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Navigating Climate Resilience in Fragile Settings: A Retrospective Analysis of the 2023 Flood Impacts, Early Warning, and Response in Ethiopia's Somali Region

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CGIAR Initiative on Fragility, Conflict and Migration

The CGIAR Research Initiative on Fragility, Conflict, and Migration aims to enhance the resilience of food, land, and water systems in fragile and conflict-affected settings, where migration-related challenges are prevalent. By taking a systems approach and working in partnership with local stakeholders, the Initiative seeks to generate evidence to inform effective policies and programs that promote social and gender equity, climate resilience, conflict mitigation, and peace building in these settings.

Learn more about the initiative here: https://www.cgiar.org/initiative/fragility-conflict-and-migration/.

Executive Summary

The Fall 2023 floods in the Somali Region of Ethiopia caused widespread devastation, disproportionately affecting vulnerable populations, including refugees, internally displaced persons (IDPs), and host communities. This case study, conducted by the International Water Management Institute (IWMI) as part of the CGIAR Fragility, Conflict, and Migration (FCM) initiative, provides a detailed examination of the systemic factors that exacerbated the disaster's impacts. It evaluates the strengths and weaknesses of early warning systems and offers actionable recommendations to enhance disaster risk management (DRM) in the region. The analysis is based on rigorous desk research and in-depth interviews with key stakeholders, including government officials, humanitarian organizations, non-governmental organizations (NGOs), and development actors, both at the national and sub-national levels.

The study reveals critical insights into the systemic vulnerabilities, early warning challenges, and resource gaps that exacerbated the impacts of the 2023 floods in the Somali Region, as follows:

1. **Systemic Vulnerabilities:** The impact of the 2023 floods was magnified by entrenched challenges, which include poverty, lack of access to essential services, and inadequate infrastructure. These vulnerabilities were worsened by the region's exposure to conflict and the accelerating effects of climate change, which have left communities with limited capacity to cope with disasters.

2. **Forecast and Early Warning Challenges**: While advanced climate models and meteorological systems successfully predicted extreme rainfall, gaps in translating these forecasts into actionable flood warnings hindered timely responses. Factors such as insufficiently localized data, unclear communication of potential impacts, and a general mistrust of official forecast sources among communities further diminished the effectiveness of early warnings.

3. **Resource Constraints and Infrastructure Gaps**: The Somali Region's response to the floods was hampered by a lack of resources. Limited funding, damaged roads, and inadequate access to disaster response tools delayed interventions. Additionally, fragile infrastructure and maintenance difficulties exacerbated the destruction, leaving many communities stranded and vulnerable.

To enhance resilience and reduce the risk of future disasters, the study offers a set of targeted recommendations aimed at addressing identified challenges, including the following:

1. **Strengthen Data Systems**: Prioritize the creation and regular updating of localized disaster risk profiles at the district (woreda) and community (kebele) levels. These profiles should include detailed information on hazards, vulnerabilities, and community capacities, enabling stakeholders to make informed, evidence-based decisions for disaster risk management and preparedness.
2. **Advance Impact-Based Forecasting (IBF)**: Allocate resources to develop and implement Impact-Based Forecasting systems that combine meteorological data with localized vulnerability and exposure information. This approach will allow for more precise, actionable, and timely warnings that link forecasted events to their potential impacts on communities and infrastructure.
3. **Improve Early Warning Dissemination**: Strengthen communication systems to ensure that early warning messages reach remote and vulnerable communities effectively. This includes investing in "last-mile connectivity" by utilizing a mix of communication methods such as community radio, mobile alerts, and trusted local leaders to disseminate warnings in accessible languages and formats.
4. **Enhance Community Preparedness and Response**: Build the capacity of local communities and institutions through training programs and the development of pre-agreed action plans. Establish financing mechanisms that allow for rapid, anticipatory actions when disaster warnings are issued, ensuring timely and effective responses.
5. **Integrate Cultural and Social Dimensions**: Design communication strategies that are culturally and socially sensitive, taking into account local beliefs and practices. Engage religious and community leaders as advocates for disaster preparedness to build trust in scientific forecasts and increase the likelihood of early warning adoption.
6. **Expand Financial and Infrastructure Support**: Invest in disaster-resilient infrastructure such as flood shelters, water storage facilities, and robust transportation networks. Establish contingency funds to enable quick recovery and reconstruction efforts, reducing the long-term impacts of disasters on affected populations.

The 2023 floods in the Somali Region of Ethiopia underscore the urgent need for a transformative approach to disaster risk management that prioritizes systemic resilience, inclusive preparedness, and timely, actionable responses. The findings and recommendations in this case study highlight the critical importance of addressing the root causes of vulnerability while leveraging innovative tools such as impact-based forecasting and community-centered strategies. By fostering collaboration

among government entities, humanitarian organizations, and local stakeholders, Ethiopia and the Somali Region have the opportunity to not only reduce the risks associated with climate-related disasters but also to build a stronger foundation for resilient development in fragile contexts. Implementing these measures will be essential to safeguarding lives, protecting livelihoods, and empowering communities to adapt to an increasingly uncertain climate future.

Contents

Abbreviations and Acronyms

AA	Anticipatory Action
AF	Afar Region
CGIAR	Global research partnership for a food-secure future
DPPC	Disaster Prevention and Preparedness Commission
DRM	Disaster Response Management
DRM-SPIF	Disaster Risk Management Strategic Program and Investment Framework
DRR	Disaster Risk Reduction
EDRMC	Ethiopian Disaster Risk Management Commission
EWEA	Early Warning and Early Action
FAO	Food and Agriculture Organization
FbF	Forecast-Based Financing
FCAS	Fragile and Conflict-Affected Settings
FGDs	Focus Group Discussions
FORIN	Forensic Investigations of Disasters
GloFAS	Global Flood Awareness System
IBF	Impact-Based Forecasting
ICPAC - IGAD	Climate Prediction and Applications Centre
IDPs	Internally Displaced Persons
IGAD	Intergovernmental Authority on Development
IOD	Indian Ocean Dipole
IOM	International Organization for Migration
MH-IB-EW-EAS	Multi-Hazard, Impact-Based, Early Warning and Early Action System
MoWR	Ministry of Water Resources
NbS	Nature-Based Solutions
OCHA	Office for the Coordination of Humanitarian Affairs

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1. Introduction

The Somali Region of Ethiopia is a critical hotspot characterized by overlapping crises of climate-induced and conflict-driven displacement, exacerbated by recurrent extreme weather events. In 2023, the region transitioned from a historic three-year drought to unprecedented flooding, displacing tens of thousands of people before earlier displacement crises were resolved.

As of the latest reports from the United Nations High Commissioner for Refugees (UNHCR) and the International Organization for Migration (IOM), the Somali Region of Ethiopia hosts a significant number of refugees and internally displaced persons (IDPs). According to the UNHCR, as of mid-2023, there are approximately 250,000 registered refugees in the Somali Region, primarily from Somalia, reflecting the ongoing instability and conflict in the neighboring country (Pieterse, 2022). In addition to the refugee population, the IOM reports that the Somali Region has also seen a substantial increase in IDPs due to various factors, including ethnic conflicts and environmental challenges including climate change. The IDPs from the Somali Region are being displaced from various locations within the region, primarily due to ongoing conflicts and disputes along the borders that the Somali Region shares with neighboring regions such as Oromia, SNNPR, and Benshangul-Gumuz (Regasa & Lietaert, 2022). As of early 2023, there are estimated to be around 1.2 to 1.5 million IDPs within the Somali Region, many of whom have been displaced multiple times due to ongoing violence and natural disasters such as droughts and floods (OCHA 2024 and Tamir et al., 2023). According to the International Organization for Migration (IOM), as of October 2022, approximately 50% of IDP households in the Somali Region had been displaced for five years or more, indicating a significant protracted displacement situation. The combination of these figures highlights the pressing humanitarian needs in the Somali Region, necessitating coordinated efforts from various humanitarian organizations to provide adequate support and resources to both refugees and IDPs.

