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Assessing the effectiveness of early warning systems in Somaliland: Functionality, community response, and system gap

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ABSTRACT

In Somaliland, a region vulnerable to recurrent droughts, conflict, and disease outbreaks, effective early warning systems (EWS) are essential for mitigating the impacts of disasters. This study assessed the effectiveness of Somaliland's EWS in four climate-vulnerable regions, focusing on their functionality, community response, and systemic gaps. Employing a mixed methods design that integrated household surveys with qualitative data from key informant interviews and focus group discussions, this study used descriptive statistics, Chi-square analysis, and thematic analysis for data interpretation. The findings revealed that the EWS were only partially functional, demonstrating moderate success in hazard monitoring but significant failures in disseminating clear and timely warnings and enabling community response. Systemic gaps, including institutional weaknesses, fragmented coordination, inadequate resources, and operational failures, such as data inaccuracies and delays, hinder effective warning dissemination. Consequently, these deficiencies result in low levels of community preparedness and adaptive capacity. The analysis confirmed this vulnerability, showing that awareness of EWS is significantly lower among women and less-educated individuals, placing them at a disproportionately greater disaster risk. To enhance efficacy, this study's recommendations include strengthening communication channels via appropriate mobile technologies, empowering local communities through targeted training and resources, systematically integrating indigenous knowledge with scientific data, and expanding the system's scope to cover a broader range of hazards.

Keywords: assessment, early warning systems, gaps, functioning, Somaliland

INTRODUCTION

Globally, natural disasters disproportionately harm low-income nations, with African countries being particularly vulnerable to their impacts (Adedeji et al., 2020; Lumbroso et al., 2016). Within Africa, droughts are exceptionally destructive hazards, accounting for over 88% of all disaster-related impacts on the continent (Masinde, 2015). This threat is not purely natural; it is amplified by human activities, such as overgrazing and land degradation, which compound climate-induced stress (Awale, 2024). This convergence of factors has created a severe crisis in Somaliland, where the International Organization for Migration (2024) reports that recent droughts have internally displaced over a million people, devastating livelihoods and underscoring the region's profound vulnerability (Rajasekar et al., 2024).

Somaliland, an arid and semi-arid region in the Horn of Africa (HOA), is profoundly susceptible to the escalating impacts of climate change, including the increased frequency and intensity of droughts, floods, and cyclones, as well as general environmental degradation (Abdullahi, 2014; Omer, 2024b, 2024c). These extreme weather events directly threaten predominantly agricultural and livestock-dependent livelihoods, leading to widespread crop failure, significant livestock loss, pervasive food insecurity, water scarcity, and mass displacement (Abdullahi, 2014; Gure, 2017; Sharmake et al., 2022). Such events disrupt agricultural production, inflate food prices, destabilize incomes, and contribute to widespread food insecurity and malnutrition, a situation evidenced by over one-third of Somaliland's population experiencing increasing food insecurity since 2010 (Omer, 2024c). Although communities have adopted some adaptation measures, these are often short-term and insufficient (Sharmake et al., 2022). This underscores the urgent need for more permanent and effective adaptation strategies, among which robust early warning systems (EWS) are paramount.

Effective disaster risk management (DRM) requires a holistic understanding of risk factors, including hazards, exposure, vulnerability, and community capacity. EWS are fundamental components of disaster risk reduction (DRR) and

serve as structured mechanisms for mitigating the adverse impacts of hazards (Trogrlić et al., 2022). As defined by the United Nations International Strategy for Disaster Reduction (2015), a people-centered EWS encompasses four interconnected components:

(1) risk knowledge (understanding hazards and vulnerabilities),

(2) monitoring and warning service (observing parameters and forecasting events),

(3) dissemination and communication (ensuring timely, clear, and actionable warnings reach those at risk), and

(4) response capability (ensuring communities are prepared and able to act appropriately).

The effectiveness of warning dissemination critically depends on its timeliness and accuracy (Basher, 2006; Kelman & Glantz, 2014).

Despite the globally recognized importance of EWS in DRR, comprehensive assessments of their on-the-ground effectiveness remain limited, particularly in complex and vulnerable contexts such as Somaliland (Lumbroso, 2017). The HOA, including Somaliland, faces a pervasive and increasing threat of natural disasters, particularly droughts, which significantly affect food security. Research indicates that the HOA experiences moderate droughts approximately every five years and severe droughts every 10 to 15 years, exacerbated by declining atmospheric water availability and increased rainfall variability (Alasow et al., 2023). Studies have confirmed the spatiotemporal variability of agricultural drought severity in Somaliland, underscoring the need for targeted mitigation and adaptation strategies (Omar et al., 2024b).

