

Causal Chains Linking Weather Hazards to Disasters in Somalia

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ABSTRACT: Weather risk management products can be critical for supporting effective humanitarian actions to mitigate and prevent disasters; however, to be truly actionable, they must be based in an understanding of how weather contributes to disaster risk, informed by humanitarians' decision-making context. Our paper seeks to identify considerations for weather risk management products to support disaster risk management, through analysis of humanitarian perceptions of the factors and processes that contribute to weather-influenced disasters, taking Somalia as a case study. We carry out semistructured interviews with humanitarian actors familiar with using weather information in their work, and we apply social cascades and disaster risk creation as conceptual tools in our analysis. Our study finds that humanitarian actors perceive historically influenced social networks, livelihood dependence on seasonality, terrorist territorial control, public capacities to manage disasters, and household-level factors related to asset control and coping mechanisms contribute to weather-influenced disasters in Somalia. These factors and processes are part of humanitarians' dynamic decision-making context. Key insights from our study concern the importance of understanding local geographies of marginalization to design weather risk management products with the context specificity necessary for effective humanitarian actions. Also, assessing weather effects on livelihood calendars can help identify those seasonal weather conditions most responsible for detrimental livelihood impacts. Consideration of livelihood calendars can also promote accurate assessment of the effects of consecutive weather-related hazards on coping capacities and resiliency.

KEYWORDS: Social Science; Africa; Decision support; Emergency preparedness; Emergency response; Vulnerability


1. Introduction

A wide variety of factors influence disasters, including those related to weather hazards; how they fit together is complex and often unclear, which can limit or delay effective humanitarian interventions (Maxwell et al. 2021; Lewis and Kelman 2012). Weather-related information is essential to support disaster risk preparedness (Funk et al. 2019). Yet, without a thorough understanding of the local societal fabric and history of sociopolitical stressors, decontextualized weather information is difficult to incorporate into effective planning and action. Researchers recognize that efforts at mitigation and prevention must critically consider local coping mechanisms and potential impacts on livelihoods, including the interrelated effects of multiple hazards (Maxwell et al. 2016, 2021; Levine et al. 2020). Moreover, disaster impacts are influenced by local power relations, sociopolitical institutions, and international humanitarian policies that evolve over a region's history, affecting coping and adaptive capacities (Maxwell et al. 2016; Majid and McDowell 2012; Peters 2021). Research in high income countries has also found that social well-being and inequality (Emrich and Cutter 2011) and aspects of social capital (Collins et al. 2018) are important factors contributing to differences in impacts from weather-related hazards within a given region.

As climate change-related hazards increase (IPCC 2022), weather risk management is becoming an increasingly important component of the humanitarian caseload. Here we define weather risk management (WRM) in its broadest sense, as the use of historical, present, and forecast weather data to inform humanitarian response. This includes monitoring current conditions, tools to enable early action in the event of a hazard, plus historical weather analysis for ex post attribution of impact, or as a guide for the design of future interventions.

A more nuanced, contextualized understanding of how weather contributes to disaster risk can help promote more effective WRM tools for humanitarian planning. Tool development can fail to critically consider socioeconomic factors associated with disasters, misunderstand the origins of risk, and, consequently, fall short of addressing humanitarian needs for disaster risk mitigation and prevention (Majid and McDowell 2012). While there exist substantial weather information products and tools for disaster response in East Africa, recent studies highlight a disconnect between disaster risk management needs and the existing products (Maxwell et al. 2021; Levine et al. 2020). Information is only useful to humanitarian actors if tailored to their decision-making context (Coughlan de Perez and Mason 2014; Tozier de la Poterie et al. 2018; Maxwell et al. 2021). Correspondingly, risk management products must incorporate analysis of disaster risk perceptions and corresponding response or mitigation measures.

Assessing humanitarian perceptions of the factors and processes linking hazards, losses, and impacts can provide the knowledge needed for more effective WRM products, informed by end users' decision-making context at the spatiotemporal scale of action. Humanitarian actors (i.e., nongovernmental

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organizations) tend to require information specific to the subregion or populations they target; consequently, their scale of decision-making can be smaller than that which is captured by existing WRM products, more appropriate to the needs of, for example, national governments and international funding agencies (Maxwell et al. 2021). The act of comparing perceptions with weather data has a long and rich history, a solid theoretical foundation, and has been critical for understanding outcomes and impacts associated with weather patterns. Although there has been extensive research on individual community members' perceptions and their microclimates (Adekan et al. 2015; Osbahr et al. 2011; Below et al. 2015; Harclerode et al. 2016), there has been less work focusing on the perceptions of the institutional decisionmaker.

In this paper, we assess how humanitarian actors perceive the evolution of a disaster and the key factors that influence disaster impacts, applying disaster risk creation and social cascades as conceptual tools. Our research focuses on the case of Somalia, a fruitful research context to assess as its social and geographic complexity makes for diverse vulnerabilities to weather-influenced disasters, also conditioned by years of long-term political instability. Furthermore, the region has a limited amount of historical loss data on which to calibrate WRM products. Because of security concerns related to conflict, it is also challenging to carry out fieldwork in Somalia, as often occurs in contexts of humanitarian work (Peters 2021). In recent decades, Somalia has suffered from multiple humanitarian crises, including famine driven by droughts that many meteorologists regarded as "well forecast," but where humanitarian action was insufficient to prevent catastrophe (Hillbruner and Moloney 2012; Loewenberg 2011; Menkhaus 2012). By analyzing humanitarian perceptions of the processes that contribute to weather-influenced crises, our study takes an important first step in identifying considerations necessary for WRM tools to better support decision-making for disaster risk management and humanitarian planning.¹

In the next section we discuss disaster risk creation, social cascades, and other concepts underlying our understanding of disaster risk. We then present the qualitative methodology used for the study, as adapted to the Somali context. Subsequently, we present results of our analysis of how a disaster develops, from the perspective of humanitarian actors, focusing on the factors that shape vulnerabilities and disaster risk creation. In our presentation, we include examples of disaster development processes or causal chains of impacts throughout Somalia's history.

