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PERSPECTIVE

The Long Road to Acting Ahead: Lessons from the Evolution of Early Warning Systems and Anticipatory Action

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Abstract
This perspective traces the emergence and evolution of early warning systems (EWS) and anticipatory action (AA). It revisits how major disasters, advances in science and forecasting, and global policy frameworks progressively expanded the ambition of EWS—from hazard-centered monitoring to more impact-based, people-centered approaches—while exposing persistent gaps in communication, local capacity, financing, and political will that prevented warnings from reliably triggering timely action. We examine how AA emerged in the humanitarian sector from these shortcomings as an operational bridge between long-term risk reduction and disaster response using risk information to enable pre-agreed, financed early actions, reviewing evidence that anticipatory interventions can improve food security, protect assets and livelihoods, enhance dignity and agency, and strengthen coordination in humanitarian contexts. Despite having the same goal of protecting the lives and livelihoods of at-risk populations, AA and EWS investments remain fragmented, and they struggle in fragile, data-poor, and conflict-affected settings. Drawing on this history and evidence, we argue that efforts to strengthen EWS and AA must be coherent and mutually reinforcing, building on the broader work on disaster risk reduction and climate-resilient development. The paper outlines concrete action points: align investments across EWS and AA; link government-led and humanitarian mechanisms wherever possible; strengthen inclusive, locally grounded partnerships; level up regional hydrometeorological and climate service capabilities; and institutionalize accountability and learning at scale. By acting on these priorities, practitioners and policymakers can move from pilots and parallel initiatives toward integrated systems that consistently enable people to act ahead of crises. The paper aims to address the following research question: From a humanitarian perspective, how have early warning systems and anticipatory action evolved in theory and praxis over the last three decades?

Keywords Anticipatory action · Climate resilient development · Climate risk management · Disaster risk reduction · Early warning early action · Early warning systems · Forecast based financing · Index insurance

1 Introduction

Over the last century, disaster risk management (DRM) and disaster risk reduction (DRR) have emerged as frameworks for helping at-risk populations prepare for, prevent, mitigate, and respond to disasters. Building on the foundations of risk analysis and hazard forecasting, early warning systems (EWS) have become a core feature of DRR. The prospect of using rapidly improving weather forecasts to act before disasters strike opened pathways to reducing the number of people at risk and the risks to their lives, assets, and livelihoods. Early warning systems alert exposed populations of impending hazards to facilitate action and minimize adverse impacts.

Warnings long predate modern international institutions. Throughout history, people have relied on observation, intuition, and lived experience to anticipate and mitigate crises: moments when hazards, vulnerabilities, and exposure intersect to threaten lives and livelihoods. Meteorological records from eighteenth and nineteenth century Latin America and the Caribbean indicate that people used astronomical observations to predict rainfall (Garcia and Fearnley 2012; Domínguez-Castro et al. 2018; Perera et al. 2020), Ethiopian farmers assessed soil fertility and seasonal indicators

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for crop planting (Mekonnen et al. 2021), and Ayurvedic practitioners in India monitored temperature and humidity to forecast disease outbreaks (Morandi et al. 2011).

The establishment of the World Meteorological Organization (WMO) in 1951 marked a step change in formal international coordination of meteorological observation, forecasting, and related warning services. These national and internationally supported EWS have been shaped by scientific and technological advances, changing public perceptions, increasing involvement of technological partners, growing awareness of the impacts of climate change, the availability of climate finance and related policy reforms, along with shifts in social and political priorities (Kelman and Glantz 2014; Potter et al. 2021). Although the stated purpose of EWS has always been to provide people with advance warning so that they can safeguard lives and livelihoods, in practice, numerous barriers have impeded effective implementation of timely protective action (Garcia and Fearnley 2012; Perera et al. 2020).

More than a decade ago, experiences in piloting parametric insurance inspired a new approach to humanitarian financing, focused specifically on enabling communities to safeguard their lives and livelihoods through tailored financing mechanisms for anticipatory action triggered by a hazard forecast. The first initiatives of forecast-based financing (FbF)—now called anticipatory action (AA)—began in 2013 in response to persistent challenges in translating warnings into funded early action in humanitarian settings. In particular, while conceptually EWS has always included early action, in practice, humanitarian financing and operating models did not reliably provide resources to act on forecasts beyond evacuation and warning dissemination.