Establishing a robust and effective EWS requires a thorough understanding of region-specific hazards, exposures, and vulnerabilities to empower communities with practical coping strategies (Agbehadji et al., 2023). However, the existing literature reveals critical gaps in Somaliland's EWS and its capacity to adequately address climate risk reduction. Challenges include fragmented subsystems, inadequate infrastructure, and insufficient technical capacity (Askar, 2019). These issues are not unique to Somaliland, as similar challenges plague EWSs across Africa, manifesting as ineffective communication, bureaucratic delays (Chinguwo & Deus, 2022), unclear institutional roles, and a lack of integration of community risk perceptions (Moisès & Kunguma, 2022). Furthermore, broader issues such as insufficient drought forecasting and prioritization of flood monitoring in multi-hazard EWSs have been noted across southern Africa (Nhamo et al., 2019). This is further compounded by the concerns raised by Adedeji et al. (2020) regarding conventional drought monitoring mechanisms in sub-Saharan Africa, which often exhibit inherent limitations in timeliness, objectivity, reliability, and adequacy.

However, a critical gap persists in understanding how formal EWS interact with community-level responses and indigenous knowledge systems (IKS). IKS often comprises a deep, localized understanding of environmental indicators accumulated over generations, which communities use to predict changes (Masinde, 2015). In many contexts, particularly where formal EWS infrastructure is limited, IKS can serve as the primary or sole source of early warning (Masinde, 2015). Therefore, the effectiveness of an EWS often hinges on successfully bridging this gap and recognizing the value of local perceptions and traditional adaptive strategies (Mercer et al., 2009). The ultimate goal of an EWS is to enable timely and effective community response, which necessitates a focus on community-based disaster risk reduction (CBDRR) principles (Twigg, 2009). However, a warning, however accurate or timely, is ineffective if communities lack the resources, training, or organizational capacity to act on it. This includes developing household emergency plans, establishing local DRM committees, and fostering trust in the warning systems. Thus, the effectiveness of response capability is intrinsically linked to community engagement, resource accessibility, and practical application of preparedness measures.

Sub-Saharan Africa's pervasive vulnerability to weather-related hazards underscores the critical importance of implementing effective EWS. Although numerous EWS have been established, comprehensive assessments of their effectiveness are limited (Lumbroso, 2017). Despite advancements in science and technology, EWSs often fall short when implemented in isolation rather than as part of a comprehensive DRR strategy. This is particularly evident in Africa, where significant obstacles impede the development and effective implementation of EWS, including inadequate observation capacity, poor infrastructure, weak scientific research capabilities, and political instability (Liu, 2025). Aligning with the UNISDR's definition of DRR as a proactive effort to anticipate, reduce, and manage disaster risks (Alcántara-Ayala & Oliver-Smith, 2016), and recognizing the renewed emphasis on EWSs through the UN's "Early Warnings for All" initiative, significant gaps persist in achieving comprehensive DRR, particularly in vulnerable regions such as Somaliland (Rokhideh et al., 2025).

Therefore, this study addresses this critical gap by employing a mixed-methods approach to comprehensively evaluate the functionality, analyze community response mechanisms, and identify systemic gaps within Somaliland's EWS. By providing a nuanced understanding of Somaliland's EWS landscape, this study aims to provide targeted recommendations for its improvement, ultimately enhancing community resilience to climate-related hazards in the region.

METHODOLOGY

Research Area

This study assessed the functionality and identified gaps in EWS across four regions of Somaliland: Maroodijeeh, Togdheer, Sool, and Sanaag (**Figure 1**). These regions were strategically selected to represent the diverse geographic, socioeconomic, and cultural landscapes within Somaliland, enabling a comprehensive evaluation of EWS effectiveness across varied contexts. Notably, Somaliland declared independence from Somalia in 1991, although its sovereignty remains internationally unrecognized (Omer, 2024a).

Research Design, Approach, and Sampling Procedure

This study employed a mixed-methods research design, integrating quantitative and qualitative data collection and

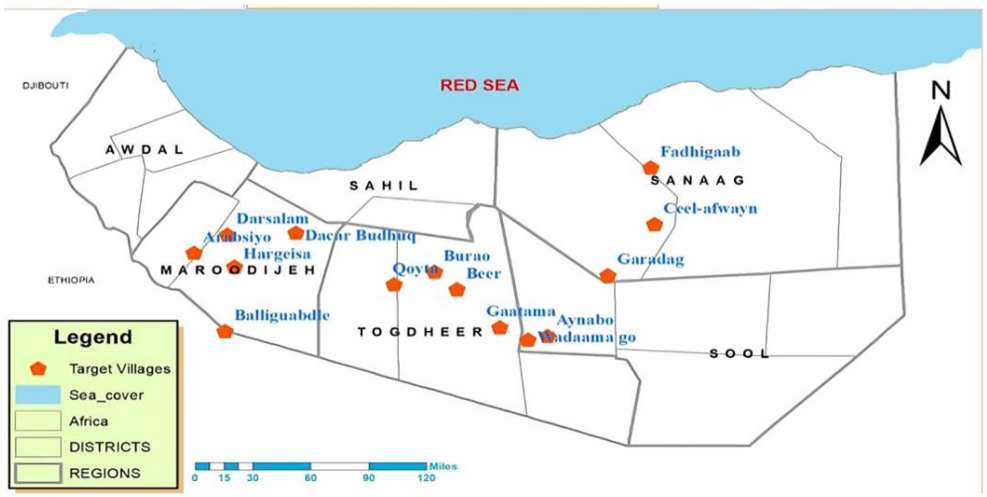

Figure 1. Study location (Source: Authors' own elaboration)

