable populations (Omoruyi et al., 2025).

This study investigates indigenous – based early warning method for flood prevention in Ayetoro and its environs, Ilaje Local Government Area of Ondo State Nigeria. Specifically, the study aims to: identify and discuss the existing indigenous knowledge based on early warning method for flood prediction in the study area; assess the effectiveness of indigenous knowledge based EWM in flood prediction; examine community perception on the need for integrating indigenous knowledge based EMW into modern technology for flood control; and to identify the challenges of integrating indigenous knowledge and modern methods of flood prediction in the study area.

2. Methods

2.1 Study area

The study area selected for this research is Ayetoro and its environs, which is situated within the Ilaje Local Government Area of Ondo State, Nigeria. Ayetoro and its environs was chosen due to its vulnerability to recurrent flooding in the coastal region of Nigeria. Ayetoro and its environs is located in the coastal region of southwestern Nigeria, approximately at Latitudes 05°16' and 06°30' North of Equator and Longitudes 04°45' and 05°45' East of the Greenwich Meridian (Fig. 1). It lies adjacent to the Atlantic Ocean, making it susceptible to the impacts of coastal flooding and storm surges (Ekpoh, 2015).

The climate of Ayetoro and its environs is characterized by a tropical monsoon climate, with distinct wet and dry seasons. The wet season typically spans from April to October, marked by heavy rainfall and high humidity. The dry season, occurring from November to March, is characterized by lower precipitation levels and relatively cooler temperatures (Emeribeole, 2015). The soil in Ayetoro and its environs is predominantly sandy due to its coastal location, with patches of clayey soil in certain areas. Vegetation consists of mangroves along the coastline, dense tropical forests inland, and agricultural lands used for cultivation of crops such as cassava, yams, and oil palms (Iwayem et al., 2025).

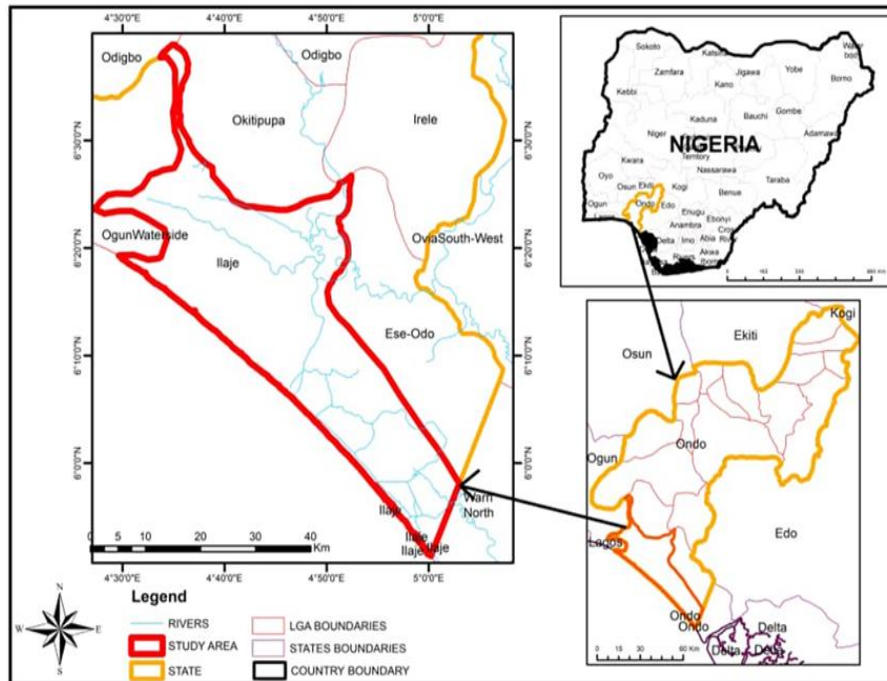


Fig. 1. Map of Nigeria showing, Ondo State and Ilaje LGA (Ondo State Ministry of Works, 2023)