The 10-year anniversary of the first Global Dialogue Platform on AA and the first FbF pilots offer an opportunity for the AA community of practice to reflect on the connection between EWS and AA, to consider what we have learned about AA's ability to deliver faster, more efficient, more effective, and more dignified aid, to identify what we still do not know, and to consider possible ways forward. Drawing on literature and the experience of a range of stakeholders in EWS and DRR, this perspective paper outlines the evolution of EWS and AA to examine the challenges, evidence, lessons, and way forward for AA and EWS.

After defining EWS and AA, we present a brief history of major events propelling the development and evolution of EWS since 1970. We then review some of the persistent challenges with EWS that motivated experimentation with AA (then called forecast-based financing), followed by a review of what is known about AA's progress toward those objectives and what challenges persist. Based on this assessment, we conclude with some overarching lessons and by examining what is needed to ensure that EWS and AA achieve the goal of protecting at risk populations, their livelihoods, and well-being going forward.

This abbreviated history is intentionally bound to the post-1970 acceleration of top-down, internationally driven investments in EWS, primarily for hydrometeorological hazards. We focus primarily on climate-related hydrometeorological hazards because these are the hazards anticipatory action initially emerged to address.[1] This focus does not discount the importance of indigenous, community-based, or other autonomous systems of warning and action or lessons that come from non-climate-related hazards. Indeed, ensuring context- and population-specific knowledge, needs, and practices are respected by larger systems remains critical if EWS are to be effective for last-mile (or first-mile) populations (Tozier de la Poterie et al. 2025). Nevertheless, the historical cases and institutional developments reviewed below propelled the modern system's engagement with early warning and early action, shaping the current institutional landscape this paper seeks to analyze and influence.

As communities of practice applying EWS and AA continue to grow through initiatives such as the Climate Risk and Early Warning Systems (CREWS), the International Network for Multi-Hazard Early Warning Systems (INMHEWS), the Weather and climate Information Services (WISER), the Risk Informed Early Action Partnership (REAP), the Anticipation Hub, and the United Nations Secretary General's Early Warning for All (EW4All), an understanding of the history, known pitfalls, and the relationship of EWS and AA to climate-resilient development is critical to formulating and implementing strategies and processes that are fit for purpose and achieve the goals of protecting at risk populations. By recognizing the advancements made and the persistent challenges faced, the EWS and AA communities can better understand the opportunities to be leveraged and continue to adapt and innovate accordingly.

2 Terminology

The following section describes the early warning systems and anticipatory action definitions.

2.1 Early Warning Systems

According to the United Nations Office for Disaster Risk Reduction (UNDRR), an EWS is "An integrated system of hazard monitoring, forecasting and prediction, disaster risk

[1] Although humanitarians have since expanded the focus of AA to biological and other non-climate-related hazards (such as human mobility and displacement), the humanitarian concept originated with climate-related, weather hazards.

assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events" (UNDRR 2017). Although there is no universal definition of what constitutes an early warning system (Kelman and Glantz 2014), the United Nations states that effective, people-centered early warning systems should comprise four fundamental and interrelated pillars:

(1) Risk knowledge: understanding the hazard types, exposure to hazards, and vulnerabilities of different population groups, in a given area;
(2) Monitoring and forecasting: detecting and predicting hazard threats in real-time using scientific data and technology (for example, seismic sensors for earthquakes, satellites for cyclones);
(3) Warning dissemination and communication: ensuring that alerts reach authorities, emergency responders, and the public through multiple communication channels (for example, sirens, mobile alerts, radio), and that warnings are understandable by those at risk;
(4) Preparedness and response capability: ensuring communities and authorities are able to act on the warnings.