analysis techniques to provide a comprehensive understanding of the effectiveness of EWS. This approach facilitated the triangulation of findings, enhancing the validity and reliability of the study by examining both measurable outcomes (e.g., awareness levels and preparedness measures) and the contextual factors influencing implementation and impact (e.g., community perceptions and institutional capacities).

The quantitative component used a multistage sampling approach. First, four regions (Maroodijeeh, Togdheer, Sool, and Sanaag) were selected based on their vulnerability to climate-related disasters. These regions were strategically chosen to capture Somaliland's diverse profiles of vulnerability. Maroodijeeh, the most populous and administrative hub, represents urban and peri-urban vulnerabilities. Togdheer and Sool are predominantly arid pastoralist zones that have historically been recognized as epicenters of severe drought. Sanaag presents a unique combination of coastal and mountainous terrain, making it susceptible to both flash floods and droughts. This selection ensured that the assessment covered the primary livelihood systems and hazard typologies across Somaliland, enhancing the representativeness of the findings. Subsequently, districts within each region were randomly selected, followed by the selection of villages within those districts based on their population size and proximity to potential hazard zones. . Finally, a systematic random sample of 390 households was drawn from the selected villages, stratified across the four regions to ensure representativeness (Maroodijeeh 36.92%, Togdheer 22.05%, Sool 20.51%, and Sanaag 20.51%) (**Table 1**). This stratification aimed to capture diverse demographic groups (men, women, and youth) and livelihood sectors (agriculture and pastoralism) within each region of the country.

For the qualitative component, purposive sampling was employed to select participants for key informant interviews (KIIs) and focus group discussions (FGDs). Eight KIIs were conducted with individuals possessing expertise and influence within the EWS context, including government officials from relevant ministries (e.g., environment, agriculture, and water development), community leaders, and non-governmental organization (NGO) representatives. The KIIs explored expert perspectives on EWS's strengths and weaknesses of the EWS, institutional coordination, resource availability, and perceived barriers to effectiveness. Five FGDs were conducted with 6-10 participants per group, ensuring representation across diverse community segments, including women, youth, and community elders. FGDs aimed to elicit community experiences and perceptions through open-ended questions, focusing on their experiences with warnings, preparedness actions, traditional knowledge, and preferred methods of communication.

Table 1. Sample size and locations

No	Region	Village	Sample Size (n)
1	Maroodijeeh	Hargeisa	33
		Baligubadle	30
		Darasalaam	21
		Arabsiyo	30
		Dacarbudhuq	30
	Subtotal		144
2	Sool	Ainabo	32
		Wadaamo Go	28
		Gaatama	20
	Subtotal		80
3	Togdheer	Qoyta	26
		Burao	40
		Beer	20
	Subtotal		86
4	Sanaag	Gar-Adag	30
		Fadhigaab	19
		Ceel-Afweyn	31
	Subtotal		80
	Total		390

Data Sources and Collection Methods

Quantitative data were collected using a standardized household survey questionnaire comprising closed-ended questions to assess awareness, preparedness, and perceived effectiveness of EWS. The questionnaire underwent rigorous pre-testing with a small sample of households to ensure clarity, cultural appropriateness, and reliability, before full deployment. This process included face and content validation, involving feedback from local enumerators and subject matter experts to refine ambiguous questions, ensure

that the terminology was locally understood, and confirm the relevance of the indicators being measured. Its development was guided by a comprehensive review of the existing literature and consultations with subject matter experts, ensuring its validity and relevance to the study objectives. Qualitative data were gathered using semi-structured interview guides for KIIs and FGD guides for open-ended questions. Ethical protocols were strictly adhered to, including obtaining informed consent from all participants, ensuring anonymity and confidentiality, and explaining the purpose of the study. This study engaged with the inherent complexities of field research in Somaliland, including geographical access, community engagement dynamics, data reliability concerns, and temporal constraints. Rigorous mitigation strategies were employed to manage these complexities, such as logistical planning, using trained local facilitators to build trust and ensure accurate data collection, triangulating data across multiple sources, and efficient scheduling to minimize the respondent burden.