This convergence of climate shocks and protracted displacement has severely strained resources and governance systems. Refugees, IDPs, and host communities face compounded vulnerabilities in these circumstances, which are contributing to loss of livelihoods, food insecurity, inadequate shelter, and limited access to essential services such as healthcare, water, and education (WMO, 2023; OCHA, 2024).

The 2023 floods in Ethiopia's Somali Region were among the most devastating in recent memory, severely affecting lives, livelihoods, and infrastructure across nine zones (provinces). The floods were driven by the 2023/24 El Niño season, which brought unusually heavy and prolonged rainfall to southern Ethiopia, as predicted by the Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC). The Deyr rainy season started earlier than usual, with persistent rainfall causing rivers such as the Genale (Ganale), Dawa and Wabe Shebele rivers to overflow, resulting in widespread devastation.

Event Evolution and Impacts

The 2023 floods unfolded in three significant episodes:

1. October 2023
   Heavy rains in the Oromia highlands caused the Genale (Ganale) River to overflow, resulting in Cherrati district in the Afder Zone experiencing its worst flooding in three decades. Floodwaters submerged farmlands, displaced thousands, and destroyed crops and livestock (Regional Disaster Risk Management Bureau, 2023).

2. Late October to November 2023
   Torrential rains led to flash and riverine flooding in the Dollo Ado district and had especially strong impacts on

historically flood-prone communities, such as Gode and Bokolmayo. Rivers such as the Ganale and Dawa overflowed, displacing large portions of the population (OCHA, 2023).

3. November 2023
Heavy rainfall caused the Shabelle River to breach its banks, leading to severe flooding in the Shabelle Zone. Entire villages were submerged, roads blocked, and livelihoods destroyed, significantly impacting access and transport, as well as food security (OCHA, 2023).

Impacts on Populations and Infrastructure

The floods affected 33 woredas (districts) and 156 sites across the Somali Region, directly impacting over 611,640 people and displacing 240,000 individuals (OCHA, 2023). Vulnerable groups, such as refugees, IDPs, and host communities, were disproportionately affected. For instance, in Melkadida town residents, particularly refugees, internally displaced persons (IDPs), and host communities, experienced compounded vulnerabilities due to their already marginalized status, characterized by limited access to resources, services, and protections (UNHCR, 2023).

Key impacts included:

1. **Displacement:** The floods caused widespread displacement, particularly in Dollo Ado and Shabelle zones, forcing many communities into makeshift shelters or dependence on already strained host communities, further exacerbating their vulnerabilities (OCHA, 2023).

2. **Livelihood Losses:** The destruction of over 112,900 hectares of farmland and the death of 40,170 livestock severely impacted the livelihoods of pastoralist and agro-pastoralist communities. The loss of irrigation systems and agricultural tools further hindered recovery efforts (RDRMB, 2023).

3. **Infrastructure Damage:** Floodwaters significantly damaged public infrastructure, including the submergence of 54 schools in the Shabelle Zone, disrupting education for 10,457 students. Roads and water supply systems were also affected, limiting access to critical services (OCHA, 2023).

4. **Health Risks:** The floods led to a rise in public health issues, including diarrhoea, malaria, and malnutrition, as damaged health facilities and collapsed sanitation systems amplified health risks (OCHA, 2023).

5. **Protection Concerns:** Vulnerable populations, including women and children, faced heightened risks of exploitation. Children were increasingly engaged in child labor, while women lacked access to essential hygiene products (OCHA, 2023).

The destruction of livelihoods, homes, and infrastructure, coupled with governance challenges (e.g. response capacity from authorities reflected through administrative coordination short comings in situ as well as financial limitation to respond) and inadequate early warning systems, underscores the urgent need for further research to guide the design and implementation of more robust disaster preparedness and response mechanisms in the region.

This case study examines the 2023 floods in the Somali Region of Ethiopia to uncover critical knowledge gaps in disaster management and propose a comprehensive framework for improving preparedness and response in fragile and conflict-affected settings (FCASs). Through an in-depth analysis of operational responses and the performance of early warning systems, this study seeks to generate actionable insights that can strengthen disaster risk management practices and bolster the resilience of vulnerable communities against future extreme events.

2. Approach and Methodology

Objectives

The primary objectives of this report is to analyze the 2023 flood disaster in the Somali Region in order to:

1. **Understand the drivers of risk:** Identify the natural, socio-economic, and political factors that led to the 2023 flood impacts and analyze how these factors interacted to amplify disaster impacts.
2. **Assess EWEA performance:** Assess the functionality of the EWEA system during the flood event, focusing on risk understanding, forecast dissemination, early action planning, and governance and institutional capacity.
3. **Provide actionable recommendations:** Propose targeted recommendations for strengthening anticipatory action and long-term DRM investments in the Somali Region to mitigate risks to the most vulnerable populations of refugees, IDPs and host communities.

Research Questions and Analytical Approach

With the objective outlined above in mind, the study is guided by the following refined research questions:

1. What were the underlying drivers of risk—including natural, socio-economic, and political factors—that contributed to the 2023 floods impacts, and how did these drivers interact to create compounded impacts?
2. How effective were the existing EWEA systems during the flood event, particularly in terms of climatic and environmental risk understanding, forecast dissemination, early action planning, as well as the institutional response to the event?
3. How can anticipatory action frameworks and long-term disaster Risk Management (DRM) be strengthened in contexts like the Somali Region, where climate risks intersect with systemic vulnerabilities such as displacement and fragile governance?

While this case study focuses on the Somali Region of Ethiopia, and aims to provide guidance in this context, the research provides insights that may be relevant to other FCAS contexts. This dual focus supports the broader objectives of FCM research under its ANTICIPATE work package, which aims to strengthen institutional partner's capacity for up-scaling frameworks for disaster risk management in fragile settings, through an anticipatory action lens.

The report aims to support Ethiopian national and Somali Region authorities by providing knowledge and analysis to strengthen disaster risk management (DRM) frameworks from an 'anticipatory action' perspective. By evaluating the performance of Early Warning Early Action (EWEA) systems during the 2023 flood and identifying systemic vulnerabilities like displacement and fragile governance, the research highlights gaps and opportunities for improvement. The findings are tailored to enhance the authorities' capacity to respond proactively to increasingly frequent hazards, building resilience among vulnerable populations and ensuring more effective and coordinated disaster responses.

Methods

This study uses a mixed-methods retrospective analysis, guided by the Forensic Investigations of Disasters (FORIN) framework, to examine the 2023 floods in Ethiopia's Somali Region. The methodology integrates qualitative and quantitative approaches to

identify the natural, socio-economic, and political drivers of the disaster, evaluate the performance of Early Warning Early Action (EWEA) systems, and develop evidence-based recommendations for enhancing disaster risk management (DRM). In assessing the institutional and operational response to the 2023 floods, the study also reviewed key policy documents that guide disaster preparedness, response, and early warning systems in Ethiopia.

The FORIN framework, adapted for the Somali Region's complex socio-political and environmental context, emphasizes the root causes and cascading effects of disasters, focusing on the interplay of physical, social, and governance-related factors. This study expands the framework to include compounding risks and a detailed evaluation of EWEA systems, such as risk understanding, forecast dissemination, early action planning, and financing mechanisms.

The study also used the Pressure and Release (PAR) model (Wisner et al., 2004) to analyze flood vulnerabilities in Ethiopia's Somali Region, shedding light on the root causes, dynamic pressures, and unsafe conditions that exacerbated the 2023 floods. These insights are essential for developing effective strategies to mitigate future disasters.

By examining how risk drivers interacted and assessing anticipatory measures, the study offers actionable insights to address both immediate and systemic challenges, forming a foundation for stronger preparedness and resilience in fragile and conflict-affected settings (FCAS).

Data Collection

The data collection process for this study was conducted in two main phases, combining desk-based research with primary data collection in the field. These phases were designed to ensure a thorough and balanced analysis, drawing on both existing knowledge (i.e. scientific literature, government reports, international data sources, and historical data) and first-hand insights from affected communities and stakeholders.

The desk-based research involved a review of secondary data sources, including peer-reviewed literature, humanitarian reports, government documents, and climate data. It also included the examination of key policies guiding disaster preparedness, response, and early warning systems in Ethiopia, such as the *National Policy on Disaster Prevention and Management* and the *Roadmap for Multi-Hazard, Impact-Based Early Warning and Early Action System 2023–2030*.