2. Conceptual framing

We take as a point of departure Cutter's (2018) discussion of complex disasters and emergencies and social cascades for

our analysis of humanitarian actors' narratives of disaster development. A complex disaster is characterized by food shortages, famine, and displacement impacts. It also involves multiple types of hazards, taking place in conflict-ridden areas, and whose losses and impacts are conditioned by varying levels of unresolved vulnerabilities (Cutter 2018). Complex disasters often require large-scale humanitarian assistance, as response efforts needed surpass national capacities; furthermore, civil conflict can obstruct humanitarian actions (Menkhaus 2012; De Waal 2018b). The concept of social cascades (Cutter 2018) emphasizes that social processes evolving over time in response to disasters are key factors influencing the ultimate impacts of hazards. In tandem with disaster experiences, learned behaviors develop and local institutions form and adapt to manage and cope; these processes are ingrained in the sociocultural fabric, influenced by local history. Social cascades can highlight how layer upon layer of disaster-related social effects can contribute to the institutions and behaviors that mediate future impacts of disasters. The concept is helpful for the context of Somalia where weather-influenced disasters, occurring in succession, have become common in recent decades.

A primary component of disaster development concerns how vulnerabilities are shaped and perpetuated, termed disaster risk creation (Kelman 2018; Lewis and Kelman 2012). The formation of predetermined vulnerabilities might be considered the first "disaster" to take place, prior to the hazard event itself. In our study, we sought to understand the sociopolitical processes of disaster risk creation, with a particular interest in weather-influenced disasters. As Peters (2021) points out, "disasters are not natural, but socially constructed" (p. 2). Application of disaster risk creation helps to probe into social processes of disaster construction and focus on questions of why or to whom disasters have been experienced, rather than the extent of disaster impacts (Lewis and Kelman 2012). Social cascades can reshape and reform vulnerabilities; however, we also recognize that social processes occur irrespective of weather-influenced disasters, such as power relations undergirding societal inequalities, and continuously influence vulnerabilities.

Analyzing weather-influenced disasters through the lens of social cascades and disaster risk creation highlights the importance of sociopolitical contextualization for weather-related information and effective risk management products. The concepts illustrate how local agency and institutions contribute to the dynamic context of weather-influenced disasters, conditioning potential impacts. Combined, social cascades and disaster risk creation emphasize the need to look back to previous disaster processes to understand how past responses and coping strategies built up over time influence current impacts. In Somalia, populations commonly manage and cope with conflict and multiple natural and anthropogenic hazards over the seasons. Histories of marginalization of minority communities also influence power relations among the country's ethnic-racial groups, as well as their livelihoods strategies. In the next section we describe the methods used for the study and elaborate on the Somali context.

¹ We emphasize our interest in disaster risk management, understanding it as the implementation of policies, strategies, and plans to reduce the detrimental impacts of hazards and possibilities of disasters; we also view it as the "operationalization of disaster risk reduction" (Kelman 2018). We seek to focus on actions and planning processes taken by humanitarian actors.

TABLE 1. Interviewees per occupation category.

Occupation category	No. of interviewees
Top-level employees responsible for management and policy	6
Midlevel employees who engage in day-to-day decision-making	7
Local community representative/authority	3
Humanitarian aid research practitioner	5
Total	21

3. Methods

We relied on qualitative methods to collect and analyze rich information from humanitarian users of weather data on past weather-influenced disasters, the contexts in which they evolved, and how impacts were experienced among the populations that humanitarian organizations serve. We did not seek to provide representative information on exposure, sensitivity, and adaptive capacity in the face of shocks, as other types of studies and research approaches do (Parker et al. 2019; Baca et al. 2014); we did not seek, either, to help establish causation between factors and outcomes of weather-influenced disasters (Ajefu and Abiona 2020; Randell et al. 2021; Thennakoon et al. 2020). Rather, with an interest in gaining an understanding of the decision-making context in which disaster risk managers must take early actions, we sought to assess their narratives of the chains, or cycles, of factors and processes responsible for weather-influenced disasters.

Consequently, the lead author conducted 21 semi-structured interviews with humanitarian actors from international nongovernmental organizations (NGOs), research and development organizations, community organizations, and government ministries. Table 1 breaks down the interviewees per their occupation category. The study was supported institutionally by Concern Worldwide-Somalia (Concern); correspondingly, using purposive sampling, we developed a short list of contacts knowledgeable of disaster risk management or humanitarian actions taken in Somalia, with inputs from Concern. We also used snowball sampling, asking informants to suggest additional organizations or contacts to include in the interviews, until saturation was reached. As an aim of the project was to generate knowledge useful for the development of weather indices and weather information products, the sampling frame included contacts who would have knowledge or experience using weather information. Given that the short list was developed with Concern's support, sampling may have been biased toward organizations and contacts who work in the areas and livelihood groups Concern targets (south-central Somalia, and agropastoralists and farmers).