Data Analysis

A mixed-methods approach was used to analyze the data. Quantitative survey data were analyzed using descriptive statistics (frequencies and percentages) to summarize the respondents' demographics and perceptions of EWS (e.g., importance, trust, effectiveness, and preparedness). Pearson's Chi-square tests were used to identify significant disparities, such as differences in EWS awareness by gender and education level. Specifically, Chi-square tests of independence were conducted to assess the association between EWS awareness (a categorical variable: 'aware' vs. 'not aware') and key demographic variables, namely gender ('male' vs. 'female') and education level ('formal education' vs. 'no formal education'). Qualitative data from the KIIs and FGDs were subjected to an iterative thematic analysis. Transcripts were coded to identify recurring themes related to EWS strengths, systemic gaps, community preparedness and adaptive strategies. Findings from both methodologies were triangulated to corroborate insights and provide a comprehensive, contextualized understanding of EWS functionality and community response.

RESULTS

Respondent Demographics

The demographic profiles of the 390 respondents from Somaliland's Maroodijeeh, Togdheer, Sool, and Sanaag regions (**Table 2**) revealed inherent vulnerabilities that significantly influenced the efficacy of the EWS. The near-equal gender distribution (54% men, 46% women) suggests the potential for inclusive EWS participation, but low educational attainment (48.7% without formal education) poses a substantial communication challenge, particularly for warnings that rely on literacy or complex information. The predominantly middle-aged population (32.82% aged 35-44, 24.36% aged 45-54) may represent a stable knowledge base but also highlights a potential generational shift in engagement with information sources. Large household sizes (34.36% with 7-9 members, 33.59% with 4-6) underscore the significant resource demands during emergencies. The heavy reliance on vulnerable agricultural livelihoods (44.36% pastoralism and 25.38% farming) necessitates a robust climate-sensitive EWS that is integrated with social safety nets. Limited representation in non-agricultural sectors indicates restricted economic diversification and potentially limited access to diverse information sources for the farmers. These demographic characteristics collectively emphasize the need for tailored communication strategies, community-based EWS strengthening, and investment in accessible technology to overcome barriers related to low literacy, limited technology access, and economic vulnerability in the target population.

Table 2. Demographic characteristics of respondents

Variable	Categories	Frequency	Percentage
Gender	Male	210	54.00
	Female	180	46.00
Education level	No formal education	190	48.70
	Primary school	99	25.30
	Secondary school	59	15.20
	Higher education	42	10.80
Age group	18-24	35	8.97
	25-34	89	22.82
	35-44	128	32.82
	45-54	95	24.36
	55 and above	43	11.03
Household size	1-3 members	48	12.31
	4-6 members	131	33.59
	7-9 members	134	34.36
	10 or more members	77	19.74
Occupation	Farmer	99	25.38
	Livestock herding	173	44.36
	Formal employment	30	7.28
	Other/non-agricultural	88	22.56

Respondents' Knowledge of Existing Early Warning Systems in Somaliland

Quantitative survey data (**Table 3**) indicates that 71.5% of respondents reported being aware of EWS. However, qualitative insights from FGDs and KIIs revealed that this "awareness" often did not align with formal EWS concepts or protocols. Instead, communities have heavily relied on IKS for hazard prediction and management. As one FGD participant explained, "in our village, we look at the sky. We observe the constellations, speed, and direction of the wind, and compare these with what we remember from past seasons and what our elders have taught us." Beyond these traditional indicators, participants noted that information is often shared informally through word of mouth at local markets and mosques. Although these channels are widespread, they can be slow and susceptible to rumors, highlighting the need for accessible and trusted official communication. This suggests that while the term "EWS" may be recognized, many respondents did not associate it with institutionalized warning mechanisms, instead depending on traditional environmental observations.

A deeper breakdown of awareness levels across regions and hazard types revealed significant disparities: highest awareness in Maroodijeeh, moderate in Togdheer, and low in Sool and Sanaag, reflecting uneven EWS dissemination. Warnings for natural disasters (63.58% of respondents identified this type) were far better recognized than those for

Table 3. Awareness of EWS

Category	Item	Frequency	Percentage
Awareness of EWS	Yes	279	71.50
	No	111	28.50
Types of EWS known	Conflict	78	20.00
	Natural disasters	248	63.58
	Food security	22	5.64
	Disease outbreaks	42	10.78
Initial source of EWS knowledge	Government initiatives	84	21.54
	Radio/television	90	23.10
	Community meetings	64	16.41
	Traditional elders/leaders	61	15.64
	NGOs/CSOs	80	20.51
	Social media	11	2.80
Information provided by EWS	Conflict alerts	64	16.41
	Weather forecasts	259	66.41
	Disease outbreak	48	12.31
	Crop failure	19	4.87
Frequency of receiving early warning updates	Daily	7	1.79
	Weekly	29	7.44
	Monthly	113	28.97
	Rarely	191	48.97
	Never	50	12.83