This policy review provided a critical foundation for assessing the institutional and operational response to the 2023 floods. By synthesizing insights from a range of sources, the desk-based research provided a foundational understanding of the disaster and informed the design of subsequent data collection efforts.

Primary data collection captured (i) data on local experiences and perspectives from DRM practitioners on the flood event and the performance of EWEA systems. Semi-structured interviews were conducted with 12 key informants, including government officials, humanitarian workers, and representatives from non-governmental organizations (NGOs) and development agencies. These interviews explored critical topics such as the dissemination of early warnings, decision-making processes, and challenges in implementing anticipatory actions. To complement these insights, 10 focus group discussions (FGDs) were held with affected community members in five flood-affected villages across the Shebelle, Liben, and Afder zones. Separate FGDs were conducted with men and women to ensure diverse perspectives, with discussions addressing issues such as the local impacts of the floods, access to early warning information, and community-level responses.

Table 1: Summary of Primary Data Collection: Participant Categories and Information Provided (*Source: Authors' Own*)

Type of research participant	**Information provided**
Government officials	Performance of early warning and early action (EWEA) systems. Institutional decision-making processes during the flood event. Challenges in implementing anticipatory actions. Policy and operational gaps in disaster response frameworks.
Humanitarian workers	On-the-ground experiences during the flood response. Effectiveness of early warning dissemination. Challenges in mobilizing resources for interventions. Lessons learned from previous disaster responses.
NGO and development agency representatives	Strategies for mitigating flood impacts. Collaboration with government and stakeholders. Barriers to integrating anticipatory actions. Recommendations for improving coordination and response.
Community members	Local-level impacts of the floods (displacement, livelihood losses, access to services). Experiences with early warning systems. Community responses, coping mechanisms, and recovery efforts. Gender-specific perspectives (separate FGDs for men and women).
Key Informants in specialized roles	Sector-specific challenges (healthcare, education, infrastructure). Community needs and service delivery gaps. Insights into local governance and decision-making at the community level.

The review of secondary literature began in June 2024, followed by primary data collection conducted in Ethiopia in August 2024. Collecting data for a historical analysis of the 2023 floods in the Somali Region, a year after the event, presented both opportunities and challenges. The retrospective approach allowed for the collection of comprehensive data from diverse sources, including reports, community accounts, and satellite imagery, offering a broader perspective on the impacts and systemic gaps in disaster response. However, challenges arose, such as potential inaccuracies of qualitative accounts due to fading memories and difficulties in accessing key informants. To mitigate these issues, the research team employed robust triangulation methods and fostered trust with stakeholders, ensuring the collection of reliable and actionable insights.

Throughout the data collection process, ethical considerations were prioritized to ensure that participants' rights and dignity were respected. All participants provided informed consent, and their responses were anonymized to maintain confidentiality. The study also employed interpreters to facilitate FGDs in the local Somali language, ensuring clear communication and cultural sensitivity.

Data Analysis

The analysis of the 2023 flood disaster employed a combination of qualitative and quantitative methods to provide a holistic understanding of the event and its impacts on vulnerable populations. This research offers valuable insights into the opportunities and challenges shaping disaster preparedness and response in the Somali Region. The findings are intended to inform more effective anticipatory programming and enhance overall resilience to future crises.

The process began with reconstructing a detailed timeline of the disaster, using both primary data, such as interviews and focus group discussions, and secondary sources, including reports and climate data. This timeline highlighted key milestones, from the onset of heavy rainfall to the resulting impacts on communities and infrastructure. By pinpointing critical gaps in the

dissemination of early warnings and the implementation of response efforts, the timeline served as a basis for evaluating the performance and effectiveness of the Early Warning Early Action (EWEA) system.

As part of the methodology, the research team conducted a comprehensive policy review to examine the governance and institutional capacities influencing the functionality of the Early Warning Early Action (EWEA) system during the 2023 flood event. This policy analysis had two primary objectives: firstly, to understand the broader policy and institutional framework for disaster risk management (DRM) in Ethiopia, including how national and regional systems are structured to anticipate and respond to climate-induced hazards. Secondly, as part of the assessment of the responses to the 2023 floods, the team sought to complement this institutional perspective with insights from affected communities. This involved exploring how the response was perceived on the ground, identifying gaps and successes in coordination, and capturing community perceptions of the EWEA system's effectiveness.

Furthermore, the assessment of the early warning system (EWS) in this study utilized a structured approach to evaluate its effectiveness, efficiency, and capacity to achieve its objectives of reducing disaster risks and enhancing preparedness. The evaluation focused on the four key components of an EWS: risk knowledge, monitoring and warning services, dissemination and communication, and response capability. This included analyzing the availability and quality of risk data, the accuracy and timeliness of hazard monitoring (using data from IGAD Climate Prediction and Applications Centre (ICPAC) and the Global Flood Awareness System), the clarity and accessibility of warning communication, and the readiness of communities and institutions to act on warnings. Cross-cutting factors such as governance and policy frameworks, resource availability, community engagement, and inclusivity were also examined to understand systemic influences on EWS functionality.

The analysis was verified in a workshop held with representatives from government and humanitarian organizations in Jijiga in November 2024. The objective of the meeting was to bridge any critical gaps in the research and to strengthen the recommendations drafted by the research team. This was done to ensure that the findings and proposed actions incorporated diverse perspectives from the widest possible range of relevant stakeholders. While the group may not have represented every perspective comprehensively, the workshop aimed to provide a balanced platform for feedback and improvement of the research output.

Limitations

While the methodology was designed to provide a comprehensive analysis, certain limitations should be acknowledged. First, the availability of data and detailed climate records for some locations in the study area were limited, which may have affected the precision of certain analyses. For instance, data on 10 - day and extreme rainfall forecast was not difficult to access from EMI (Ethiopian Meteorological Institute); and disaster risk profiles of the visited villages were not available from village administrators. Second, security and logistical constraints restricted the field research team’s access to some flood-affected zones, potentially limiting the representativeness of the primary data. Finally, qualitative data collected through FGDs and interviews may reflect biases or recall bias although efforts were made to address this through triangulation and iterative validation.

Despite these challenges, the study’s mixed-methods approach and rigorous analytical techniques provide a solid foundation for understanding the 2023 flood disaster and for identifying pathways for improving early warning and early action systems including opportunities for implementing anticipatory action initiatives in the Somali Region.

3. Case Study Findings and Analysis

3.1 Policy and Institutional Framework for DRM In Ethiopia

The National Policy and Strategy on Disaster Risk Management (2013) is the current legal framework for Ethiopia's comprehensive national disaster management system. It is an amendment of the 1993 *National Policy on Disaster Prevention and Management* and outlines general protocols and major implementation strategies. These include establishing a decentralized DRM system, advancing early warning and risk assessment, improving information management, building capacity, and integrating disaster risk reduction (DRR) into development plans (REAP, 2022).

This policy is further supported by the Disaster Risk Management Strategic Program and Investment Framework (DRM-SPIF), which operationalizes the DRM policy by identifying priority investment areas (such as strengthening systems and institutions, investing in physical infrastructure for disaster prevention and post-disaster recovery) and estimating financing needs to be met by the Government and its development partners (GoE, 2014). Additionally, the Disaster Risk Management Research and Training Strategy (2022–2037) was developed to enhance the capacity of staff and key stakeholders while generating evidence for effective preparedness and response (EDRMC, 2022). Other tools and approaches developed in collaboration with partners (i.e. humanitarian and development agencies collaborating with the government to enhance disaster risk management efforts) since 2015 have further enhanced Ethiopia's DRM system. Notably, these include the Drought Anticipatory Action Plan (AAP) and the Flood Anticipatory Action Plan (AAP), which were developed by which were developed by humanitarian organizations (such as the Ethiopian Red Cross Society, the World Food Programme, and Save the Children) in partnership with the regional DRM Bureau (DRMB) for the Somali region.