The terrain morphology of an area plays a vital role in the determination of drainage architecture, especially Digital Elevation model of a place. Usually, run-off water tends to flow down areas of lower elevation or flat terrain from areas of higher elevation. Therefore, drainages or convergence of run-off waters will be denser at rivers mouth which are more prone to flooding than river sources (Teng et al., 2017). The study shows that higher values of densities mean higher drainage densities and lower values of drainage densities mean lower concentration of drainage. From the study, the highest drainage density values range from 114 to 176 and the lowest drainage density values range from 4.35 to 57.4. The area is characterized by high relief ranging from 2,000 m above sea level in the western part to 3,900 m above sea level in the southern part of the area (Lazarus et al., 2020). The geology of Ayetoro and its environs is characterized by coastal plains and low-lying areas, with some elevation inland. The region is prone to land subsidence due to factors such as groundwater extraction and natural compaction of sediments, exacerbating the risk of flooding (Agbonkhase et al., 2014).

2.2 Methods

This study employed primary and secondary data that comprised of questionnaire administration and map of the study area. The questionnaire was targeted at collecting information on identification and discussion of existing methods of indigenous-based early warning for flood prediction in the study area, assessing the effectiveness of the indigenous methods, examining community perception on the need for integrating these methods into modern technology for flood prediction in Ayetoro and its environs. The target population of the study encompasses all the residents of the study area. These target population comprises of male and female residents of Ayetoro and its environs in Ilaje Local Government area of Ondo State, Nigeria.

The study employed descriptive survey design using systematic sampling techniques where 309 respondents were investigated in order to find out the impact of indigenous-based early warning method on flood prevention in Aiyetoro and its environs in Ilaje Local Government Area of Ondo State, Nigeria. Four research questions were raised and answered using descriptive statistics. The communities under consideration are presented in Table 1.

Table 1. Population and sample size for the study

S/No	Town	Population	Sample size (5% of the population)
1.	Ayetoro	820	41
2.	Erunna	620	31
3.	Oroto	560	28
4.	Olotu	500	25
5.	Yaye	640	32
6.	Womiterin	580	29
7.	Idi-ogba	520	26
8.	Lepe	600	30
9.	Obe-Adun	680	34
10	Obe-nla	660	33
Total	10	6,180	309

Frequency and vice versa age distributions and descriptive statistical method were decision based on calculated values of Grand Mean (GMV) and Mean Weight Value (MWV). The decision stated thus, accept the response if GMV is below the MWV, and vice versa. The mean score below 2.50 was regarded as low, mean score between 2.50 and 3.49 were regarded as moderate and mean score from 3.50 and above were considered high.

3. Results and Discussion

3.1 Socio-economic characteristics of the respondents

The result shows on Table 2 revealed that majority of the respondents are male with 47.81% and female with 52.19%. Further, 89.2% are married, 5.4% of the respondents were divorced, and 5.4% are widowed. The respondent on age distribution revealed that 10.1% fell below 25 years; 19.2% fell within the age bracket of 25-34 years; followed by 25.6% that fell between 35 and 44 years of age. 17.2% of 45- 54 years, and 27.9% fell within the age bracket 55 years and above. The highest records 27.9% of the respondents between age 35 and 44years, which confirmed the accessible age group during the survey. This implies that most of the respondents are within their active age and knowledgeable about flooding prevention methods in Ayetoro and its environs. The age distribution shows a significant proportion of respondents (27.9%) are 55 years and older, followed by those aged 35–44 (25.6%). Younger age groups (below 25 and 25–34) represent a smaller fraction, suggesting an older demographic predominates in the sample.

Demographic result on marital status of the respondents revealed a large majority (89.2%) of respondents are married, indicating a strong presence of married individuals in the sample. The low percentages of divorced and widowed respondents (5.4% each) suggest that marital stability may be a common trait in this population. Length of Stay in Ayetoro and its environs significantly revealed that 6.0% have been in Ayetoro and its environs for 1 and 10years, 9.1% for 11 and 20years, 5.4% for 21 and 30years and majority (79.5%) have lived in their Ayetoro and its environs for 21 years or more. This indicates a stable population that has likely formed strong community ties, while only a small percentage have lived there for less than 20 years.