2.2 Anticipatory Action

As with EWS, there is no single definition of AA. Also known as forecast-based financing (FbF), forecast-based action (FbA), or anticipatory humanitarian action, there is a growing convergence around the use of AA, although the processes by which organizations operationalize their programs differ.[2] The Grand Bargain definition, negotiated and collectively agreed by over 18 signatories, defines AA as "acting ahead of a predicted hazardous event to prevent or reduce impacts on lives and livelihoods and humanitarian needs before they fully unfold" (Grand Bargain 2024, p. 2). The Red Cross Red Crescent Movement's 34th International Conference marked the first time 192 governments and all Red Cross Red Crescent National Societies worldwide agreed on a definition. Signed in October 2024, the Red Cross Red Crescent Resolution "Protecting people from the humanitarian impacts of extreme climate and weather events" states that Anticipatory Action refers to "actions taken to reduce the humanitarian impacts of a forecast hazard before it occurs or before its most acute impacts are felt; the decision to take action is based on a forecast or collective risk analysis of when, where and how an event will unfold" (IRCRC 2024, p. 1). Other commonly used definitions are those used by the Anticipation Hub, the REAP glossary, and the G7 Foreign Ministers' statement on strengthening AA in humanitarian assistance.

3 Disasters Drive International Frameworks and the Ascendency of Modern Early Warning Systems

While locally-led early warning systems based on local knowledge and processes have existed for centuries, the push for national EWS was influenced by several high-profile, devastating disasters that turned national and international attention to the need for policy to drive the development of EWS to prevent similar devastation in the future. Among these were cyclone Bhola in Bangladesh (1970) (Haque et al. 2022), large-scale famine and food shortages in Bihar India, West African Sahel, and the Horn of Africa in the 1960s, 1970s, and 1980s, and the 2004 Indian Ocean Tsunami.

Cyclone Bhola, which struck East Pakistan (present-day Bangladesh) in November 1970, was the deadliest tropical cyclone in recorded history. It killed between 300,000 and 500,000 people (Griffin-Elliott 2015). This catastrophic event spurred the development of EWS in the region, including the establishment of the Cyclone Preparedness Programme (CPP), which facilitates large-scale evacuations for people in high-risk areas (Haque et al. 2022). By 1991, when another severe cyclone hit Bangladesh, warning and evacuation systems had advanced to the point where several million people were evacuated ahead, and although an estimated 130,000 people drowned, studies estimated the death toll would have been much higher without early warning and evacuation systems (Chowdhury et al. 1993).

In the 1970s and 1980s, the Food and Agriculture Organization (FAO) and the United States Agency for International Development (USAID) developed famine early warning systems in response to food shortages and famine in Africa. The FAO created the Global Information and Early Warning System (GIEWS) to monitor supply and demand for food, assess food security, and provide early warning for food security crises worldwide. Following severe famines in Sudan and Ethiopia from 1983 to 1985 that killed an estimated several hundred thousand people (de Waal 1997), USAID developed the Famine Early Warning Systems Network (FEWS NET) to collect, analyze, and distribute information to decision makers regarding potential or current famine and food insecurity situations, allowing them to monitor and warn of the

[2] Although people have been forecasting hazards and taking actions to reduce their impacts long before humanitarians adopted the term anticipatory action (for example, the development and delivery of vaccines based on disease forecasts), we focus here on how the concept has emerged and been used in the humanitarian sector. This is not to discount efforts outside of the international humanitarian system, but because the objective of this perspective paper is to trace how Anticipatory Humanitarian Action emerged specifically to fill known gaps in EWS and disaster risk reduction and to propose how AA and EWS can move forward together.

risk of famine, and help humanitarian organizations plan their response (Kim and Guha-Sapir 2012; Funk et al. 2019).

Alongside investments in specific EWS, Community based Early Warning Systems (CBEWS) also gained support as part of DRR programming in the 1970s, and international initiatives and policy frameworks pertaining to EWS began in the late 1980s. In 1987, the United Nations General Assembly designated the 1990s the International Decade for Natural Disaster Reduction (UNDRR 2023). The German Government and the United Nations International Strategy for Disaster Reduction (now United Nations Office for Disaster Risk Reduction—UNDRR) also held a series of pioneer conferences on EWS in 1998 (UNDRR 2003a), 2003 (UNDRR 2003b), and 2006 (UNDRR 2006).