The Ethiopian Disaster Risk Management Commission (EDRMC), established in 2015 under Regulation No. 363/2015 by the Council of Ministers, is responsible for coordinating and supporting the implementation of the 2013 DRM policy and strategy across its organizational structures, administrative levels, and relevant sectors. The Commission reports to the Disaster Risk Management Council (DRMC), chaired by the Prime Minister, which is mandated to ensure a streamlined DRM approach. This includes managing an integrated Early Warning and Response System across all government administrative levels, including Federal, Regional, Woreda, and Kebele levels, as well as city administrations (EDRMC, 2022).

The DRR Directorate within the EDRMC provides leadership in the planning and implementation of activities to manage disaster risk in Ethiopia. The approach implicit in this design uses a decentralized and participatory model, which engages local governments through the Woreda Disaster Risk Reduction Planning (WDRRP) framework (European Commission, 2018).

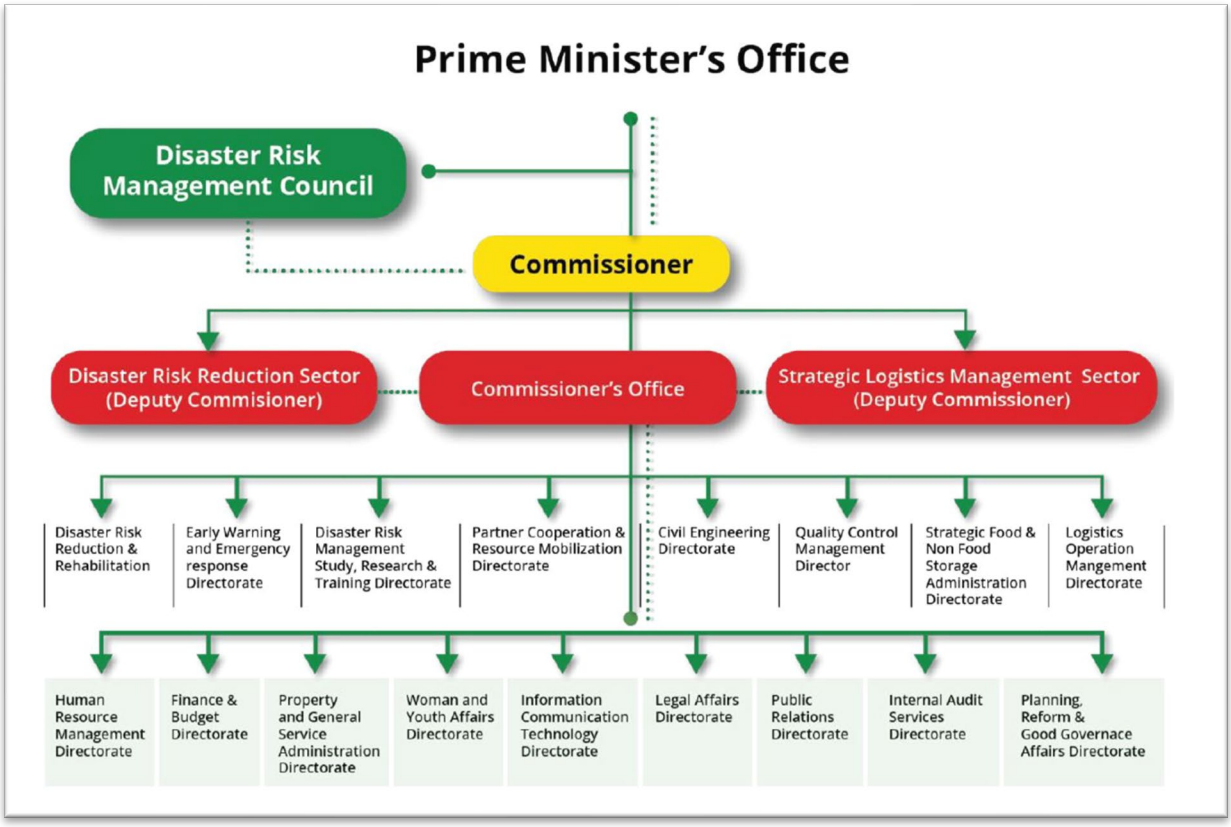

Figure 1: Ethiopian disaster risk management government and institutional structure. (Source EDRMC/ADPC, 2021)

Through discussions with experts at the national office of the EDRMC, we gained a deeper understanding of the institutional structure and its key functions. Figure 1, depicts the Ethiopian disaster risk management structure. The organigram refers to the functional architecture for DRM, The functions of each node extend beyond policy development to include the allocation of government resources and the mobilization of both domestic and international support for disaster response efforts. The Ethiopian government's primary strategy document for early warning is the Roadmap for Multi-Hazard, Impact-Based Early Warning and Early Action System 2023–2030, published in 2022. This roadmap outlines the establishment of a Multi-Hazard, Impact-Based Early Warning and Early Action System (MH-IB-EW-EAS) designed to enhance disaster resilience within communities. It adopts a comprehensive approach to mitigating the impacts of both natural and human-induced hazards, such as droughts, flooding, conflicts, and epidemics, which have cascading effects on food security, agriculture, displacement, and humanitarian needs (EDRMC, 2022). The roadmap has 4 key pathways and change goals as illustrated below.

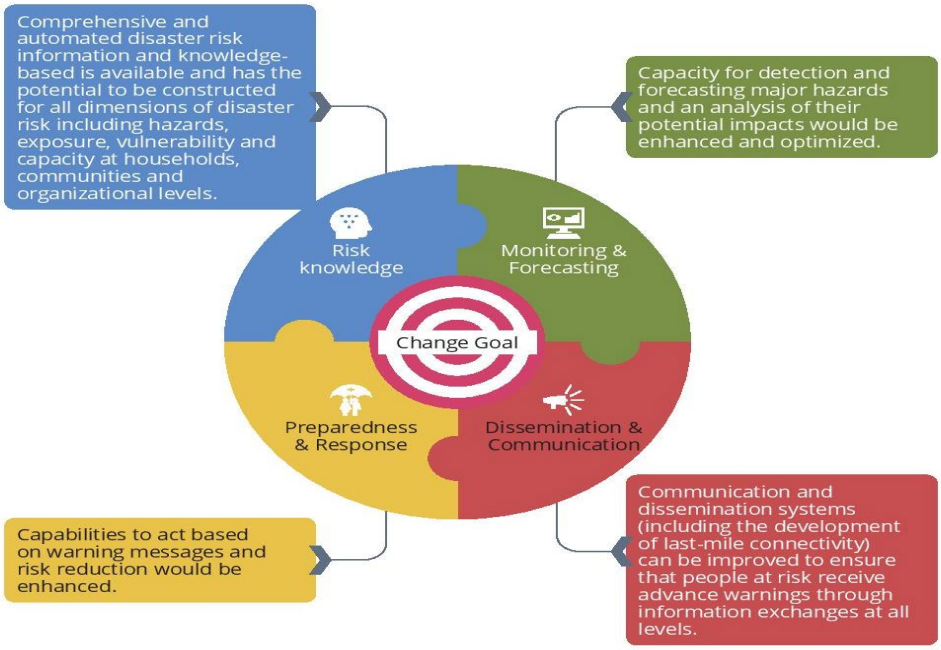

Figure 2. Four pathways and change goals of the Ethiopian multi-hazard, impact-based early warning and early action system. Source: (EDRMC, 2022).

The main objective in the strategy document (roadmap) is to implement a Multi-Hazard, Impact-Based Early Warning and Early Action System that integrates hazard information with risk analysis to provide meaningful early warnings that allow communities, and individuals not only to understand the risks related to impending events but also to act early and respond to disasters to minimize negative impacts (EDRMC, 2022). The roadmap also outlines the structure and roles and responsibilities that the different levels of administration play in the implementation of early warning activities emphasising cooperation among the various departments and actors involved at each level as shown in the table 2 below.