The educational qualification of the respondents indicated that 4% had no formal education, 10.4% possessed their SSCE certificate, 37.8% possess NCE/OND certificate and 47.8% possessed B.SC/B. Ed/B.A. this indicated that most respondents hold a degree (B.SC/B.ED/B.A) at 47.8%, and a substantial portion (37.8%) have completed NCE/OND. Only a small percentage lack formal education, suggesting a generally educated population. Higher educational attainment often correlates with better access to information and resources, which can enhance community resilience through improved preparedness and recovery strategies. The occupational result from the respondents revealed that the majority (57.24%) are involved in trading or business, indicating a strong entrepreneurial presence. A smaller segment is employed as civil servants, while only 5.4% are unemployed, reflecting a generally active workforce (5.30%, 21.21%, 13.46%, 57.24%, and 2.69%).

Table 2. Socio- economic characteristics of the respondents

Variables	Responses	Frequency	Percentage %
Sex	Male	142	47.81
	Female	155	52.19
Age	Below 25 years	30	10.1
	25– 34 years	57	19.2
	35 – 44 years	76	25.6
	45 – 54 years	51	17.2
	55 years and above	83	27.9
Marriage	Married	265	89.2
	Divorced	16	5.4
	Widowed	16	5.4
Length of Stay	1 – 10 years	18	6.0
	11- 20 years	27	9.1
	21 – 30 years	236	79.5
	31 years and above	16	5.4
Education qualification	No formal education	12	4.0
	SSCE	31	10.4
	NCE/OND	112	37.8
	B.SC/B.ED/B.A	142	47.8
Occupation	Unemployed	16	5.4
	Civil servant	63	21.21
	Self – employed	40	13.46
	Trader/Business	170	57.24
	Others	8	2.69
Income	Below N50, 000	10	3.4
	N50,000 to N99,000	63	21.2
	N100,000 to N199, 000	218	73.40
	N200,000 and above	6	2.0

Demographic income of the respondents revealed a significant majority (73.40%) earn between N100,000 and N199,000, indicating a relatively stable income range for most respondents. Very few earn below N50,000, and only a small percentage earn N200,000 or more, suggesting that higher income brackets are less common. Significant majority (70%) earn between N100,000 and N199,000, indicating a middle-income bracket. This group might have some resources for resilience-building but may still struggle with significant losses during flooding events. Understanding income dynamics can help in designing financial assistance programs. The results provide insights into the socio-economic characteristics, stability, educational attainment, occupational engagement, and income levels of the sample population.

3.2 Indigenous knowledge and practice on flood prediction in the study area

In Table 3, the mean values on indigenous knowledge and practices of flood prediction, within the study community was high. The result showed that total grand mean weight value 3.11 was greater than standard mean score 2.50. This indicated that the indigenous knowledge and practices on flood prediction, mitigation, and adaptation exist within the study community was moderate. Therefore, indigenous knowledge and practices on flood prediction, mitigation, and adaptation exist within the study community are traditional (oracle) consultations, seasonal rainfall pattern, plant indication, appearance of special fish, movement of certain flies, thunder sound /storm, appearance of strange bird, water volume, sea noise and direction of wind.

Results of our findings in Table 3 further revealed that there was moderate level of indigenous knowledge as observed on plant indication, sea noise, direction of wind, water volume, appearance of strange bird, appearance of special fish, thunder sound /storm, movement of certain flies, traditional (oracle) consultations, seasonal rainfall pattern and direction of cloud formation in relation to mean weight values (MWV) of 2.68, 3.30, 2.77,

3.41, 3.59, 3.37, 3.56, 3.20, 2.46, 3.37 and 2.53 respectively. The MWV higher than GMWV (3.11) implying that there was majorly existing indigenous knowledge based on early warning method for flood prediction in the study area. These practices rely on natural signs, highlighting a strong connection between local ecological knowledge and flood control. This result disagreed with Matsika (2012), who emphasized that indigenous knowledge is rooted in the experiences of local communities as they navigate their daily lives. Similarly, (Sillitoe, 2000) stressed that such knowledge emerges from long-standing relationships between society and nature, passed down through generations. These findings indicated that, indigenous practices are effective to some extent, their moderate rating indicates potential limitations in addressing more complex or unprecedented flood events. Therefore, integrating traditional knowledge with modern approaches could enhance overall flood management in the community.