Interviews were carried out using a semistructured interview guide (see Gumucio et al. 2021, where the guide is included as an appendix) over November 2020–February 2021. Two of the authors developed the interview guide together, such that it reflects inputs from both a social scientist and a meteorologist; it also seeks to glean information of interest to a designer of WRM products. The interviews sought

to address additional objectives besides those of the present study, relevant to the larger project of which the study is a component. The questions analyzed for this study included those prompting the respondent to discuss: a normal, non-disaster period in comparison with a disaster period in a region in Somalia served by their institution; the primary causes and factors influencing the disaster's development; the disaster's impacts on livelihoods; how the respondent's institution intervened during the disaster year, and the institution's process for taking actions, in general; and who is most detrimentally affected during a disaster and why. Interviews were conducted remotely, using Microsoft Teams and Zoom, because of travel restrictions resulting from the COVID pandemic. All interviewees' names and identifying information were considered to be confidential and were anonymized in the analysis. Interviews are referred to in this report by number only. This study was approved by the institutional review board of The Pennsylvania State University. Interviews were recorded (with permission from informants) and transcribed. They were then qualitatively coded and analyzed using Atlas.ti software, according to key themes: the factors and processes that contribute to disasters, encompassing both aspects related to weather hazards as well as sociopolitical conditions and developments, with a particular focus on disaster risk creation. We also assessed aspects of humanitarian decision-making processes. In addition, we drew on historical materials, including reports from 2005 to 2020 (i.e., post-rainy-season outlooks) from Famine Early Warning Systems Network (FEWS NET)–Food Security and Nutrition Analysis Unit (FSNAU) to elaborate on the historical details of the weather hazards informants reported and information related to the disaster periods discussed.

Our choice of methods reflects our study's objectives and the challenges of conducting field research in conflict-ridden areas. We targeted humanitarian sector representatives for our study population, to better understand end users' needs for WRM products. Humanitarian decision-making also has a unique spatiotemporal scale that requires consideration for effective product design. We draw from past studies that have similarly used semistructured interviews with humanitarian actors, recognizing them as key sources of knowledge to understand drivers of disasters, as well as to assess humanitarian user needs for weather and climate information (Peters 2021; Tozier de la Poterie et al. 2018). Consequently, our study can be seen as an initial foray into identifying appropriate methods for producing the contextualized information on weather-related impacts and causes that meteorologists and other designers of WRM products need (Peters 2021). Future work could ground-truth humanitarians' perceptions of the factors responsible for weather-influenced disasters, with data collected from disaster-affected populations.

Somalia provides an important case study, as a primary recipient of humanitarian assistance. In 2019, it received \$1.9 billion in official development assistance, about one-half of which was humanitarian aid (United Nations 2020). It is also a country wherein weather hazards, such as drought and flooding, have played a significant role in complex emergencies occurring in recent decades (Gure 2021). Long-term

political instability and conflict are also component elements of the Somali context (De Waal 2018b). In particular, since the U.S.-backed invasion of Somalia by Ethiopian troops in 2006, there have been recurrent conflicts between the “Transitional Federal Government,” the African Union Mission to Somalia (AMISOM), Western donors, and differing terrorist groups, including Al-Shabaab (Majid and McDowell 2012; Menkhaus 2014). Ongoing conflict and insecurity hampers both disaster response and can contribute to countries underinvesting in disaster prevention (Stein and Walch 2017). Myriad humanitarian organizations are at work in Somalia, with efforts focused on disaster risk management and resilience building. Anticipating disaster situations, identifying triggering events and developments, and interpreting potential impacts on vulnerable populations are challenging given variations in weather conditions across the country and its diverse geography. However, efforts at planning and management are also inhibited by weak government institutions, civil conflict, and deeply ingrained social inequalities.

4. Results

Analyzing the interview data, we identify five key elements that contribute to disaster risk creation in Somalia, according to humanitarian perceptions of how disasters develop and create impacts. Several concern macrolevel processes and others are household and individual-level factors, related to aspects of livelihood management. Findings from our analyses also illustrate the interrelated effects of the various elements and their collective responsibility for disaster impacts. We highlight themes that were emphasized and elaborated on by the informants themselves. After discussing our findings, we examine how these processes combined with weather-related hazards create impacts on at-risk populations for two time periods and two locations: 2007–11 in the Bay and Bakool regions and 2018–20 in Gedo.

a. Social networks

Historical forces undergirding social networks constitute a first step in disaster risk creation. Informants repeatedly highlighted that the degree of impacts of disasters were influenced by an individual’s “social connectivity,” or rather, the social networks and associated capital to which one has access [interviewees (INT) 1, 3, 4, 5, 8, 9, 10, 13, 16, and 17]. Findings from the humanitarian actors we interviewed are consistent with other findings identifying the importance of social and clan-based kinship networks (Maxwell et al. 2016; Majid et al. 2016). Political elite and paramilitary groups have utilized sectarian discourses emphasizing clan divisions to solidify their power in times of conflict and civil strife; however, clan divisions in Somalia are not antagonistic in practical, daily life (Besteman 2016; Samatar 1997; Samatar and O’Keefe 2004). Clan-based kinship critically structures Somali society, and it is an important source of support during crises (Besteman 2016; Majid and McDowell 2012; Lwanga-Ntale and Ofino 2020).

Characteristically, minority clans and other marginalized groups have less access to strong social networks, in

comparison with Somalia’s dominant clans (INT 8). This is due to racial, ancestral, and class-based inequalities particular to Somalia’s history that effectively discriminate against Bantu-speaking people, descendants of slaves brought to the region years ago (Besteman 2016); furthermore, the structural injustices marginalize the livelihood Bantu groups have typically engaged in, farming (INT 5). Although they do not experience the same type of discriminations, non-Bantu groups who engage in farming or agropastoral livelihoods are commonly marginalized. Dominant clans are composed of pastoralists, and livestock assets represent important wealth in Somali society; consequently, pastoralists tend to be positioned more powerfully in Somali society in comparison with farmers. Historically, Bantu groups have been prey to warlords across Somalia’s periods of civil war, losing their land and agricultural yields to them and to dominant clans in the process (INT 5, 8, and 9). At the present, in addition to landless wage labor on others’ farms, marginalized communities engage in other precarious livelihoods such as petty trade (INT 7).