Although not a climate-related disaster, the 2004 tsunami in the Indian Ocean prompted significant advancements in disaster management and EWS in the region and globally. A 2003 study by the United Nations Office for Disaster Risk Reduction (UNDRR) emphasized the need for an EWS for tsunamis in the Indian Ocean region, but nothing had been established when the Indian Ocean tsunami struck in December 2004. Humanitarian organizations estimate that the tsunami killed between 230,000 and 280,000 people and thousands more were reported missing (Paul 2009; Brown et al. 2012). This was a wake-up call for the global humanitarian community, spurring a wave of international discussions on DRR and EWS (Basher 2006). The World Conference on Disaster Risk Reduction held in Kobe, Japan in January 2005 culminated in 168 national governments adopting the Hyogo Framework for Action 2005–2015 (HFA). The Hyogo Framework's second priority was to "Identify, assess, and monitor disaster risks and enhance early warning." It called for the development and strengthening of EWS at all levels (national, regional, and community-based), emphasized the importance of multi-hazard early warning systems, recognized the need for technological improvements in forecasting and dissemination of warnings, and encouraged international cooperation to improve data-sharing and communication systems.

Following the tragedy and visits to affected areas, United Nations Secretary-General Kofi Annan made the first call for global early warning systems covering all hazards around the world: "We need a global warning system—and one that covers not just tsunamis, but all other threats, such as storm surges and cyclones" (UN 2005). He then launched a Global Survey of Early Warning Systems to assess and identify solutions to improve EWS worldwide (UN 2006). The HFA and its successor, the Sendai Framework for Disaster Risk Reduction 2015–2030, laid the groundwork for international cooperation in developing EWS, emphasizing the need for a paradigm shift from reactive disaster response management to proactive disaster risk management (Kim and Chung 2024). Organizations such as the United Nations Development Programme (UNDP) played a key role in supporting low and middle-income countries around the world in the setting up of EWS, taking a technological approach focused on understanding risks, increasing hydrometeorological or other hazard forecasts, monitoring infrastructure, and enhancing forecast monitoring and dissemination (UNDP 2018).

In parallel, food security EWS evolved into much more predictive systems that used livelihoods and market baselines combined with standardized food security outcome classifications, to project food security crises six to nine months in advance, especially using drought information. This shift emerged from efforts to standardize warning and analysis systems, first by FEWS NET who reviewed their alert system benchmarking it to malnutrition rates in 2003/4, and then the creation of the Integrated Phase Classification System inspired by the Howe Deveraux Famine Scales. This shift brought renewed light to the poor linkages between early warning and early action and was also accompanied precursors to AA (Brown 2008), such as USAID's use of FEWS NET forecasts to increase or decrease food procurement process for the Food for Peace program six to nine months in advance (USAID and USDA 2019; Choularton and Montier 2023).

3.1 Persistent Challenges in Early Warning Systems for Humanitarian Action Spur Calls for Change

Despite decades of investment in EWS and growing emphasis on community engagement and clear communication (Glantz 2003), development and humanitarian organizations continued to struggle to provide timely assistance in response to early warnings, also due to a lack of mandate for it. Although forecasts were available, humanitarians had limited understanding of how to translate them into action, particularly at longer lead times (Tozier de la Poterie 2018; Kalita 2019), and confidence in forecast accuracy and reliability was limited, which contributed to donor hesitation to fund actions based on forecasts (Hillbruner and Moloney 2012; Lautze et al. 2012). At the national and community levels, people who received forecast information often lacked the resources or capacity to respond (Buchanan-Smith et al. 1994; O'Brien et al. 2000), and there was no reliable funding to enable humanitarians to act or to support community-level actors (Hillbruner and Moloney 2012; Lautze et al. 2012; Tozier de la Poterie et al. 2018).

Evaluations repeatedly highlighted structural weaknesses in how EWS were designed and implemented. Systems tended to concentrate on the first two elements—risk knowledge and hazard monitoring/forecasting—while neglecting warning dissemination and communication, and preparedness and response capabilities (Basher 2006; IFRC 2009; Alfieri et al. 2012; UNEP 2012; Cools et al.

2016; Perera et al. 2020), as well as people-centered community engagement across all four pillars (Sufri et al. 2020; Budimir and Fearnley 2023; Tozier de la Poterie et al. 2025). Although more recent frameworks stress social dimensions such as community engagement, inclusive governance, and local adaptation in disaster risk management (WMO and UNDRR 2024), earlier EWS development was dominated by advances in hazard science and forecasting technologies (Cools et al. 2016). Limited involvement of users—whether local communities or humanitarian actors—in the production, interpretation, and dissemination of risk and monitoring information led to warnings that neither humanitarians nor local actors fully understood or could act upon (Vogel and O'Brien 2006; Tozier de la Poterie et al. 2018; Tozier de la Poterie et al. 2025).