Table 3. Indicators of Indigenous flood prediction

Variable	Responses				Likert's rating				TWV	MWV	Decision
	SA	A	DS	SD	4	3	2	1			
Plant indication	136	31	80	-	544	93	160	-	797	2.68	Rejected
Water volume	94	201	2	-	376	603	4	-	983	3.30	Accepted
Sea noise	98	75	84	40	392	225	168	40	825	2.77	Rejected
Direction of wind	130	162	4	1	520	486	8	1	1,015	3.41	Accepted
Appearance of strange bird	186	105	3	3	744	315	6	3	1,068	3.59	Accepted
Appearance of special fish	113	183	1	-	452	549	1	-	1,002	3.37	Accepted
Thunder sound /storm	171	123	2	1	684	369	4	1	1,058	3.56	Accepted
Movement of certain flies	97	165	35	-	388	495	70	-	953	3.20	Accepted
Traditional (oracle) consultations	63	105	35	94	252	315	70	94	731	2.46	Rejected
Seasonal rainfall pattern	142	124	31	-	568	372	62	-	1,002	3.37	Accepted
Direction of cloud formation	63	48	170	16	252	144	340	16	752	2.53	Rejected
GMWV = Grand Mean Value										3.11	

Note: SA = strongly agree; A = agree; DS = disagree; SD = strongly disagree.

It was also revealed in Table 4 that 68.4% of the respondents agreed with the statement that the prevention of flood activities in Ayetoro and its environs are based on traditional practices, while 31.6% disagreed. This implies that prevention of flood activities in Ayetoro and its environs are based on traditional practices. It was also observed that 88.4% of the respondents agreed that Warning of flood occurrence are by natural signs, while 11.6% disagreed. This implies that Warning of flood occurrence are by natural signs. Item 3, indicated that 88.4% agreed that the community's indigenous methods for flood prevention are majorly from local perception while 11.6% disagreed. Item 4 observed that 80% of the respondents agreed that information on flood prevention from modern technology are not adequate while 31.7% disagreed. Item 5 observed that 80% of the respondents agreed that local farmers and fishermen are the major sources of information for flood control in Ayetoro and its environs, while 20% disagreed. Item 6, indicated that 94.4% agreed that our community actively preserves and transmits indigenous knowledge of flood control to younger ones in Ayetoro and its environs, while 5.6% disagreed. Item 7 observed that 68.3% of the respondents agreed that indigenous are practically behind in IEWM while 31.7% disagreed. Item 8, indicated that 73.7% agreed that IEWM has preventing us from flooding while 26.3% disagreed. Item 9 observed that 31.7% of the respondents agreed that there is still flooding disconnection despite IEWM while 56.8% disagreed. Lastly, item 10 affirmed

with the majority 72.7% that government needs to consider adoption of integrating IEWM with modern technology, while 27.3% disagreed.