Majority groups tend to have the highest degree of social connectivity. Their kinship networks and contacts include wealthy connections in the business community and urban areas; they also include international diaspora (INT 8). Correspondingly, those members of more dominant clan-based kinship networks are able to rely upon these networks in times of duress, through remittances, informal loans, and temporary displacement to housing with contacts in urban areas for the length of a crisis period (INT 6 and 17; Majid et al. 2017). This aligns with other research (Collins et al. 2018), which shows that social connections can influence decisions to displace oneself in times of disaster events. In this way, dominant groups’ social connectivity provides them important coping mechanisms, as well as informal social protection, unavailable to minority groups (INT 1).

Furthermore, minorities are unable to voice their needs to sources of outside assistance, unlike those pertaining to more dominant clans. Marginalized communities often cannot access cash transfers, a common humanitarian intervention, due to local power relations favoring more dominant, land-owning clans (Jaspars et al. 2020). Furthermore, minority groups are underrepresented in the government and tend to be overlooked and underserved by the state (INT 2 and 16). In contrast, dominant clans are more prone to benefit from state aid, through their representation in the government (INT 10). Their needs can also reach the ears of international humanitarian organizations through their international diaspora (INT 10). Moreover, their diaspora engages in significant fundraising to help whole communities in Somalia recover and withstand losses from disaster (INT 17).

For this reason, it becomes important for humanitarian actors to understand where marginalized groups are based, or rather, the Somali “geography of marginalization” (INT 2), to consider how impacts will vary in different parts of the country. Marginalized communities, along with less dominant agropastoral clans, tend to live around the rivers in southern Somalia. Although they are not dependent on rainfed farming due to their proximity to the river, these social groups tend to

be affected more detrimentally by drought in comparison with populations based in other parts of the region, due to their lack of social connectedness and their subjugated position in Somali society (INT 9 and 13). This point has also been raised by Maxwell et al. (2020), who noted that famines may occur by livelihood, by class, or by degree of marginalization. Respondents based at humanitarian organizations targeting southern regions of Somalia highlighted that their beneficiaries tended to lack remittances as a coping mechanism, being from these subjugated communities (INT 17). Moreover, the areas noted in southern Somalia consistently have a high food insecurity rating according to the Integrated Food Security Phase Classification (IPC), of 3 or 4 on a scale of 1–5, across seasons (INT 9).

b. Livelihood dependence on seasonality

Disaster risk creation evolves through livelihood-specific aspects, including how resources are used for food security and subsistence, and how livelihood strategies depend on the seasons. Across Somalia, rainfall pattern is primarily bimodal, although there exist important regional variations (Gure 2021). Nearly all respondents noted that the primary rainy season, the *Gu*, normally starts in mid-April (15–20 April) in southern Somalia, with the most intense rains falling in May and early June. The *Gu* usually finishes by the end of June. The secondary rainy season, the *Deyr*, also starts normally around 20 October and lasts until the beginning of December. The *Gu* is typically cooler than the *Deyr* season (INT 18). Riverine areas are prone to flooding during rainy seasons (Gure 2021). The primary dry season, the *Jilaal*, takes place prior to the *Gu*, from January to March. The secondary dry season, the *Hagaa*, follows the *Gu*, taking place over July–September. Although northwestern and northeastern Somalia also generally follow a bimodal rainy season, a few distinct differences with southern Somalia exist. Northern regions are substantially drier than those in the south. In terms of precipitation-related distinctions, the Guban coastal strip in the northwest receives *xays* rains (sea mist) during the colder months of December and January. Furthermore, in other areas of the northwest supplementary *Karan* rains are received over July–August, after the *Gu*. Cyclones are also a hazard experienced in northern regions, but not in the south. Because of the north's differing climatic trends in comparison with southern regions, the *Deyr* season can start much earlier in northern Somalia than in the south (Muchiri 2007).

Respondents noted that all of Somalia's rural livelihood groups were dependent on the performance of the rains (INT 4 and 5), contributing to their vulnerability to weather-influenced disasters (INT 1, 9, and 18). For example, organizations who worked substantially with pastoralists emphasized how rain was critical for pasture and for watering animals; without livestock feed or water, animals would perish (INT 3 and 12). Consequently, pastoralists constantly move their livestock from place to place, according to the weather (INT 10). In comparison, those who worked significantly with agropastoralists and farmers highlighted the necessity of appropriate soil humidity for crop planting and maturation (INT 1 and 18).

Delays of rain onset or early cessation of rains greater than 15 days were detrimental for planting and cultivation of key crops, for example, maize and sorghum (INT 1). Additionally, dry spells greater than 15 days during the *Gu* season were catastrophic for agricultural livelihoods (INT 1). The performance of the seasons also affects the livelihoods of those who engage in landless wage labor on others' farms, with work opportunities depending on crop productivity and landowners' solvency and success from current and recent seasons (FSNAU–FEWS NET 2016).

Representatives of humanitarian organizations explained how poor livestock and agricultural production harm rural households' income and food security. Death of lactating animals has detrimental effects not only on household income (milk they would have sold) but also on nutrition, eradicating an important source of food and nutrients (INT 1 and 10). Furthermore, consecutive failed rainy seasons can dangerously reduce agricultural stockpiles, affecting household food stores (INT 3). Poor agropastoralists and farmers tend to not produce enough for subsistence and must purchase staple foods; consequently, seasonal inflation of food and water prices during the dry season can exacerbate their vulnerability to shocks and weather-influenced disasters (INT 1). Locust infestations in recent years have been an additional hazard contributing to agricultural losses and vulnerability (INT 1 and 18).