The 2011 famine in Southern Somalia and the 2015–2016 El Niño-Southern Oscillation (ENSO) starkly illustrated these persistent challenges in mobilizing resources and acting ahead of impacts, even when skilled forecasts were available (Tozier de la Poterie et al. 2018). Despite nearly a year of advance warning, humanitarians were largely unable to act before a disaster was declared because of the absence of funding mechanisms to enable forecast-based action, the constraints of protracted conflict, limited operational capacity, and discomfort with forecast uncertainty (Haan et al. 2012; Hillbruner and Moloney 2012). An estimated 258,000 people died and many more fled to Ethiopia and Kenya. This massive and well-studied failure (Haan et al. 2012; Hillbruner and Moloney 2012; Seal and Bailey 2013) intensified calls to enable forecast-based action through pre-agreed funding triggers, pooled funds, and clear guidelines for acting ahead of crisis (Seal and Bailey 2013).

3.2 Improvements in Forecasting and Forecast Communication

Improvements in forecast skill and communication expanded the scope for AA. Improved forecast accuracy at longer lead times made it increasingly possible to predict impacts and act before they materialized. The early warning community had already experimented with Regional Climate Outlook Forums for over a decade, but tercile consensus forecasts with variable skill were difficult to use to mobilize resources (Broad and Agrawala 2000; O'Brien et al. 2000; Patt et al. 2007; Hansen et al. 2022). The development of improved climatologies and multi-model forecasts, as well as reliable short and medium range forecast—where probabilities and skill could be assessed more rigorously—shifted this landscape, giving humanitarians greater confidence to allocate resources ahead of disasters. Although still a young concept, especially in developing countries, the advent of impact-based forecasting, exemplified by the UK's National Severe Weather Warning Service, which communicates "what the weather will do" rather than "what the weather will be" (WMO 2021; Young and Grahame 2024), is gradually helping actors at all levels understand what actions to take in response to early warnings.

In parallel, the humanitarian sector began to reframe early warning explicitly around early action. Early action as a core element of EWS took center stage with the concept of Early Warning, Early Action (EWEA), coined by the International Federation of Red Cross and Red Crescent Societies in the 2009 *World Disasters Report* to respond to persistent shortcomings in existing systems (IFRC 2009). Improvements in hazard early warning and the emergence of climate services partnerships also provided a crucial foundation for AA (Coughlan de Perez et al. 2015; Wilkinson et al. 2018). One early operational example was FEWS NET's Darfur Rainfall Timeline, which overlaid internally displaced people (IDP) and refugee camp locations, road types, and the decadal average, current, and forecast positions of the Intertropical Convergence Zone (ITCZ); this product transformed pre-positioning and logistics for the Darfur crisis (Hellmuth et al. 2011).

3.3 The Rise of Anticipatory Action

Inspired by innovations happening in the insurance sector led by the World Bank, a sense of moral obligation to reduce the impacts of forecastable events on the most vulnerable—those who often lack the resources to act because of poverty and inequality—and in response to persistent challenges mobilizing resources for action based on warnings, the Red Cross Red Crescent Climate Centre and Columbia University's International Research Institute tackled a critical gap: the lack of financial mechanisms to allocate humanitarian funding based on weather forecasts. In partnership with the International Federation of Red Cross and Red Crescent National Societies, they worked to facilitate the release of humanitarian response funding based on forecasts to prepare for floods in West Africa in 2008 (IFRC 2009). In 2009, the IFRC World Disaster Report was dedicated to Early Warning Early Action (EWEA), highlighting the 2008 Disaster Relief Emergency Fund (DREF) experience, and charting a road map for the humanitarian sector. This crucial milestone marked the beginning of efforts to transform the humanitarian sector from a reactive to proactive actor (Braman et al. 2013).