Table 4. Early warning methods for flood prediction

Variable	Responses				Likert's Rating				TWV	MWV	Decision
	SA	A	DS	SD	4	3	2	1			
The practices of flood prevention in Ayetoro and its environs are by traditional institutions	198	5	90	4	792	15	180	4	991	3.33	Accepted
Warning of flood occurrence are observed through natural signs	201	-	95	1	804	-	190	1	995	3.35	Accepted
The community's indigenous knowledge on flood prevention has been for many years	-	246	48	3	-	738	96	3	837	2.81	Rejected
Information on flood warning by modern technology are not adequate	212	2	5	78	848	6	10	78	942	3.17	Rejected
Local farmers and fishermen are the major sources of information for flood warning in Ayetoro and its environs	201	2	94		804	6	188	-	998	3.36	Accepted
Community elders believe in transmitting indigenous knowledge of flooding control to younger ones in Ayetoro and its environs	188	93	16	-	752	279	32	-	1,063	3.57	Accepted
Indigenous are practically behind in IEWM	204		93		816	-	186	-	1,002	3.37	Accepted
IEWM has not totally prevented us from flooding	219	-	78	-	876	-	156	-	1,032	3.47	Accepted
There is still flooding disconnection despite IEWM	127	1	169	-	508	3	338	-	842	2.85	Rejected
Government needs to consider integrating IEWM with modern technology	185	31	81	-	740	93	162	-	995	3.35	Accepted
GMWV	3.26										

3.3 Effectiveness of indigenous-knowledge based EWM for flood prediction in the study area

In Table 5, a high consent (97.3%) of respondents on the effectiveness of indigenous-based EWM, supported by the grand mean value of 3.32 were observed. However, the

recorded 3.18, 3.14, 2.77, and 3.23 MWVs for this parameter indicates that GMWV (3.32) is higher than the MWVs implying that variables under consideration have not totally prevented flooding occurrence, and that there is still flooding activities. Hence, government needs to consider integrating modern technology to enhance the existing flood related indicators of indigenous flood prediction in the study area. Factors contributing to this perception include the timeliness and reliability of the information, trust in the accuracy of predictions, the ease of understanding through local dialects, and the role of EWM in improving preparedness.

Table 5. Effectiveness of the indigenous- knowledge based EWM for combating flood in Ayetoro and its environs

Variable	Responses				Likert's rating				TWV	MWV	Decision
	SA	A	DS	SD	4	3	2	1			
The information provided by the indigenous-based EWM is timely and reliable	97	160	37	3	388	480	74	3	945	3.18	Rejected
Community members trust only the accuracy of the indigenous-based EWM predictions`	169	3	123	2	676	9	246	2	933	3.14	Rejected
The indigenous-based EWM is easily understood through the local dialect involved	113	3	181	-	452	9	362	-	823	2.77	Rejected
The indigenous-based EWM has improved our community's preparedness for flood occurrence	160	130	4	3	640	390	8	3	1,041	3.50	Accepted
The IEWM is no sufficient in preventing us from yearly flood occurrence.	184	4	105	4	736	12	210	4	962	3.23	Rejected
There is sufficient evidence in EWM in averting flood occurrence in the past	129	160	6	2	516	480	12	2	1,010	3.40	Accepted
So far, the indigenous-based IEWM has to certain extent so far enhanced our community's resilience to flood disasters	234	19	44	-	936	57	88	-	1,081	3.63	Accepted
Nature is best believed as indicator of early Warning of flood in my community	258	8	31		1,032	24	62	-	1,118	3.76	Accepted
GMWV	3.32										

This finding resonates with the work of various scholars who emphasize the importance of trust and cultural relevance in the success of early warning systems. For instance, Wisner et al. (2004) noted that the effectiveness of any warning system depends significantly on the level of trust and understanding it generates within the community. The strong community trust in indigenous-based EWM indicates a deep-rooted cultural alignment with these systems, which underscores their importance in flood risk reduction.

Further analyses of effectiveness of the indigenous-based EWM in combating flood in Ayetoro and its environs were equally presented in Table 5. It was indicated that the respondents (86.5%) affirmed that information provided by the indigenous-based EWM is timely and reliable, although 13.5% of them refuted. In a similar trend 57.9% of the respondents agreed that community member's trust only the accuracy of the indigenous-based EWM predictions, however 42.1% of them disagreed.