Consequently, humanitarian planners must understand the timing of livelihood activities and how livelihood-dependence on seasonality can affect resilience for the specific areas where they work. Respondents particularly emphasized how consecutive weather-related hazards across seasons can be important catalysts for disaster situations (INT 1, 3, 4, 5, 6, 8, 11, 12, and 18; see also Howe 2018). If the prior rainy season's harvest has been poor, the cascading effects can be especially detrimental as households have less income, food stores, and productive capacity for the subsequent rainy season (INT 1) (Barrett and Constan 2014; Maxwell et al. 2020). In riverine areas, weather-induced disasters characteristically include drought conditions followed by flood, for example, a failed rainy season followed by extreme rainfall events during the subsequent rainy season (FSNAU–FEWS NET 2016), as coping capacities are diminished from the prior rain failure and spikes in food and water prices. Moreover, agricultural and agropastoral households commonly experience a “hunger gap” in the months (July–September) just prior to harvests from the primary rainy season (INT 1). The losses and impacts associated with a hazard are heavily influenced by its timing with seasonal hunger. Correspondingly, an informant responsible for a humanitarian organization's use of weather information highlighted that existing risk management products, such as food security outlooks and analyses issued by FEWS NET–FSNAU, are not produced in time for humanitarian actions to prevent or mitigate populations' vulnerability and losses during the critical hunger gap period (INT 1). The information products are not well adapted for short-term, within season, anticipatory planning that humanitarians must make. Furthermore, FEWS NET–FSNAU early warning thresholds for rainfall do not consider location specificities, to the extent required by humanitarians (INT 1).

c. *Isolation due to terrorist control*

As a third lever in disaster risk creation, conflict effectively cuts communities off from humanitarian assistance (Walch 2018). Humanitarian actors highlighted how terrorist control of an area can be an important factor contributing to a community's vulnerability to weather-influenced disasters. Importantly, conflict and terrorist control can inhibit people's capacities to displace themselves in search of water and pasture, a significant coping mechanism for several livelihood groups (INT 7 and 10). Moreover, they explained that Al-Shabaab control can prevent humanitarian organizations from reaching communities in the controlled areas, effectively isolating them from assistance (INT 1, 2, 8, and 9; Menkhaus 2012). Terrorist groups can even eject humanitarian organizations from their areas of control; this was an important factor influencing the great 2011 famine, wherein Al-Shabaab had banned several key humanitarian actors, including the World Food Programme, in the years just prior (INT 7). De Waal (2018a) has noted such tactics employed by terrorists (or national governments) as "counter-humanitarianism," increasingly a factor contributing to famine across country contexts. Furthermore, as a result of terrorist control, humanitarian organizations must often engage in more costly endeavors to access certain areas, for example, air lifting nutrition supplies to bypass the risk of their being usurped on roads controlled by Al-Shabaab (INT 9). Terrorist control and civil conflict can also inhibit the state from providing key public services, for example, those related to sanitation, hygiene, and health care. In general, terrorist control critically limits the government's and NGOs' abilities to coordinate (INT 10); as a result, controlled areas are like "islands" (INT 7), cut off from public services and international assistance important for coping and recovering from the effects of weather-influenced disasters. Similar to the geographical differences in social connectivity available to Somalis living across the country, terrorist control and its isolating effects are more prevalent in areas in southern Somalia, as opposed to the north (INT 7 and 10).

d. *Public institutions*

Humanitarian actors also noted that the strength of public institutions was an important factor in disaster risk creation; furthermore, it can be an important element of social cascades, conditioning the development of informal and formal mechanisms and strategies for risk management. Weak state institutions allow for the invasion and solidification of terrorist control, crime, and corruption (INT 7; Menkhaus 2014; Jeong 2019). Moreover, referring to several prior cases of disaster periods, respondents highlighted how a weak state and a lack of institutional mechanisms—for example, an appropriate early warning system, ministries with disaster risk management mandates, corresponding policy frameworks—to address drought had greatly contributed to scale of losses (INT 4, 5, 11, and 16). A strong government is also important to inspire donor confidence, effectively raise funds, and coordinate among development partners in times of escalating disaster (INT 7). Several respondents provided examples comparing

the current public institutional environment with that in 2011 and earlier, highlighting the lack of government agencies and coordinating mechanisms to address drought in 2011 and progress in developing the state's institutional capacities since then (INT 7 and 8).

Respondents highlighted other effects of a weak state that have contributed historically to disaster risk creation in Somalia. For instance, lack of market regulations has allowed for spikes in water and staple food prices during times of water scarcity and famine conditions (INT 1) and contributed to corruption in water governance (Mourad 2022). As a result of a weak state, national social protection and pro-poor financing are lacking, enhancing vulnerabilities for particularly marginalized groups (INT 1). Furthermore, weak state institutions have contributed to poor land and natural resource management, promoting communities' exposure to weather hazards (INT 2): an example cited frequently concerned the government's failure to ensure desilting of riverbeds, diminishing rivers' capacities to carry water and facilitating flooding during periods of extreme rains (INT 18).

Although not discussed in association with Somalia's weak state institutions, other factors that contribute to vulnerabilities to weather-influenced disaster highlight areas where state interventions are lacking. For example, fluctuations in market prices of livestock and farm products put household income sources at risk and inhibit capabilities to manage and recover from losses (INT 10 and 12). Additionally, indigenous institutions for water storage management fail to serve people's needs (INT 8). The majority of rural Somalis depend on hand-dug water catchments, which have extremely limited capacities to retain water.

e. *Household-level factors*

Additional aspects of disaster risk creation are salient at a more granular level, in comparison with the previous elements, although associated with prevailing social inequalities. For example, humanitarian actors emphasized that access to productive assets, such as land and livestock, were important for being able to manage and cope with disasters (INT 1 and 18). Smallholder farmers with limited land face low yields during drought. These yields are often sold rather than consumed to cope with loss, contributing to food insecurity. Similarly, among livestock producers, those who have a greater number of heads are better able to sell livestock as a coping strategy, experiencing less livelihood damage in comparison with producers who have just a few (INT 1) (see also Lybbert et al. 2004). In riverine areas where pump irrigation is common, pump ownership tends to be limited to middle and large-scale farmers (INT 5 and 18).