In 2012, building on these experiences, the German Red Cross and the Climate Centre proposed (and later developed) an approach, originally called forecast-based financing (FbF), to systematically link humanitarian funding to pre-defined forecast thresholds to enable action ahead of crisis impacts (Coughlan de Perez et al. 2015). The German Red Cross invested in the first FbF pilots in Uganda and Togo as part of a 6-year Climate Change Adaptation project

(Coughlan de Perez et al. 2015). In parallel, the World Food Programme advanced better use of forecasts through the FOODSECURE programme (WFP 2014). In 2015, the German Federal Foreign Office made a landmark decision to support the establishment of mechanisms that enable and fund action based on a forecast—a strategic evolution of EWS in the humanitarian sector—by launching the "GFFO Action plan on humanitarian adaptation to climate change," which funded FbF pilot projects in several regions and the establishment of an exchange format among the pioneer actors, the Global Dialogue Platform.

By the 2016 World Humanitarian Summit, financing emerged as a transformative agenda for humanity. While calls for a more proactive approach to disasters were not new, the humanitarian system was still largely reactive, mobilizing aid only after disasters struck, often too late to prevent loss and suffering. The Summit called for the humanitarian sector to shift from responding to crises to managing risk, emphasizing the need for predictable, timely, and accountable funding. Anticipatory action (still called FbF at the time) embodied this vision. By linking pre-agreed financing to scientifically defined forecast triggers, AA turned early warnings into early action, demonstrating that humanitarian aid could be anticipatory rather than reactive.

The appeal was immediate because it was about using the best possible science to anticipate disasters and enabling financing for it. The Start Network, the FAO, Welthungerhilfe (WHH), and the United Nations Office for Humanitarian Affairs and Coordination (OCHA), among others, embraced the idea of creating pre-arranged financial mechanisms to enable action before disasters based on forecasts. Early pilots by these humanitarian agencies demonstrated that acting before disasters struck was feasible, yet most actors initially developed separate, agency-based mechanisms, for example using their own instruments, such as pooled funds. Over time, the disaster risk financing community began to recognize the potential of its own instruments, such as contingency funds, risk pools, and parametric insurance, to support AA.

As pilots expanded across regions, a methodology for linking forecasts to pre-agreed financing was developed (Coughlan de Perez et al. 2016) and implemented in more contexts (Hossain et al. 2025) and a body of evidence began to grow showing that AA could work in practice. This learning, coupled with government (both donors and implementing governments) interest and ownership, marked a turning point: AA was no longer viewed merely as a financial innovation, but as a key approach within the broader disaster risk management toolbox.

The establishment of the Anticipatory Action Task Force (AATF, formerly Early Action Task Force) in 2018 and the growth of the Global and Regional Dialogue Platforms, as well as the creation of the Anticipation Hub in 2020, created common spaces for humanitarians, development actors, scientists, practitioners, and policymakers to test, learn, and refine AA models. By facilitating peer learning and linking AA with existing systems, these platforms are helping to translate global commitments and ambitions such as those made under the umbrella of the Early Warning for All (EW4All), the Risk Informed Early Action Partnership (REAP), the Grand Bargain Caucus Outcome, and the Red Cross International Conference Resolution into operational pathways tailored to regional contexts. The evolution of these collaborations illustrates how AA has grown from a humanitarian innovation into a collective and system-wide approach that has transformed the humanitarian sector; one that is increasingly government-anchored, linked to EWS ambitions and that redefines how risk information, financing, and partnerships come together to protect lives and livelihoods before hazards strike.

By planning activities in advance, ensuring timely funding, and defining pre-agreed triggers or mechanisms for rapid deployment of funds, AA offers possible solutions to lack of funding or resources to respond to warnings. This is true at the organizational level by ensuring advanced planning and faster access to funds and at the household and community level by providing direct support or action. Although AA still comprises less than one percent of humanitarian budgets worldwide (Plichta and Poole 2024), a rapidly growing community of practice champions it as a faster, more efficient, and more dignified approach to delivering humanitarian action (AATF 2021; Chaves-Gonzalez et al. 2022).