Table 4. Cross-tabulation analysis of disparities in EWS awareness in gender and education, among the respondents

Demographic category		Total (n)	Aware of EWS (% within this group)	Not aware of EWS (% within this group)	Chi-square (df)	p-value
Gender	Female	180	38.33%	61.67%		181.020 (1)
	Male	210	100.00%	0.00%		
Education level	No formal education	190	41.58%	58.42%	163.33 (1)	0.000
	Formal education	200	100%	0.00%		

Note: Percentages are row-based; Chi-square tests assess the association between demographic variables and EWS awareness; and a p-value < 0.05 indicates statistical significance

conflict (20%), disease outbreaks (10.78%), or food security alerts (5.64%), indicating that the respondents prioritized climate-related threats. Radio/TV (23.1%) and government initiatives (21.54%) were the primary EWS information sources, while social media (2.82%) played a minimal role, highlighting the digital divide. Weather forecasts (66.41%) were the most frequently received alerts; however, 48.97% of respondents reported infrequent updates, and 12.83% received none, undermining their preparedness for disasters.

Nearly 92% of respondents knew local experts–primarily elders (67%), farmers (17%), and community leaders (14%)–who predicted hazards using weather patterns (65%), animal behavior (13.96%), soil conditions (11.50%), and celestial observations (8.49%). However, KIIs with representatives from the ministries of environment and climate change, agricultural development, and water development revealed that younger generations increasingly disregard traditional methods, preferring unreliable digital or radio-based forecasts to traditional methods. This erosion of indigenous knowledge, combined with inconsistent formal EWS updates, creates a critical resilience gap. In summary, these findings reveal a mismatch between perceived EWS awareness and its functional application in rural Somaliland. Communities demonstrate strong environmental observation skills but often lack access to consistent and formal warning systems to report their findings. A hybrid approach merging institutional EWS with indigenous knowledge could significantly improve disaster preparedness in these vulnerable regions.

Pearson's Chi-square tests in **Table 4** reveal significant disparities in EWS awareness across gender and education levels among the 390 respondents from Somaliland's Maroodijeeh, Togdheer, Sool, and Sanaag regions. The data show a dramatic gender gap, with 100% of male respondents reporting EWS awareness compared to only 38.33% of female respondents (χ^2 = 181.02, $p < 0.001$), indicating systemic barriers that limit women's access to warning information. Similarly, a striking educational divide existed; while all formally educated respondents (100%) were aware of the EWS, only 41.58% of those without formal education were aware (χ^2 = 163.33, $p < 0.001$). These disparities compound existing vulnerabilities, as women (often primary caregivers) and less-educated individuals face heightened risks during disasters when they are excluded from formal warning systems. The findings suggest that current EWS dissemination strategies disproportionately reach educated males, while marginalized groups that may rely more on IKS remain underrepresented. This gender and education gap in EWS awareness intersects with previously identified challenges of infrequent updates and regional disparities, further undermining community resilience. Addressing these inequities requires targeted interventions, such as gender-sensitive communication strategies, oral/local language messaging for low-literacy populations, and training programs that empower women and traditional knowledge holders as EWS disseminators within their communities.

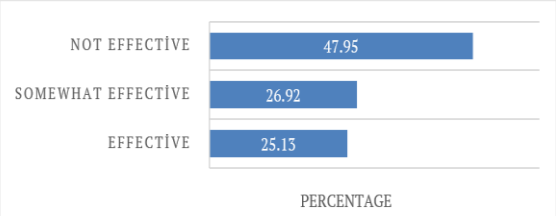

Figure 2. Perceived effectiveness of current EWS (Source: Authors' own elaboration)

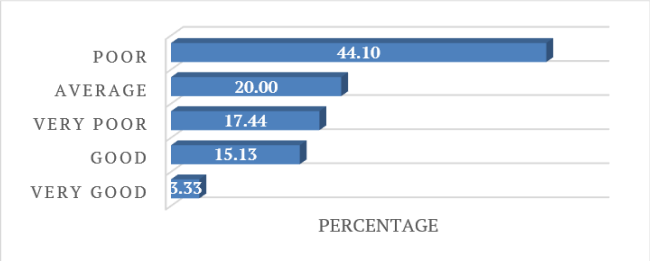

Figure 3. Perceived accuracy of EWS information (Source: Authors' own elaboration)

Analysis of Early Warning System Effectiveness, Strengths, and Systemic Gaps: Respondent Perspectives

An analysis of the EWS in Maroodijeeh, Togdheer, Sool, and Sanaag, Somaliland, reveals mixed and predominantly negative perceptions regarding its overall effectiveness, highlighting critical gaps across multiple system components.