Humanitarian actors highlighted how minority status and gender influence access to assets, particularly land control. Although marginalized communities tend to live in riverine areas, they rarely have access to pumps (INT 1 and 18). Furthermore, in times of rain shortage, pastoralists commonly migrate and invade farmers' lands near the rivers for pasture (INT 8). In general, minorities' land tenure is insecure, due to frequent infringement on their use rights by pastoralist groups

(INT 18). Those minorities who do not own land often work as casual laborers on others' farms or they rent land in a sharecropper-type scheme, both situations with insecure income streams in times of weather-influenced disasters (INT 1 and 5). Female-headed households also experience similar land and income insecurity; like those from minority groups, they often work as casual laborers or rent land (INT 1).

Moreover, the vulnerability of livestock assets themselves to weather conditions contributes significantly to disaster risk creation (INT 7, 10, 11, and 12). Livestock producers often lose substantial amounts of money on water and feed, in their efforts to keep animals alive and avoid livelihood damage in times of rain deficits.

Humanitarian actors often emphasized Somali people's familiarity with shocks, such that they had developed mechanisms and strategies for managing them (INT 6). However, their responses indicated that those worse off in times of disaster were those with fewer coping mechanisms available to them, typically those from marginalized communities and minority groups. Correspondingly, respondents noted that the FEWS NET-FSNAU use of "livelihood zones" for anticipating emergency situations does not effectively represent the vulnerabilities of Somalia's varying social groups as the categorization can oversimplify and miss the significance of socioeconomic factors (INT 13 and 9; Maxwell et al. 2020). Remittances and displacement to urban areas were a few of the critical coping mechanisms used (INT 4, 6, and 10). Another involved the use of mobile phone technology to identify where water and pasture was available and to coordinate with owners of water trucks or other transport to bring water or to transport livestock to areas with pasture (INT 10). This latter mechanism was more prevalent in the north than in the south (INT 10). Particularly vulnerable populations can frequently be in a high state of food insecurity and are at high risk as a disaster develops (INT 7); furthermore, they are more prone to resort to detrimental coping mechanisms, for example, complete abandonment of homes and livelihood (INT 6).

5. Weather-influenced disaster periods

This section presents examples of weather-influenced disaster periods as they affected particular regions of southern Somalia. The explanations of disaster periods are useful for demonstrating the influences of the sociopolitical context and weather and non-weather-related factors on disaster risk creation; they also exemplify the integrated and cascading effects of social and biological processes. While the examples might not speak to long historical processes (for example, related to power relations affecting marginalized communities), they are particularly helpful for showing the short-term intereffects of weather and non-weather-related hazards and processes, to which humanitarian actors must respond. The narratives differ in the aspects of disaster development highlighted; this reflects variations across each disaster period but may also illustrate the differing perspectives of the humanitarian actors who contributed to each narrative.

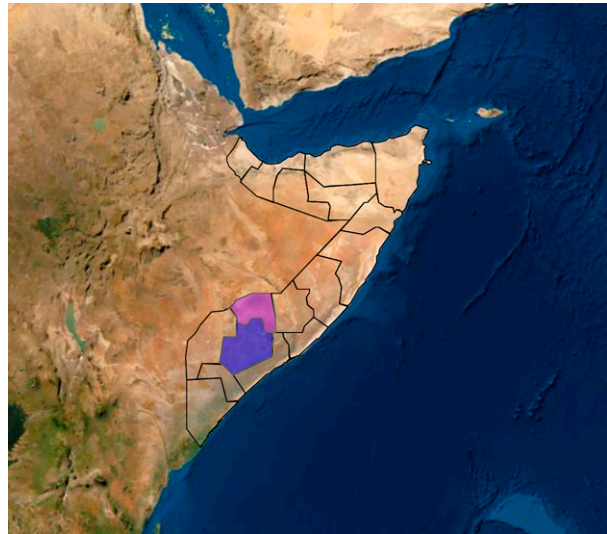


FIG. 1. Map of Bay and Bakool regions in Somalia.

a. 2007–11 in the Bay and Bakool regions

In the Bay and Bakool regions (see Fig. 1), various factors over multiple years culminated in a severe famine in 2011. In these regions, farming activities are important for several livelihood groups, primarily agricultural and agropastoral communities who tend to be from marginalized communities. Agricultural activities include those related to sorghum and cowpea production as well as sesame cash cropping (FSNAU-FEWS NET 2016). Livestock production is also a significant economic activity for various livelihood groups. Commonly, crop production serves households' subsistence needs, while livestock production is a primary source of cash income. Several areas in Bay and Bakool are prone to conflict and civil insecurity.

Over 2007–09, shifts in livelihood strategies played a large role in disaster risk creation. Bay and Bakool agropastoralists invested substantially in sesame cash crop production, instead of customary cereal cultivation (INT 8). The shift ultimately resulted in households' reduced food stores and stock for livestock. The change was influenced in part by Al-Shabaab promotion of sesame crop production during this period (Majid and McDowell 2012). Additionally, the region experienced a bumper harvest year in 2008, caused by Al-Shabaab influences: as de facto authority in the region at the time, Al-Shabaab had been taking idle land and requiring that households plant on it (INT 7). Simultaneously, in-kind food being distributed by the World Food Program caused market value of sorghum crops to decline, contributing to households' preference to cultivate cash crops (INT 8). Furthermore, they used their cash income to increase livestock holdings over this period. It was in this context that the food security situation for agropastoralists deteriorated as a result of consecutive failed rainy seasons throughout 2007–09.