3.4 What the Evidence Says About Successes and Challenges in Anticipatory Action So Far

The emerging evidence base, while still limited by the difficulty of funding and conducting research in humanitarian settings, points to the benefits of AA. Households that receive anticipatory support are more likely to evacuate (Gros et al. 2023) and to take preparedness measures such as protecting assets or adjusting livelihoods (Gros et al. 2019; Balana et al. 2023; Swift and Schofield 2024). They tend to have better livestock outcomes than households receiving no aid (Gros et al. 2020; Gros et al. 2023; Mogge et al. 2024), and better livelihood coping strategy scores than those supported only after a shock (Balana et al. 2023). Studies consistently show improved food consumption scores among recipients of AA (FAO 2025; WFP 2025), and monetizing these gains reveals substantial value compared to post-disaster aid (de Brauw 2025). Cost-effectiveness analyses suggest that AA can achieve comparable or greater humanitarian outcomes than traditional response at roughly similar or lower cost once set-up investments are absorbed (Cochran 2023) and that the costs of mistargeting are outweighed by

short-term reductions in food insecurity and livestock loss (de Brauw 2025). Beyond household-level effects, stakeholders report strengthened capacities, improved collaboration, and faster response times (Tozier de la Poterie et al. 2023), and there is growing evidence that AA can enhance people's agency and dignity in the face of impending hazards (Kersting 2025).

At the same time, experience to date highlights persistent operational and structural challenges and areas for improvement. Anticipatory humanitarian mechanisms can move funding weeks or months earlier than traditional response (WFP 2025) yet delivering assistance within short time frames in logistically constrained environments remains challenging (Chaves-Gonzalez et al. 2022; Tozier de la Poterie et al. 2023; Iqbal et al. 2024; Jaime Sanchez 2025). Evaluations of AA programs to date do not demonstrate consistent reductions in waterborne diseases or improvements in mental health, underscoring the need to refine theories of change or to concentrate investments where impacts are most reliably achieved (Kersting 2025; WFP 2025). National Meteorological and Hydrological Services (NMHS) are often hindered by having little or no national budget, leading to understaffing, reduced skill, and the inability to maintain national observation networks or access regional or global models needed to accurately predict the timing and location of a hazard (WMO 2025). Nor does AA automatically address issues common to EWS and other programs, such as the need for meaningful community engagement and local ownership, organizational capacity and staff turnover, supply-chain and logistics bottlenecks, or discomfort with forecast uncertainty (Tozier de la Poterie et al. 2023).

These challenges are even more acute in fragile and conflict-affected settings (FCAS). People in conflict-affected contexts with high levels of displacement often have limited knowledge across all four pillars of EWS (Jaime et al. 2024). Data gaps are often greater and hydrometeorological capacity is often weaker in FCAS settings, undermining forecasting accuracy and impact monitoring. Insecurity, political constraints, and access challenges in FCAS settings, factors that hinder delivery of all humanitarian assistance, make delivery even harder in the narrow window between warning and impact (Jaime Sanchez 2025). More work needs to be done to adapt to these challenges if EWS and AA are to serve these vulnerable populations.

Institutionalizing anticipatory action—especially the financing mechanisms that enable early action—within national disaster risk management systems, as part of existing early warning system (EWS) commitments (for example, the Sendai Framework), is a key next step for ensuring that early warnings translate into early action. At present, EWS and AA investments remain split across mandates and funding streams: international financing for EWS largely comes from climate and development institutions, while AA is financed by humanitarian donors and pooled funds (Scott 2022). Yet both EWS and AA require sustained funding across all system elements (Tozier de la Poterie 2023), and AA still represents a small share of overall humanitarian budgets (Plichta and Poole 2024; ALNAP 2025). This fragmentation makes it harder to coordinate roles and resources across actors. Ensuring that different actors can contribute to aligned systems in ways that make sense for their mandates will require government coordination of national frameworks and multi-actor collaboration. Encouragingly, governments, humanitarian agencies, and development partners are increasingly collaborating on practical coordination mechanisms; in some contexts, governments are revising DRM laws and contingency plans to incorporate AA and releasing sovereign funding ahead of hazards. These shifts show that AA can be embedded in national DRM and EWS architectures, though progress remains highly context-dependent (Pham 2025). In a growing and increasingly complex landscape of actors and initiatives, strengthening government-led coordination and harmonizing investments across EWS and AA remain critical to reduce fragmentation, optimize limited funds, and avoid duplication.

4 Lessons and the Way Forward

As illustrated by the history outlined above, EWS and AA are parts of the same process that complement each other by enabling people to act ahead of hazards to protect their lives, livelihoods, and assets. We identify six interrelated lessons drawn from the preceding analysis.