Quantitative survey data (**Figure 2**) show that while 25.13% of respondents found the EWS effective and 26.92% found it somewhat effective, a significant 47.95% deemed it ineffective. This strongly implies that awareness alone does not necessarily translate into effective action if the underlying functional and systemic gaps are not comprehensively addressed during the training. These quantitative findings align with qualitative insights from KIIs with government ministries, FAO representatives, and local NGOs, which shed light on the system's strengths and weaknesses. Among the notable strengths is the famine early warning systems network, which is recognized for its robust data collection methods, collaborative multi-stakeholder approach, and timely reporting. Additional strengths include the coexistence of formal and informal EWS structures, general community awareness of climate risks (reflecting the 'risk knowledge' pillar of an effective EWS), and the involvement of knowledgeable local leaders and IKS holders. However, these strengths are significantly undermined by pervasive systemic weaknesses, particularly in information dissemination, directly impacting the 'dissemination and communication' pillar of the EWS. Addressing these inequities requires targeted interventions, such as gender-sensitive communication strategies, oral/local language messaging for low-literacy populations, and training programs that empower women and traditional knowledge holders as EWS disseminators in their communities. This finding directly implies that a one-size-fits-all approach to warning dissemination is ineffective and that future strategies must be tailored to the specific social and educational contexts of at-risk populations.

Furthermore, Accuracy emerged as a significant concern, with **Figure 3** revealing that over 61% of respondents perceived early warning information as either "poor" or "very poor," indicating critical deficiencies in the reliability of disseminated warnings.

Timeliness is a major concern, **Table 5**, with only 43.58% of respondents rating information as 'somewhat timely' and a substantial 38.46% reporting it as 'not timely.' Qualitative data from KIIs and FGDs triangulated these findings, with participant reports of delayed warnings corroborating the survey data and highlighting the inefficiency of existing channels (e.g., radio, word of mouth), which often led to warnings arriving too late. Clarity was also problematic, with 34.62% of participants describing warnings as unclear, which

Table 5. Effectiveness of communication of EWS

Category	Item	Frequency	Percentage
Timeliness of climate risk information	Very timely	70	17.96
	Somewhat timely	170	43.58
	Not timely	150	38.46
Clarity of warnings received	Very clear	93	23.85
	Somewhat clear	162	41.54
	Not clear	135	34.62
Information provided by EWS and effectiveness of current EWS	Conflict alerts	64	16.41
	Weather forecasts	259	66.41
	Disease outbreak	48	12.31
	Crop failure	19	4.87
	Very well	85	21.79
	Somewhat well	167	42.83
	Not well	138	35.38
Effectiveness of EWS in timely disaster/conflict alerts	Very effective	68	17.44
	Effective	71	18.20
	Somewhat effective	156	40.00
	Ineffective	95	24.36
Reach and community response to EWS	Always	28	7.18
	Sometimes	121	31.03
	Rarely	154	39.49
	Never	87	22.31

Table 6. Local capacity to respond to early warnings

Category		Frequency	Percentage
Community preparedness for conflict and natural disaster warnings	Very prepared	51	13.00
	Prepared	113	28.97
	Unprepared	226	58.03
Measures taken by households in response to early warnings	Yes	143	36.67
	No	247	63.33
Household emergency plan preparedness for disasters	Yes	175	44.87
	No	215	55.13
Key resources needed to improve community preparedness	Training in emergency response	66	16.92
	Access to information	113	29.97
	Financial resources	155	39.74
	Community drills/exercises	56	14.35

hindered appropriate interpretation and action, and suggested a critical need for clearer messaging.

Weather forecasts were widely disseminated (66.41%), whereas other critical information, such as conflict alerts (16.41%), disease outbreak warnings (12.31%), and crop failure predictions (4.87%), were significantly less frequent. This limited scope of hazard coverage leaves communities vulnerable to diverse threats, highlighting a gap in the comprehensiveness of the 'risk knowledge' and 'monitoring' pillars of the DRR framework. This infrequent dissemination of non-weather information was consistently echoed qualitatively, emphasizing a significant coverage gap for diverse hazards and reflecting a disproportionate focus on certain hazards (e.g., droughts) while neglecting others (e.g., floods and conflict-related displacement).

These persistent informational challenges (accuracy, timeliness, clarity, and coverage) directly contribute to the overall perception of EWS ineffectiveness, reinforcing why nearly half of the respondents viewed the system negatively. Similarly, the effectiveness of EWS in timely disaster/conflict alerts was rated as 'somewhat effective' by only 40%, with 24.36% deeming it 'ineffective.'

Critically, this translated into a weak community response, the ultimate measure of EWS efficacy: 39.49% reported rarely acting upon warnings, and 22.31% never acted upon them. This inaction is attributed to several systemic factors that directly impact the 'response capability' and 'dissemination' pillars: limited communication infrastructure (50%), restricted literacy and technology access (24%), geographic isolation (15%), insufficient resources (50%), poor coordination (20%), and lack of trust in the system (15%). Experts have estimated that <20% of the population receives timely and actionable EWS information, further underscoring these deficiencies.