Subsequently in 2010, the secondary rainy season failed in both Bay and Bakool. Afterward, the 2011 primary rainy season failed, in terms of amount, intensity, and distribution in

both regions (INT 8). In Bay in particular, primary rains ceased abruptly at the end of the second dekad of May, in the very middle of the season, and a dry spell persisted until the season's end (FSNAU 2011). Agropastoralists were in a less resilient state to cope with the series of shocks, due to their already reduced food stores and stock for livestock, especially considering that their livestock holdings had increased due to past investment decisions (INT 8). The shocks also affected casual laborers, who were left without sources of work, income, and food (Majid and McDowell 2012).

Other social cascades also rendered unfeasible previously effective coping mechanisms and learned behaviors. First, Al-Shabaab limited individuals' movements, preventing migration with livestock to areas with water (INT 7). Al-Shabaab had also previously forced out humanitarian agencies from the regions. Last, Somali traders, who were usually able to provide food on credit to households, were so affected by the large-scale crisis that they were no longer able to do so. This eroded what had been an additional source of food and staple goods for households during times of scarcity. These factors compounded the impacts of the dried water catchments, depleted pasture, livestock deaths, consecutive seasons of crop failure, and food price inflation, making 2011 exceptionally hard to endure for households.

Those who bore the brunt of impacts were those of marginalized communities, who had the weakest social capital and were unable to access informal loans and remittances through social networks, as those from other social groups could. At its peak, the crisis effects were such that 235 000 people experienced famine in Bay and Bakool (FSNAU 2011). Famine conditions were most prevalent in agropastoral and interrivine areas (Majid and McDowell 2012). The impact of the weather events was mediated not only by Al-Shabaab's curtailment on movement and ejection of humanitarian organizations (Menkhaus 2012), but also through processes of disaster risk creation involving Al-Shabaab's usurpation of the state's role in rural development. Moreover, longstanding power relations that assign high social status and wealth to livestock holders influenced livelihood management decisions; social inequalities also effectively limited minority groups' access to social capital (Menkhaus 2012). Correspondingly, although impacts of the famine were experienced throughout Somalia, because of the combination of factors at play in Bay and Bakool they were most detrimental in these regions.

b. 2018–20 in the Gedo region

The Gedo region (see Fig. 2) case highlights how disaster risk creation evolves through the effects of weather conditions on livelihood calendars. Moreover, it highlights how consecutive weather hazards can have compounding effects on markets and livelihood outcomes and strain coping capacities. Important to Gedo region's geography is the presence of a major river, the Juba. Nonriverine agropastoralists engage in sorghum production, while in riverine areas farming activities

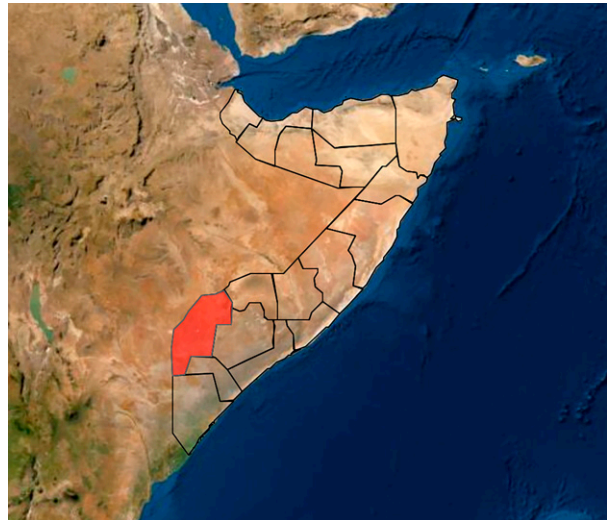


FIG. 2. Map of Gedo region in Somalia.

include cultivation of sorghum and maize as staple crops. Cash crop production primarily takes place in riverine areas, principally of onions and tobacco, although sesame can also be common (FSNAU–FEWS NET 2016). Although motorized pumps are critical for accessing water from the river, few farmers own them. Because of local mechanisms of accessing water for agriculture, communities near the river can be particularly vulnerable to flood-influenced disasters. Various areas in Gedo also tend to be prone to conflict and civil insecurity. Poor agricultural and agropastoral communities can be the least resilient populations in the region, in part because of their marginalized status.

The 2018 secondary rainy season was well below average, as much as 50%–60% below the average in some areas (INT 1). Subsequently, the 2019 main dry season was particularly long and harsh. By early in the dry season in January 2019 water catchments were already dry, and market prices of water were high by February–March. The secondary harvest was also poor, and staple food prices spiked by February–March 2019.

The 2019 primary rainy season was delayed, with a mid-May onset, preventing full cycle and maturation of maize and sorghum crops. As a result, the primary harvest was exceptionally low. In parallel, food market prices spiked again, and households' food reserves reduced. The consecutive shocks and resultant effects on livelihood outcomes contributed to communities' diminished coping capacities entering the third quarter of 2019.

Correspondingly, while the 2019 secondary rainy season was above average, it resulted in flooding in riverine areas. Additionally, desert locust infestations occurred in December 2019 and January 2020, damaging any crop and pasture regrowth that may have taken place because of the rains (INT 1). The 2020 primary rainy season was poorly distributed over time, characterized by severe floods in the beginning,

a dry spell in the middle, and an early end to the season. The effects were particularly detrimental to agropastoralists, who confronted failed germination of crops. Agropastoralists in southern Gedo, where crop moisture stress was most intense, felt the effects most harshly (FEWS NET-FSNAU 2020). In this context, the COVID pandemic began and evolved over 2020 through the present.