Respondents (39%) were of the opinion that indigenous-based EWM was easily understood through the local dialect involved, meanwhile 61% of them refute this impression. The statement that says the indigenous-based EWM has improved our community's preparedness for flood occurrence was supported by 97.7% of the respondents, meanwhile 2.3% of them report contrarily. Item 5, revealed that 63.3% of the respondents feel safer knowing that our community has an indigenous-based EWM in place for flood predictions, although 36.7% of them report contrarily.

Item 6 on Table 5 indicated that the respondents (92%) opined that there is sufficient evidence in EWM in averting flood occurrence in the past, although 8% of them were of a contrary opinion. In a similar trend 85.2% of the respondents affirmed that the indigenous-based EWM has enhanced our community's resilience to flood disasters, however 14.8% of them report differently. Lastly, the percentage of the respondents (89.6%) were of the impression the indigenous-based EWM has enhanced our community's resilience to flood disasters, meanwhile 10.4% of them refuted.

The result from objective two revealed the average observation of the respondents (97.3%) consenting the statements that perceptions of community members regarding the effectiveness of the indigenous-based EWM in enhancing flood mitigation in Ayetoro. This was such that 97.3% of the respondents strongly agreed these statements, though 2.7% of them disagreed. To further confirm this result is the grand mean value of 3.49 which ascertained that majority agreed that effectiveness of the indigenous-based EWM in combating flood in Ayetoro was high due to their perception was based on the information provided by the indigenous-based EWM is timely and reliable, community members trust only the accuracy of the indigenous-based EWM predictions, the indigenous-based EWM is easily understood through the local dialect involved and the indigenous-based EWM has improved their community's preparedness for flood occurrence.

3.4 Integration of IEWM into modern technology for flood control in the study area

In Table 6, nearly all the respondents (93.9%) opined that integrating indigenous knowledge into modern technology can enhance the accuracy of flood predictions, although 6.1% of them were of a contrary opinion. In a similar trend, 89.9% of the respondents affirmed that modern technology should incorporate indigenous methods of flood prediction using local dialect, however 10.1% of them report differently. The percentage of the respondents (67.7%) in Table 6 was of the impression that local indicators of IEWM should be incorporated into the modern technology, meanwhile 32.3% of them refuted. The statement that training programs should be provided to enable the integration of indigenous knowledge with modern technology for developing an improved early warning methods by 53.5% of the respondents, meanwhile 46.5% of them report contrarily. About 88.6% of the respondents were of the opinion that government should allocate funds for the process and development and implementation of the integration, however 11.4% of them report contrarily. It was reported that the respondents (47.5%) affirmed that the technology of integration should be cultural allied for better understanding of its operation among the people while, 52.5% disagreed with statement. Nearly all the respondents (69.9%) were of

the opinion that collaboration efforts should focus on implementation of effective early warning system, meanwhile 30.1% of them were of a contrary opinion.

It was the idea of larger number of the respondents (98.7%) that regular community workshops and feedback are essential to strengthen the integration, although 1.3% of them did not bid this idea. Lastly 56.6% of the respondents were of the view that integrating indigenous knowledge with modern technology can reduce the impact of floods in Ayetoro and its environs, however 43.4% of them were of a contrary view.

Table 6. Community perception on integrating indigenous based EWM into modern technology

Variable	Responses				Likert's rating				TWV	MWV	Decision
	SA	A	DS	SD	4	3	2	1			
Integrating indigenous knowledge into modern technology can enhance the accuracy of flood predictions	128	151	18	-	512	453	36	-	1,001	3.37	Accepted
Modern technology should incorporate indigenous methods of flood prediction using local dialect	267	-	17	13	1,068	-	34	13	1,115	3.75	Accepted
Local indicators of IEWM should be incorporated into the modern technology	198	3	96	-	792	12	192	-	996	3.35	Accepted
Training programs should be provided to enable the integration of indigenous knowledge with modern technology for developing an improved early warning method	155	4	138	-	620	12	276	-	908	3.05	Rejected
Government should allocate funds for the process and development and implementation of the integration	261	2	18	16	1,044	6	36	16	1,102	3.71	Accepted
The technology of integration should be cultural allied for better understanding of its operation among the people	113	28	155	1	452	84	310	1	847	2.85	Rejected
The collaboration efforts should focus on implementation of effective early warning system	16	182	98	1	64	546	196	1	807	2.71	Rejected
Regular community workshops and feedback are essential to strengthen the integration	97	196	3	1	388	588	6	1	983	3.30	Accepted
Integrating indigenous knowledge with modern technology can reduce the impact of floods in Ayetoro and it environ.	149	19	129	-	596	57	258	-	911	3.06	Rejected
GMWV	3.23										