KIIs with representatives of government and international organizations further revealed specific EWS failures corroborating these gaps:

(1) drought–untimely warnings leading to livestock and crop losses, exacerbating food insecurity;

(2) 2023 flooding–inaccurate rainfall predictions resulting in infrastructure damage and displacement; and

(3) 2019–2020 locust invasion–slow response times amplifying the devastation.

These specific EWS failures, coupled with broader technical limitations (particularly in predictive accuracy), demonstrate that even when risks are identified, they rarely translate into preventive actions because of the weak response mechanisms. Furthermore, external threats, such as escalating climate-related disasters and political instability, exacerbate EWS challenges, despite opportunities like increasing climate awareness and potential for training programs.

In conclusion, while respondents acknowledged some EWS strengths (timely delivery, clear communication, and wide coverage at times), these were profoundly undermined by pervasive weaknesses, including delays, poor infrastructure, limited coverage, inaccuracy, low community engagement, poor coordination, and a fundamental lack of trust. These findings highlight the urgent need for comprehensive strategies to improve timeliness, communication, coverage, accuracy, engagement, and coordination across all EWS pillars, which are crucial for enhancing EWS functionality and fostering effective community responses in Somaliland.

Local Community Response Capabilities to Early Warnings: Respondent Perspectives

Community preparedness for conflict and natural disaster warnings in Somaliland is critically low, directly undermining the 'response capability' pillar of EWS. A concerning majority of respondents (58.03%) felt unprepared (**Table 6**), with only 36.67% taking measures post-warning and less than half (44.87%) possessing emergency household plans. This significant gap between warning dissemination and community action highlights a critical failure in translating 'dissemination' into an effective 'response'.

Qualitative data from FGDs and KIIs powerfully corroborate these findings, revealing the complex interplay of challenges and needs. The FGD participants unanimously expressed unpreparedness due to insufficient resources and inadequate training, with actions often characterized by haste and disorganization. KIIs with government ministries highlighted significant institutional and financial limitations, leading to reactive disaster management rather than proactive disaster management. As one official noted, "*national plans are ineffective and less coordinated, whilst humanitarian agencies may intervene after the threshold of the disasters*," underscoring systemic shortcomings in the national response. Beyond the immediate response, qualitative insights revealed deeper vulnerabilities, such as exacerbated drought impacts, erosion of traditional forecasting reliability, and emerging climate-related threats such as new pests and declining soil fertility. However, communities demonstrate agency through

"community-driven adaptation," emphasizing the need to integrate indigenous knowledge into formal EWS.

To bridge the critical response gap, respondents identified key resources: financial resources (39.74%), access to information (29.97%), emergency response training (16.92%), and community drills/exercises (14.35%). These findings collectively emphasize that while the demand for effective EWS is high, the critical challenge lies in building practical and proactive community capacity. This necessitates a multi-pronged approach encompassing increased resource investment, enhanced training, comprehensive disaster management plans, and better-coordinated government strategies to foster genuine community resilience through robust CBDRR.

DISCUSSION

This study reveals that Somaliland's EWS are undermined by significant functional and systemic weaknesses. Although general awareness of the EWS exists, its effectiveness is severely limited by sociodemographic disparities, flawed communication, and a critical gap between warnings and community action.

This study identified profound disparities in EWS awareness and comprehension, particularly in terms of dissemination and communication. Gender and education level were strong predictors of awareness; all formally educated and male respondents were aware of the EWS, compared to two-fifths of those without formal education and one-third of female respondents. This finding confirms the existing literature on how socioeconomic factors shape EWS reach (United Nations International Strategy for Disaster Reduction, 2015). Current communication strategies fail to reach vulnerable groups owing to an overreliance on traditional channels (radio/TV), varied literacy levels, and limited technological access, which is a challenge that is echoed in global EWS implementation (Intergovernmental Panel on Climate Change, 2022). The effectiveness of warnings was further compromised by poor timeliness and clarity, with over a third of alerts reported as "not timely" or "unclear." This aligns with research from other developing contexts, where ineffective and delayed communication remains a primary barrier to disaster preparedness (Basher, 2006; Chinguwo & Deus, 2022).

The minimal role of social media (2.82%) underscores the significant digital divide and highlights the inappropriateness of relying on Internet-based platforms for warning dissemination in these regions. Bridging this gap does not necessarily mean pushing for universal Internet access. Instead, it requires leveraging more accessible and appropriate technology. The high mobile phone penetration in Somaliland, including rural areas, presents a major opportunity. Strategies focused on SMS-based alerts, automated voice messages in Somali, and strengthening community radio broadcasts are more likely to succeed in reaching marginalized populations than web-based solutions.