Table 2. Structure and Key roles and responsibilities in the implementation of A Roadmap for Multi-Hazard, Impact-Based Early Warning and Early Action System 2023–2030. (EDRMC, 2022)

Level of administration	**Key roles and responsibilities in the roadmap implementation**
Federal government	The federal government is ultimately responsible for implementing DRM and risk-informed MH-IB-EW-EAS across the country. It is responsible for developing standard operating procedures for federal, regional, and local agency actions in the immediate aftermath of a disaster to allow for more systematic disaster response.
Region	Manage vulnerable population databases, vulnerability profiles, and disaster risk profiles in their area

Zone	Respond to localized hazards, assess capacities and vulnerabilities, receive early warnings, and ensure and oversee woreda, kebele and community preparedness.
Woreda	Respond to localized hazards, assess capacities and vulnerabilities, receive early warnings, and ensure community and subnational preparedness.
Kebele	Manage community-based early warning systems in all of its value cycles

3.2 Evaluating the Potential and Limitations of Anticipatory Action during the 2023 Floods

3.2.1 Analyzing the Underlying Drivers of Risk

This section addresses the first objective of this study. Drawing on the Pressure and Release (PAR) model (Wisner et al., 2004), it categorizes vulnerability into three interconnected layers: root causes, dynamic pressures, and unsafe conditions. This framework highlights how historical and systemic factors have combined to exacerbate flood vulnerabilities in Ethiopia's Somali Region, as demonstrated during the 2023 floods.

The root causes of vulnerability in the Somali Region reflect deep-seated structural issues. Recurring droughts and conflict have led to displacement, forcing people to settle in flood-prone areas despite the risks. For example, one respondent described moving to a fertile riverside area after being displaced, only to face heightened flood risks. Decentralized power dynamics further influence vulnerabilities; while tribal systems and local communities provide crucial support, the limited presence of vibrant local DRM governance structures amplifies the gaps in disaster risk reduction, preparedness, and response. This underinvestment is compounded by the fact that limited government resources are often allocated for disaster preparedness at subnational levels. Respondents also emphasized inadequate national-level investment in DRR, which restricts outreach and capacity-building activities, leaving local communities underprepared.

Dynamic pressures link root causes to specific vulnerabilities, shaping the socio-economic and political context. Widespread poverty and chronic food insecurity are pervasive, trapping communities in cycles of vulnerability exacerbated by drought and limited access to essential services like healthcare and education. Poverty diminishes the capacity of individuals and communities to implement DRR measures, with one respondent describing it as a "disaster in and of itself." Additionally, the region's decentralized governance system, while enabling local decision-making, often results in low institutional capacity at woreda (district) and kebele (village) levels. Respondents highlighted a lack of knowledge, training, and resources among local officials to implement effective DRR strategies. Weak coordination and emergency preparedness further exacerbate vulnerabilities, as insufficient collaboration among local and regional actors limits proactive disaster management efforts.

At the community level, unsafe conditions represent the tangible outcomes of systemic issues. Institutional mistrust is widespread, with many community members expressing scepticism about government services and early warning systems. Respondents described a disconnect between government agencies and at-risk populations, which hindered collaborative resilience-building efforts. Physical vulnerabilities, such as inadequate infrastructure, compound these risks. Many flood-prone areas lack protective measures like dykes or drainage systems, leaving communities exposed to recurrent hazards. Limited resources at the community level further entrench these unsafe conditions, perpetuating cycles of risk and vulnerability.

3.2.2 Retrospective Analysis of the Forecast during the 2023 Flood

An analysis of forecast data for the 2023 flood in the Somali region reveals that while rainfall forecasts were accurate in predicting extreme rainfall events, they fell short in translating these predictions into actionable flood peak forecasts. As indicated in the methodology, this analysis was done using an archive of rainfall forecasts from the IGAD Climate Prediction and Applications Centre (ICPAC) and the Global Flood Awareness System which were used to evaluate forecast issued ahead of floods.

The International Research Institute's probabilistic seasonal climate forecast had confidently predicted a wet October-November-December (OND) season for 2023 across the Horn of Africa well in advance (Figure 3). Forecasts issued as early as June and July indicated that the probability of a one-in-three wet season over the Somali region was approximately double the normal rate (60% compared to 33%). Similarly, the likelihood of a more extreme one-in-five-year wet season was also twice the usual probability (40% compared to 20%).

These forecasts were consistent with established research on seasonal predictability in the region, which has consistently linked positive Indian Ocean Dipole (pIOD) events to extreme rainfall totals (e.g., Black et al., 2003; MacLeod et al., 2021a).

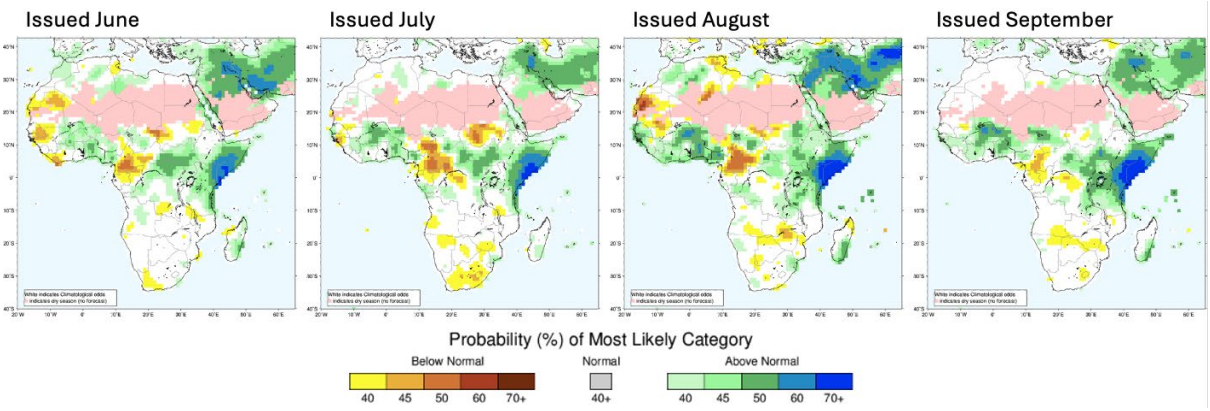

Figure 3*: Forecasts of OND 2023 tercile rainfall from the International Research Institute for Climate and Society (IRI, https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/).*

By July 2023, El Niño conditions had emerged, and climate models consistently projected the intensification of El Niño alongside the emergence of a strong positive Indian Ocean Dipole (pIOD), both expected to peak by the end of the year. These signals informed the Greater Horn of Africa Climate Outlook Forum (GHACOF) forecast in late August (Figure 4). GHACOF is a regional platform established to facilitate the production and dissemination of consensus-based seasonal climate outlooks for the Greater Horn of Africa region. It is coordinated by the Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC**)**. GHACOF serves as a mechanism for regional collaboration, enabling governments, scientists, and stakeholders to anticipate and prepare for climate variability and its impacts.

GHACOF forecast, which integrates outputs from multiple climate models with local calibration, provided probabilistic estimates of upper, middle, and lower tercile seasonal rainfall. Notably, the August 2023 forecast indicated an over 85% probability of upper tercile rainfall over Somalia and the Somali region of Ethiopia—an unprecedented level of confidence in predicting a wet season. This forecast was ultimately validated by the extreme rainfall observed during the October-November-December (OND) season.