- The humanitarian sector's rapid shift toward AA demonstrates that complex systems can be transformed when there is political will, a community of practice with a common goal, and the right financing structures.
- Effective EWS and AA systems must be people-centered and strengthen all four pillars of EWS: addressing the persistent gaps in communication, local capacity, pre-arranged financing mechanisms, and the ability of those at risk to act on warnings.
- While disasters and political leadership have repeatedly catalysed advances, lasting progress depends on legislation, institutionalizing proactive, risk-informed approaches, and pre-agreed financing mechanisms that reliably turn risk information into action.
- Scaling and sustaining EWS and AA systems will require national leadership and genuine multi-actor collaboration that align government-led mechanisms with development, humanitarian, private sector, and other actors, harmonizing investments across levels and sectors, and leveraging regional and national forecasting capabilities as shared public goods.

- Early warning systems and AA are not cure-alls or standalone systems: they must be aligned with broader climate-resilient development and DRR efforts and adapted to conflict-affected and data-poor contexts so they do not entrench existing inequalities or vulnerabilities.
- Overcoming the remaining siloes between EWS and AA communities, funding streams, and operational systems—and grounding technical advances in the lived realities and priorities of at-risk populations—remains essential to achieving EWS and AA for all.

The transformation of the humanitarian system is now being reinforced by the Humanitarian Reset and the UN80 reform process, which aim to place anticipatory, preventive, and more locally-led action at the heart of efforts to renew the humanitarian system (UNU 2025). Radical change at the systems level will happen when governments integrate anticipatory financing mechanisms into their DRM laws, policies, and financing architecture. To meet the challenge of this next phase of evolution, we recommend EWS and AA concentrate their joint efforts on the following going forward:

- Bridge government-led and humanitarian systems and close coherence gaps: Deliberately connect government-level EWS and humanitarian AA systems, ensuring aligned and/or complementary triggers, financing, and operational protocols so early warnings systematically translate into AA, especially given constrained humanitarian financing. Ultimately EWS and AA are parts of the same process.
- Invest jointly in EWS and AA: Continue aligning EWS and AA with global commitments and ensure that they are developed in partnership, in a collaborative way, and with coherent investments across global, regional, national, and local levels, rather than as parallel or competing mechanisms. For example, investments in EWS from all sources, including development actors, must consistently consider the warning thresholds and triggers that humanitarians need for anticipatory action.
- Ensure complementarity and coherence of EWS and AA with broader DRR and climate-resilient development: Design risk analysis, triggers, and early actions to complement long-term DRR and adaptation efforts, optimize use of funds, reduce duplication and project fatigue, and avoid maladaptation or increased long-term vulnerability. For example, comprehensive risk analysis done in the framework of AA programming could be also useful for long term DRR planning and for disaster response. Anticipatory actions can be triggered based on forecasting and warning systems made possible by investments in EWS. Anticipatory actions are often actions typical of humanitarian response actions that are adapted to the pre-shock context and/or DRR/resilience actions that are scaled up in the face of a new, imminent, and exceptional threat. Acting earlier has been shown to reduce short-term suffering and smooth consumption and has the potential to protect resilience if implemented intentionally and at scale (Humphrey and Kurtz 2026).
- Strengthen inclusive partnerships across all actors and levels: Ensure partnership among governments, international organizations, national and local authorities, communities, scientists, and private-sector actors so efforts are complementary, grounded in the needs and priorities of those most at risk, and leverage diverse forms of knowledge.
- Level up regional meteorological and climate centers as critical enablers and invest in systems providing/updating vulnerability data: This might include investing in regional centers and observation networks to provide cross-border predictive services and Impact-based Forecasting, and supporting countries with limited hydrometeorological capacity, shifting from one-way support to mutual learning and shared resilience.
- Accelerate and stress-test systems for a changing risk and fragility landscape: Strengthen the speed, reliability, and adaptability of EWS and AA to handle variability, including climate change, political instability, and conflict.
- Turn knowledge into practice and institutionalize learning: Move beyond technical and project-level insights to systematically track what works (and what does not), and use learning to iteratively improve design, targeting, and delivery.

We call for the EWS and AA communities to push coordinated efforts to systematically link EWS and AA at different temporal and geographic scales, while ensuring complementarity with broader DRR and climate change adaptation initiatives. Only through recognition of common aims can we rise to the call of doing more with shrinking funds: optimizing the use of funds, reducing implementation time, reducing project fatigue, and ultimately improving longer-term resilience.

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