The result on Table 6 indicated that majority of respondents (53.9%) supported the integration of indigenous knowledge with modern technology, with record of 3.37, 3.75, 3.35, 3.71 and 3.30 MWVs for these parameters, which are higher than GMWV (3.23) implying that modern technology should incorporate indigenous methods of flood

prediction using local dialect, training programs should be provided to enable the integration of indigenous knowledge with modern technology for developing an improved early warning method, the collaboration efforts should focus on implementation of effective early warning system and integrating indigenous knowledge with modern technology can reduce the impact of floods in Ayetoro and its environs was rejected and does not match up with community perception on integrating indigenous based EWM into modern technology. This reveals the community's recognition of the limitations of indigenous methods and the potential benefits of combining them with technological advancements. The desire for training programs, technology integration, and regular workshops highlights the community's awareness of the need for capacity building and enhanced communication. These findings align with research by Agrawal (1995) and Nyong et al. (2007), who advocated for a hybrid approach that integrates local knowledge with scientific advancements. This integration could potentially strengthen early warning systems, making them more robust and adaptable to changing environmental conditions. The community's openness to technology suggests a path forward for sustainable flood management strategies, combining the strengths of both traditional and modern systems.

3.5 4.5 Challenges of integrating IEWM and MEWM

Table 7 presents result on the challenges and barriers are encountered in the development and implementation of the indigenous-based and modern EWM. It was reported that the respondents (84.5%) affirmed that There is lack of funding for research and development of indigenous-based EWM while, 15.5% disagreed with the statement. Nearly all the respondents (94.3%) were of the opinion that communication barriers exist between indigenous knowledge holders and modern technology experts, meanwhile 5.7% of them were of a contrary opinion.

It was the idea of larger number of the respondents (94.3%) that they believe that resistance from community members who prefer traditional methods over modern technology could be a barrier, although 5.7% of them did not bid this idea. The statement that there is lack of integration between indigenous knowledge and scientific data for developing EWM supported by 98.3% of the respondents, meanwhile 1.7% of them report contrarily. About 98.3% of the respondents were of the view that insufficient training and capacity building programs for community members involved in EWM development, however 1.6% of them were of a contrary view.

Table 7. Challenges of integrating indigenous- knowledge based EWM with modern methods for flood control in the study area

Variable	Responses				Likert's rating				TWV	MWV	Decision
	SA	A	DS	SD	4	3	2	1			
There is lack of funding for research and development of indigenous-based EWM	250	1	1	45	1,000	3	2	45	1,050	3.53	Accepted
Modern technology should incorporate indigenous methods of flood prediction using local dialect	267	-	17	13	1,068	-	34	13	1,115	3.75	Accepted
Communication barriers exist between indigenous knowledge holders and modern technology experts	276	4	14	3	1,104	12	28	3	1,147	3.86	Accepted
Training programs should be provided to enable the integration	155	4	138	-	620	12	276	-	908	3.05	Rejected