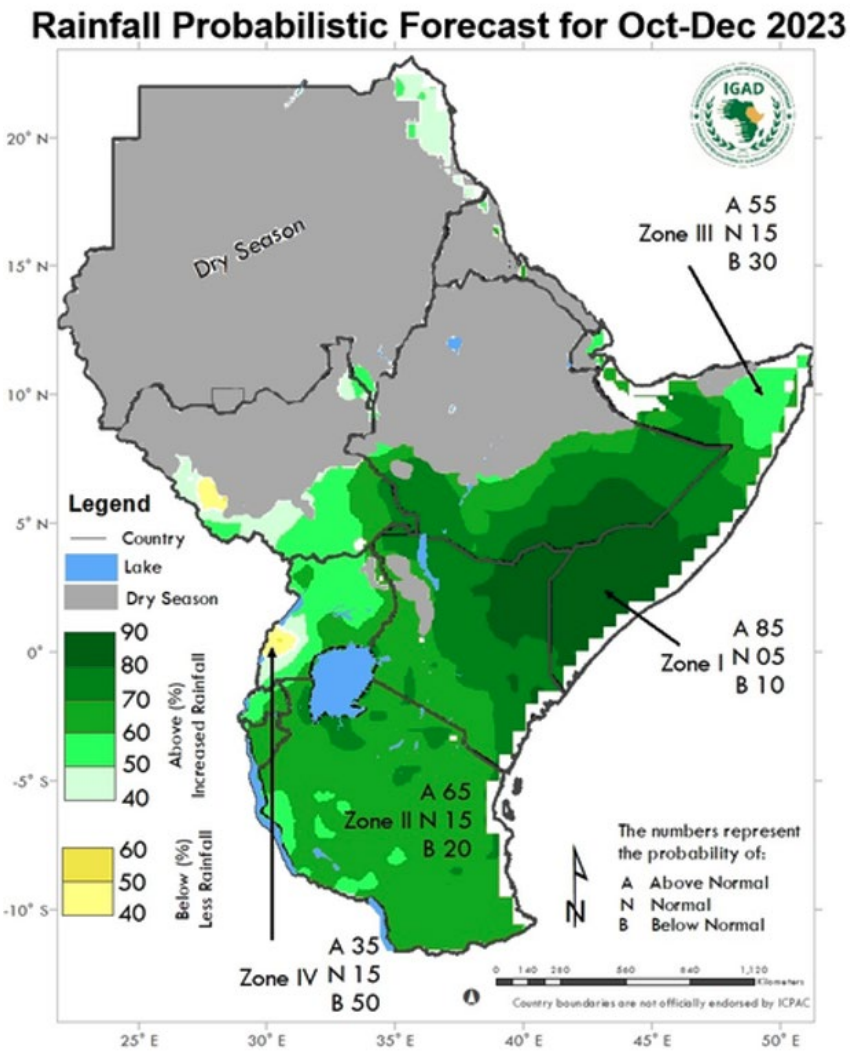

Figure 4: Seasonal outlook (2023) from the Greater Horn of Africa Regional Climate Outlook Forum (Source: ICPAC, 2023)

As the season progressed, additional rainfall forecasts from various sources became available. For example, the Ethiopian Meteorological Institute provides 10-day and extreme rainfall forecasts, although these are not easily accessible for retrospective analysis.

For this study, we focused on the weekly extreme rainfall forecasts issued by the IGAD Climate Prediction and Application Centre (ICPAC). These forecasts predict conditions for the next seven days and are released weekly. While no probabilities are provided, forecasted rainfall is compared to historical distributions to determine its relative extremity. Specifically, rainfall levels corresponding to the 90th, 95th, and 99th percentiles of the historical distribution are categorized as "heavy," "very heavy," and "extremely heavy," respectively.

The ICPAC weekly forecast archive was replotted by the regional institution to develop 'heavy rainfall forecasts for the eight weeks starting October 10th as shown in Figure 5; representing the period with the heaviest rainfall in the Somali region. These forecasts demonstrated strong consistency with observed conditions. Very heavy rainfall was predicted over the Somali region during most of these weeks, with extremely heavy rainfall forecasted for the weeks beginning October 10th, October 24th, October 31st, and November 14th—precisely aligning with the heaviest rainfall periods observed. The final two forecasts in Figure 5 (weeks starting November 21st and November 28th) indicated rainfall shifting southward, away from the Somali region, and then dissipating. These forecasts were also well-aligned with observed weather patterns, highlighting the reliability of ICPAC's weekly rainfall predictions during this period.

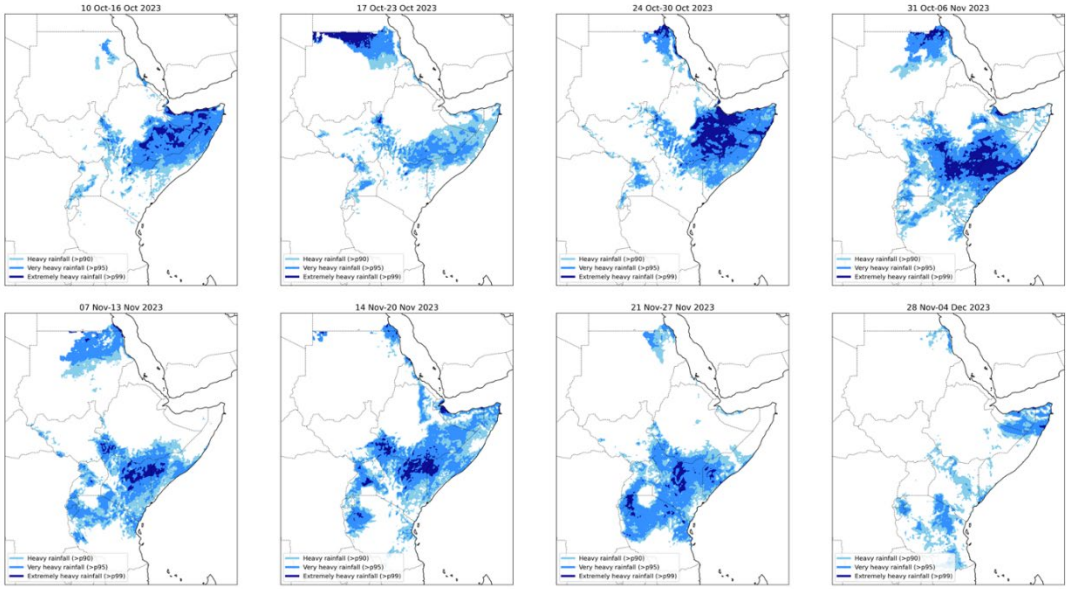

Figure 5: ICPAC weekly 'heavy rainfall' forecasts for the eight weeks commencing 10th October, 2023

Using the CHIRPS dataset as an observational reference, analyses revealed substantial rainfall totals during the OND 2023 season, with accumulations exceeding 600 mm in some areas. November was notably the wettest month, contributing the majority of the rainfall—approximately 200 mm above the long-term average. This seasonal total was the second highest on record, surpassed only by the extreme events of 1997 and 2019. The rainfall demonstrated strong consistency across various forecasts explained above.

Key rivers, including the Dawa, Ganele, Gestro, and Shabelle, which originate in the Ethiopian highlands and flow through the Somali region into Somalia, reached their maximum bankfull levels in early November. This correlated with substantial rainfall beginning in mid-October. Although gauge data for these rivers in the Somali region is unavailable, downstream monitoring at stations such as Dollow and Belet Weyne provided insight into upstream flow dynamics.

While ICPAC's weekly forecasts were effective in anticipating extreme rainfall, their once-a-week release posed limitations in monitoring rapidly changing weather conditions. This infrequent issuance restricted the ability to prepare for or respond to sudden changes in rainfall patterns occurring between forecast releases. For example, localized weather developments or critical changes could arise unexpectedly, leading to discrepancies between actual conditions and the forecasts. Additionally, the seven-day lead time provided by ICPAC forecasts limits the potential for anticipatory action.

An analysis of available information and forecasts, primarily from IRI and ICPAC, revealed that these forecasts, while valuable, were not tailored to the specific needs of the Somali Region to trigger timely early actions.

The analysis extended beyond rainfall forecasts to include river flood forecasts. The research revealed that the Somali Region currently lacks a dedicated flood forecasting system for its major rivers. However, the Global Flood Awareness System (GloFAS) (www.globalfloods.eu) provides flood risk predictions for up to 30 days.

This study evaluated GloFAS forecasts for October and November 2023 and identified a critical two-week gap in detecting potential floods along the Shebelle basin. Developers are investigating the underlying causes of GloFAS's inaccuracy, particularly in light of accurate rainfall forecasts during the same period. One hypothesis points to unrealistic land surface hydrology parameterization as a contributing factor. Further research is needed to confirm this and to develop solutions that address these limitations effectively.

Interestingly, the earlier version of GloFAS (3.1) reportedly performed better in predicting these floods. While reverting to an older version is unlikely, this finding underscores the importance of refining the current system to overcome its limitations and enhance forecasting accuracy.

3.3 Assessing the Effectiveness and Reach of Early Warning Dissemination Channels

During the research, focus group discussion (FGD) respondents were asked about the dissemination channels used during the 2023 floods. They identified the primary channels as mainstream media, including television and radio, official communication methods like letters, emails, and phone calls, social media platforms such as Facebook and WhatsApp groups, as well as local representatives and tribal leaders.