Furthermore, a critical finding reinforced by qualitative data is the deep-seated community trust in IKS over formal scientific warnings. This preference is not due to a rejection of science but stems from IKS being locally contextualized, culturally embedded, and historically proven within the community's experience. The growing disregard for this traditional knowledge by younger generations, coupled with inconsistent formal EWS updates, creates a dangerous resilience gap. Integrating these two systems is not merely about adding traditional indicators to scientific models; it is about building a hybrid system founded on mutual respect. This requires a participatory process where scientific data validates and enhances local knowledge, and local knowledge provides context and builds trust for scientific warnings (Mercer et al., 2009).

The effectiveness of EWS is also limited by its narrow focus on weather, neglecting other critical threats such as conflict, disease, and crop failure. This reflects a global issue in which few nations have comprehensive multi-hazard systems (World Meteorological Organization, 2023), a problem often associated with institutional and resource constraints (Trogrlić et al., 2022). For example, the system's failure to integrate proactive drought forecasting mirrors similar gaps in southern and sub-Saharan Africa, where outdated monitoring methods compromise the timeliness and reliability of warnings (Adedeji et al., 2020; Nhamo et al., 2019).

Qualitative findings revealed that these communication and trust issues are rooted in deeper systemic failures in the healthcare system. Government officials acknowledged that institutional and financial limitations lead to reactive and uncoordinated disaster management strategies. This is consistent with the broader challenges across Africa, where inadequate infrastructure, resource scarcity, and weak governance hinder the implementation of EWSs (Liu, 2025; Trogrlić et al., 2022).

The most critical finding of this study was the failure of the system to translate warnings into protective actions. A concerning majority of respondents felt unprepared, with just over one-third acting after a warning and more than half lacking a household emergency plan. The primary reasons for this inaction are insufficient resources, low trust in the system, and inadequate information. This confirms the core principle of DRR: warnings are only effective if communities are empowered and equipped to act (Ahmed, 2024; Twigg, 2009). Crucially, the same sociodemographic factors that limited awareness also predicted inaction, demonstrating a cascading effect in which underlying vulnerabilities prevented at-risk groups from responding effectively to the disasters.

This study was comprehensive but had several limitations. First, its geographic scope was confined to four of Somaliland's six regions; therefore, the findings may not be fully generalized. Second, the research relied on self-reported data from surveys and interviews, which may be subject to recall or social desirability bias. Third, as a cross-sectional study, it provides a snapshot in time and does not capture the dynamic evolution of EWS effectiveness across different disaster events. Future research should build on these findings. Finally, a study exploring the potential role of the private sector, particularly telecommunication companies, in financing and scaling up warning dissemination channels could provide valuable insights into sustainable improvements.

CONCLUSIONS AND RECOMMENDATIONS

Somaliland's EWS is fundamentally ineffective, constrained by a critical disconnect between the warnings issued and the community's ability to act. While a foundational system exists, its potential remains unrealized due to flawed communication, as warnings are often delayed, unclear, and fail to reach vulnerable populations. This is compounded by the neglect of deeply embedded IKS, which communities continue to trust over formal scientific warnings. Consequently, even when warnings are received, communities lack the resources, training, and trust needed to take protective action, leading to widespread inaction. These issues are rooted in profound institutional weaknesses, including fragmented coordination and chronic resource constraints that undermine the overall functionality of the system.

Addressing these deep-seated issues requires a multi-pronged strategy, beginning with a complete overhaul of communication and commitment to building community trust. The immediate priority must be to diversify communication channels beyond an overreliance on radio. A multichannel approach using SMS-based alerts, automated voice messages in Somali, and enhanced community radio programs is essential for reaching diverse audiences, including those with low literacy. Crucially, to build trust, these warnings must integrate IKS. This involves systematically partnering with communities to document and validate traditional indicators and then developing "hybrid" warnings that combine scientific forecasts with recognized local signs, thereby enhancing both their relevance and credibility.

However, improved warnings are only effective if they empower communities to take protective action. Therefore, an ongoing priority must be to strengthen local response capacity by directly investing in the resources that communities themselves have identified as critical: financial support for preparedness, enhanced access to information, targeted emergency response training, and regular community-based drills. Supporting the development and adoption of simple household emergency plans through community-led initiatives is vital for translating alerts into tangible actions.

Finally, these community-focused interventions must be supported by long-term institutional strengthening and a broader and systemic vision. This requires expanding the EWS to a multi-hazard framework that addresses drought, flash floods, locust invasions, and public health emergencies. To achieve this, the government must enhance coordination by establishing clear roles for all stakeholders and strengthening partnerships with international organizations, such as the FAO, WFP, and International Organization for Migration, to leverage their technical expertise and resources. By implementing these integrated recommendations, Somaliland can transform its EWS from a system of disjointed alerts into an effective and sustainable tool for mitigating the impacts of disasters and building genuine community resilience.

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