Variable	Responses				Likert's rating				TWV	MWV	Decision
	SA	A	DS	SD	4	3	2	1			
of indigenous knowledge with modern technology for developing an improved early warning method											
There is resistance from community members who prefer traditional methods over modern technology could be a barrier	255	18	22	2	1,020	54	44	2	1,120	3.77	Accepted
The technology of integration should be cultural allied for better understanding of its operation among the people	113	28	155	1	452	84	310	1	847	2.85	Accepted
There is lack of integration between indigenous knowledge and scientific data for developing MEWM	47	245	3	2	188	735	6	2	931	3.13	Rejected
Insufficient training and capacity building programs for community members involved in EWM development	63	229	4	1	252	687	8	1	948	3.19	Rejected
Government policies do not adequately support the integration of indigenous knowledge into MEWM	215	59	18	5	860	177	36	5	1,078	3.62	Accepted
Technological infrastructure limitations hinder the effective implementation MEWM in remote areas	220	33	42	2	880	99	84	2	1,065	3.58	Accepted
GMWV	3.43										

The percentage of the respondents (92.2%) were of the impression that government policies do not adequately support the integration of indigenous knowledge into modern EWM, while 7.8% refuted this. About 85.2% of the respondents were of the opinion that technological infrastructure limitations hinder the effective implementation of EWM in remote areas, whereas 14.8% disagreed. It was indicated that nearly all the respondents (94.2%) affirmed that low level of education contributes to low acceptance of indigenous-based integration in Ayetoro and its environs, although 6.7% refuted this. In a similar trend, 73.8% of the respondents agreed that there is fear of erosion of cultural ideas in the process of IEWM and MEWM integration, while 26.2% disagreed. The majority of the respondents (98.6%) were of the impression that collaboration between stakeholders (indigenous communities, scientists, policymakers) is essential to overcome barriers in EWM development, while 1.4% refuted this.

The result from objective four showed that the average observation of respondents (94.8%) consenting to the statements recorded 3.05, 3.13, and 3.19 MWV for the parameters. This indicates that the GMWV (3.43) is higher than the MWV, implying that communication barriers exist between indigenous knowledge holders and modern technology experts, there is lack of integration between indigenous knowledge and scientific data for developing MEWM, technological infrastructure limitations hinder effective implementation in remote areas, and there is fear of erosion of cultural ideas during IEWM and MEWM integration. This high level of agreement among respondents regarding the challenges and barriers to the development and implementation of indigenous and modern EWMs reflects significant obstacles. Challenges such as limited funding, communication barriers, preference for traditional methods over modern technology, insufficient training, and unfavorable government policies were commonly reported.

These challenges are consistent with findings from previous research. For instance, Hellmuth et al. (2007) noted that financial constraints and inadequate institutional support are major barriers to the effective implementation of early warning systems in developing countries. Moreover, Mazzorana et al. (2014) highlighted that communication barriers and lack of capacity-building programs hinder the full utilization of both indigenous and modern EWM systems. Addressing these barriers requires targeted interventions, such as increasing government funding, improving communication infrastructure, and providing community training. Strengthening policy frameworks that encourage collaboration between traditional and modern knowledge systems could also help overcome these challenges.

4. Conclusions

The study revealed that indigenous methods for early warning play a crucial role in flood prediction in Ayetoro and its environs. However, a hybrid system that leverages both traditional knowledge and modern technology would enhance the community's flood resilience. While its effectiveness could be enhanced through the integration of modern technology. The study established that funding limitations, communication barriers, and the lack of policy support are the significant hindrances to the integration of modern technology and indigenous methods. To ensure a more comprehensive and sustainable approach to flood mitigation in the study area, this study recommends government advocacy efforts that focus on securing government support through policy reforms that would prioritize funding and technical capacity for community-based flood management strategies.

Acknowledgement

The authors would like to thank all individuals who contributed to this research, including those who provided technical assistance, proofreading, and valuable suggestions during the preparation of this manuscript.

Author Contribution

Conceptualization, A.D.O. and E.O.; Methodology, A.D.O. and E.O.; Formal Analysis, A.D.O. and E.O.; Writing – Original Draft Preparation, A.D.O. and E.O.; Writing – Review & Editing, A.D.O. and E.O.; Supervision, A.D.O. and E.O.

Funding

This research received no external funding.

Ethical Review Board Statement

Not available.

Informed Consent Statement

Not available.

Data Availability Statement

Not available.

Conflicts of Interest

The authors declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the authors used Grammarly to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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