Respondents were also asked to evaluate the effectiveness of these channels in relation to the strategic goal 3 of the early warning strategic document, *Roadmap for Multi-Hazard, Impact-Based Early Warning and Early Action System 2023–2030*. This goal aims to enhance the effectiveness of warning dissemination methods, particularly for reaching remote areas—commonly referred to as "last-mile connectivity." It also seeks to ensure that more people receive timely warnings about potential disasters, allowing them more time to prepare and take protective measures.

Findings from these interviews revealed disparities in access to warning alerts. While some communities, particularly in the Gode area, reported receiving regular rainfall forecast alerts via the phone or through updates from local government authorities, others, especially in Dollo Ado and Melkadida, lacked access to regular information about impending floods.

Limited access to information and communication technologies (ICT) in remote areas like Dollo Ado and Melkadida significantly hinders the dissemination of critical information to vulnerable populations. Although national data suggests that approximately 59% of individuals aged 10 and over own a mobile phone (Ecofin Agency, 2023), this figure likely overestimates access in remote regions due to infrastructural challenges. For instance, study respondents in Dollo Ado reported lower mobile phone ownership and network coverage compared to other regions. Additionally, the unstable phone network, lack of connection to the national power grid, and limited road infrastructure in Dollo Ado further exacerbate communication difficulties (Betts and Bradenbrink, 2020).

An intriguing dynamic that emerged from the interviews was the apparent misalignment between adaptation and anticipatory action in the respondents' decision-making processes. Many focus group participants reported that, despite receiving weather forecasts, their actions were not directly influenced by this information. Instead, their decisions regarding pastoral and agricultural livelihoods were shaped by a need to cope with prevailing conditions, characterized by unpredictable and uncertain weather patterns.

In essence, these individuals were not responding specifically to forecasts of extreme weather events, such as the recent flood. Rather, they were seeking to adapt to broader, ongoing challenges, including unreliable rainfall and the increasing frequency of floods. Their strategies were driven by a need to survive in an environment where the climate could not be trusted to behave predictably. This indicates a disconnect between the provision of forecast information and the ability or willingness of communities to act on it, underscoring the need for impact-based forecasting and local capacity building to ensure that communities not only receive warnings but also understand how to respond effectively, bridging the gap between anticipatory action and long-term climate adaptation in highly vulnerable areas.

Windows of Opportunity for Proactive Interventions

The findings highlight key windows of opportunity for proactive interventions, drawing on insights from interviewees. These include constraints and opportunities for action during three critical periods: (1) before the flood, (2) immediately after the forecast was issued, and (3) between the onset of the flood and the peak of its impacts.

Preparation and Prevention before a Flood Forecast

The findings of the research revealed significant gaps in disaster risk analysis at the lower levels of the Somali Region's DRM structure, with district (woreda) and village (kebele) DRM actors lacking the technical capacity for effective disaster risk management and early warning. In many woredas and kebeles examined, contingency plans were entirely absent. Nationally, only 565 out of 1,135 woreda disaster risk profiles had been completed, with a disproportionately larger gap in the Somali Region, according to the Ethiopia Disaster Risk Management Commission (EDRMC), which is responsible for this activity in collaboration with sub-national structures such as regional DRM bureaus. Limited accessibility and the lack of public availability of these profiles further hinder effective early action planning and implementation.

Interviews with DRR practitioners and humanitarian organization representatives highlighted the absence of local-level data on hazards, exposure, risks, and vulnerabilities as a critical challenge, obstructing the implementation of impact-based forecasting. This data gap limits the ability to provide tailored warnings that predict specific impacts on vulnerable populations across defined areas and timelines, thereby reducing the effectiveness of responses aimed at mitigating damage and losses.

Despite the presence of an overarching framework, as outlined in the above strategy documents, significant gaps remain in information flow, technical capacity, resources, and data consolidation. These persistent issues frequently delay timely interventions.

Immediate Actions Following the Forecast

Research participants were asked about what transpired during the critical window immediately after flood forecasts were issued. Their responses revealed a range of experiences and challenges that influenced their ability to act effectively.

The study revealed that a significant barrier to timely action following the issuance of flood forecasts was a lack of trust in the information provided. This distrust stemmed from several factors. Firstly, respondents frequently described the forecasts as unclear, as they primarily relied on probabilistic statements rather than offering clear, definitive predictions about the likelihood and magnitude of the event. This created uncertainty about the likelihood of the event occurring. Additionally, participants noted that the warnings were too general, failing to specify the particular areas likely to be affected by the hazard. This left communities unsure if the forecasts applied to their location or warranted immediate action.

Another critical issue was the failure to communicate the potential impacts of the flood. Without clear information about the severity and consequences of the hazard, communities struggled to assess the level of risk and the necessity of taking preventive measures. In some cases, this lack of actionable detail led to complacency, as past warnings that lacked specificity or turned out to be false alarms further eroded trust in the forecasting system.

Between the Onset and Peak Impacts of Floods

The study explored whether affected communities took action in the critical window between the onset of flooding and its peak impacts, as well as the reasons behind their responses—or lack thereof.

The findings revealed that disseminating flood warnings often failed to inform or prompt necessary actions from community members to protect their assets and livelihoods. In some cases, while the information was received, communities faced challenges in taking action on it. For example, in farming communities, even when early flood warnings were received, individuals were often unable to take necessary actions to protect their assets and livelihoods, such as safeguarding crops or relocating livestock, due to limited resources and alternatives.

Early action at the household or community level was significantly hindered by the pervasive poverty in the region. Many of the communities visited during the research lacked the resources necessary for disaster preparedness or infrastructure improvements, making it challenging to respond effectively to early warnings. For instance, families often did not have the financial means to purchase essential supplies such as sandbags, emergency food stocks, or first-aid kits. Additionally, many homes were poorly constructed and unable to withstand extreme weather conditions like flooding.

The region also generally lacked critical infrastructure that was vital for mitigating flood impacts, such as flood barriers, proper drainage systems, or elevated storage facilities. Without these, early actions often failed to adequately protect homes, crops, and livestock, leaving communities highly vulnerable.

The remoteness of some communities further exacerbated these challenges. Many of these areas were situated in regions with poor road networks or no all-weather roads. During excessive rainfall, these roads frequently became impassable due to flooding or mudslides, cutting off access to essential goods, services, and external assistance. As a result, families were forced to rely solely on their own limited resources, which were often inadequate to cope with the disaster.

Disaster Risk Reduction (DRR) practitioners interviewed during the study highlighted the lack of pre-emptive action during this critical period may have been due to the absence of financing mechanisms that connect forecasts to early action. Without pre-arranged funding and pre-arranged action plans, communities and local actors were unable to implement the necessary proactive measures to mitigate the impacts of the floods.

A critical barrier to action identified in the study is the perception of what constitutes legitimate data. Many respondents expressed scepticism toward scientific forecasts, citing their reliance on probabilities as a source of uncertainty. This skepticism is further reinforced by deeply rooted cultural and religious beliefs. In the Somali Region, where the majority of the population is Muslim, disasters are often attributed to the will of Allah, with many viewing them as acts of divine fate. This perspective, while providing spiritual resilience, can diminish perceived agency and the motivation to take proactive measures, such as investing in disaster preparedness or improving infrastructure. Additionally, traditional methods of hazard prediction—such as observing animal behavior, plant changes, or astrological alignments—remain influential and are often seen as more reliable than scientific forecasts. As one participant explained, "We get the information, but sometimes we don't believe it. We believe that Allah will give us everything, that Allah knows everything" (FGD2). These intertwined factors of mistrust in scientific forecasts and reliance on cultural practices highlight the need for integrating traditional knowledge with scientific data in ways that resonate with local perceptions and prompt action.

3.4 Government and Humanitarian Responses to the 2023 Floods

The 2023 flood response in the Somali Region was led by the Somali Regional Government with substantial support from humanitarian organizations, including UNOCHA. The response officially commenced in November 2023 with the establishment of satellite offices in key flood-affected areas, such as Jigjiga, Gode, Dollo Ado, and Hergele/Charati. These offices facilitated a rapid assessment of affected areas, which informed the development of a coordinated flood response plan. This plan enabled the provision of immediate assistance, including the distribution of food, sanitation kits, and medical supplies, by both the government and humanitarian partners.

Humanitarian organizations, such as UNICEF, played a critical role in addressing health risks associated with the floods. Cholera vaccination campaigns and the distribution of medical supplies were implemented to mitigate potential outbreaks of waterborne diseases, particularly in overcrowded camps. These efforts were vital in preventing the rapid spread of cholera and other illnesses in vulnerable populations.

Despite the coordinated response, resource gaps were evident throughout the operation. The scale of the disaster far exceeded the available resources, leaving many households without adequate food, shelter, or access to clean water. These gaps highlighted the challenges of mobilizing sufficient resources to meet the urgent needs of affected populations.

Plans for recovery focused on rebuilding essential infrastructure, including schools, water systems, and health facilities, with a focus on enhancing their resilience to future climatic shocks. However, challenges in resource allocation slowed the progress of these initiatives. The need for targeted research to guide the construction of durable infrastructure, such as dykes and water diversion systems, was identified as a critical area for improvement.

Coordination and Communication Mechanisms

The Disaster Risk Management Bureau (DRMB), in collaboration with humanitarian agencies, reactivated disaster coordination committees to manage response efforts. Zonal-level task forces, chaired by local administrators, were established to oversee and coordinate actions. However, the research revealed inefficiencies in coordination, as overlapping roles and responsibilities between agencies led to confusion and delayed actions.

Infrastructure damage caused by the floods further complicated response efforts. Roads and bridges, particularly in remote areas such as Dollo Ado, Kelafo, and Charati, were destroyed, severely disrupting the transportation of relief supplies and delaying aid delivery. Poor road infrastructure, a longstanding issue in the Somali Region, exacerbated these challenges, underscoring the need for durable solutions to improve connectivity and ensure timely disaster response.

Community-Led Responses

In the absence of sufficient external support, communities mobilized to protect themselves using whatever resources were available. Local leaders, including kebele administrators, religious figures, and clan elders, played a pivotal role in organizing grassroots responses. Efforts included the use of sandbags, rocks, and other locally sourced materials to protect homes and individuals.

Despite these efforts, resource constraints significantly limited the effectiveness of community-led responses. For instance, some farmers were advised to remove their irrigation pumps ahead of the floods, but many could not comply due to a lack of alternative water sources or the financial risk of losing their crops. These findings highlight both the resilience of local communities and the critical gaps in external support needed to enhance their capacity to respond effectively to disasters.

4. Lessons Learned and Recommendations

The 2023 floods in Ethiopia's Somali Region highlighted critical gaps in disaster risk reduction (DRR) capacity, driven by the interplay of natural, socio-economic, and political factors. These compounded vulnerabilities in drought-prone, resource-strained, and conflict-affected communities underscore the need for a robust Early Warning Early Action (EWEA) system. By addressing shortcomings in risk management, forecast dissemination, and early action planning—while strengthening governance and institutional capacity—authorities can mitigate the impacts of future crises. This chapter consolidates lessons learned and provides actionable recommendations to enhance anticipatory action and long-term disaster risk management (DRM) investments, focusing on the most vulnerable populations, including refugees, internally displaced persons (IDPs), and host communities.

4.1 Summary of Findings

1. **Systemic Vulnerabilities Amplify Disaster Impacts:** Communities affected by the floods, including refugees, internally displaced persons (IDPs), and host populations, faced disproportionate risks due to entrenched social, economic, and physical vulnerabilities. Addressing these systemic issues is critical for sustainable recovery. The analysis reveals that systemic issues, such as conflict, drought, and inadequate DRR investment, drive long-term vulnerabilities in the Somali Region. Weak coordination, institutional mistrust, and insufficient protective infrastructure exacerbate community-level risks, highlighting the need for trust-building and capacity development.

2. **Forecast Accuracy Alone Is Insufficient:** While forecasts effectively predicted extreme rainfall, their translation into actionable flood warnings was hindered by gaps in tools, models, and communication systems. The lack of tailored, localized triggers further limited anticipatory action.

3. **Barriers to Early Warning Uptake Persist:** Mistrust of scientific forecasts, language barriers, and poor dissemination channels undermined the effectiveness of early warning systems. Communities often relied on traditional forecasting methods and informal networks, limiting their ability to act on early warnings.

4. **Resource Constraints Limit Preparedness:** Pervasive poverty and inadequate infrastructure, particularly in remote areas, hindered proactive disaster management. Communities lacked resources to protect livelihoods, relocate safely, or rebuild effectively post-disaster.

5. **Coordination and Infrastructure Gaps Hampered Response:** Delays in resource allocation, overlapping responsibilities among agencies, and poor road infrastructure constrained timely and effective disaster response, particularly in hard-to-reach areas.

6. **Nature-Based Solutions Hold Untapped Potential:** Nature-based solutions (NbS) such as wetland restoration, floodplain management, and sustainable water and soil conservation practices could offer cost-effective, ecologically sound approaches to mitigate flood impacts.

4.2 Recommendations

1. Strengthen fit-for-purpose data systems for EW/EA for improved disaster risk management (DRM):

- Prioritize the development and dissemination of localized disaster risk profiles, particularly at the woreda and kebele levels. This should include detailed data on hazards, vulnerabilities, exposure, and coping capacities.
- Enhance data accessibility and ensure it is integrated into a centralized, easily updatable database for all stakeholders.

2. Advance Impact-Based Forecasting (IBF):
    - Support the implementation of IBF as outlined in the *Roadmap for Multi-Hazard, Impact-Based Early Warning and Early Action System 2023–2030* (EDRMC, 2022). This includes developing tools that integrate meteorological data with vulnerability and exposure information to provide actionable and localized forecasts.
    - Build the capacity of both information providers and communities to ensure the system functions effectively on all sides, enabling accurate data generation, effective communication, and practical utilization of forecasts.
    - Collaborate with research institutions, international experts and organisations to refine forecasting models, addressing challenges such as hydrological parameterization in tools like the Global Flood Awareness System (GloFAS).
3. Improve Early Warning Dissemination Systems:
    - Focus on "last-mile connectivity" by ensuring that early warning information reaches vulnerable communities in accessible formats and local languages.
    - Expand the use of diverse communication channels, including mobile technology, community radios, and local leaders, to bridge communication gaps in remote areas.
4. Enhance Community Preparedness and Response Capacities:
    - Build local capacities through training programs that strengthen understanding and application of early warnings, particularly for pastoral and farming communities in areas facing migration-related issues.
    - Develop pre-agreed action plans and identify financing mechanisms to ensure timely anticipatory action, particularly in regions with recurring flood risks.
5. Integrate Cultural and Social Dimensions into DRM Strategies:
    - Actively involve communities in the design of early warning systems to ensure they are practical, user-centered, and aligned with local needs. Starting with the use case enables the development of systems that are both effective and widely adopted, enhancing dissemination and overall impact.
    - Develop culturally sensitive communication strategies that consider local beliefs and practices, fostering trust in scientific forecasts.
    - Engage religious and community leaders as champions of anticipatory action to enhance acceptance and uptake of early warnings.
6. Expand Financial and Infrastructure Support:
    - Invest in resilient infrastructure, such as flood shelters and storage facilities for crops, to support vulnerable communities during disasters.

4.3 Future Research Directions

Future research should prioritize enhancing local ownership and sustainability in disaster risk management by examining the role of water user associations in fostering community-driven approaches. Integrating local perspectives into anticipatory action (AA) protocols can ensure interventions are both relevant and effective. Additionally, refining Impact-Based Forecasting (IBF) through the development of localized triggers and improved communication strategies is critical for timely and targeted responses. Disaggregated analyses will further support these efforts by addressing the specific needs of refugees, internally displaced persons (IDPs), and host communities, ensuring equitable and inclusive interventions. Lastly, assessing the effectiveness of Nature-Based Solutions (NbS), such as wetland restoration and floodplain management (incl. reservoirs), is essential for mitigating flood risks while conserving the excess water for the dry season. Exploring innovative water redirection mechanisms and participatory water management approaches can enhance resilience in flood-prone areas, providing sustainable and adaptive strategies to address future challenges.

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