6. Discussion

Humanitarian perceptions of the processes that contribute to weather-influenced disasters highlight a complex, dynamic, and challenging context in which to assess risk, identify vulnerabilities, and develop plans to mitigate and prevent detrimental impacts to the populations their organizations serve. Power relations associated with race, ancestry, and class effectively disadvantage certain groups in terms of access to social networks to manage loss and recover from weather-influenced disasters. Livelihood dependence on seasonality in rural areas contributes significantly to disaster risk creation and is critical for understanding the severity of impacts of consecutive weather hazards across seasons. Terrorist control of certain areas blocks off communities from humanitarian assistance and state services key for coping and recovery. Furthermore, the state's capacity to play a role in disaster risk management is a macro-level factor influencing the cascading effects of disasters. Household-level factors related to access to land and livestock also differentiate the advantaged from the disadvantaged, concerning mechanisms for coping and recovery and impacts of weather-influenced disasters.

The analysis of humanitarians' perceptions helps identify important considerations for WRM products to support humanitarian planning. Firstly, understanding existing social inequalities can help assess the coping mechanisms available to varying populations and correspondingly, the potential impacts from weather-related hazards. International NGOs, the decision-makers whom our research tends to target, serve those with the most limited coping capacities. Understanding the country's geography of marginalization helps to develop WRM products more holistically, considering local origins of risk.

Furthermore, assessing the effects of the weather on the relevant livelihood calendars is necessary to consider potential livelihood outcomes and stresses on coping capacities. Several respondents who serve agricultural and agropastoral communities discussed weather conditions (i.e., delayed start of primary rains, dry spells, early cessation of secondary rains, etc.) in terms of the effects on soil moisture, crop calendars, and seasonal subsistence needs. Understanding calendar effects helps illuminate when coping mechanisms might be most strained. Consequently, identifying those seasonal weather conditions that are most pertinent for the livelihoods of interest to humanitarian organizations is a primary step in crafting WRM products that serve their needs.

The analyses also show the importance of products looking retrospectively at the weather effects of prior seasons to understand the current situation. Previous rainy seasons deemed poor or failed put a stress on current coping capacities.

Assessing coping capacities based on current weather conditions will result in inaccurate assessments of livelihood impacts, humanitarian interventions needed, and delayed actions. This is consistent with the recent surge in literature on resilience: households' abilities to recover from a disaster decays with repeated shocks and hazards (Barrett and Constan 2014).

Our study also shows the importance of avoiding overemphasis of the capacities of stand-alone weather information tools for humanitarian decision-making. Instead, we propose tailoring WRM products to complement existing systems of information gathering used by disaster risk managers. For example, the Building Resilient Communities in Somalia (BRCiS) Consortium of international NGOs uses a data collection system developed with local community groups to gather diverse types of information deemed indicative of crisis or disaster evolving, related to climate but also to markets, migration, agricultural and livestock production, health and nutrition, and coping mechanisms; furthermore, information is gathered at a district level, specific to the local areas where BRCiS partners are active.

Coordinating with both state actors as well as humanitarian organizations for the development of WRM products can be important considering that the state's capacities to play a role in disaster risk mitigation and prevention have been a significant factor in cascading effects of weather-influenced disasters in Somalia. The services that humanitarian agencies provide often work in parallel to those of the state, filling gaps in public service provision, for example, related to water, sanitation, and hygiene (WASH) and social protection. Communication with state actors can help promote the development of WRM products that support multistakeholder initiatives. The national scale at which state agencies work may result in differing information needs in comparison with humanitarian organizations (Maxwell et al. 2021); however, being aware of the systems of information gathering used by state disaster agencies and making new information products accessible to relevant state actors can ultimately facilitate more effective disaster risk management.

Future applications of our research can lead to WRM products being developed in a more holistic fashion, such that they better support humanitarians' specific decision-making needs. For example, the present study contributes to a project funded by insurance company AXA XL, the property and casualty and specialty risk division of AXA, on "Measuring hazards to forecast disasters." Broadly, the project aims to produce guidance on the development of weather statistics tailored to the needs of the humanitarian community active in Somalia. Study findings are being used to evaluate statistics from a wide range of remotely sensed weather products, allowing an understanding of which statistics might form effective indices.

7. Conclusions

Our qualitative research with humanitarian actors illustrates the key processes and factors contributing to weather-influenced disasters in Somalia, from their perspective as

disaster risk managers. These processes concern historically influenced social networks, livelihood dependence on seasonality, terrorist territorial control, public capacities to engage in disaster management, and household-level factors related to asset control and coping mechanisms. They contribute to disaster risk creation and social cascades and are part of the dynamic decision-making context that humanitarians navigate.

Our analyses indicate several critical insights for the development of WRM products more broadly. Products can have potential to be truly actionable when they seek to support systems of information gathering already in use by humanitarian actors, wherein weather-related information contributes to one of several indicators of disasters that disaster risk managers monitor. Knowledge of local social inequalities can help develop products with the context specificity necessary for targeted humanitarian assistance. Moreover, considering the effects of weather conditions on livelihood calendars can illuminate which conditions are particularly critical for the livelihoods of interest to humanitarian actors. It also requires that products look backward to weather conditions from prior seasons. Furthermore, including state voices in discussions of weather information product development can promote access to information by both humanitarian organizations and state institutions involved in disaster risk management, as well as effective coordination and action among the multiple stakeholders.

Our study critically acknowledges that a holistic understanding of the factors and processes contributing to weather-influenced disasters, beyond those related to weather hazards, is necessary to develop WRM products tailored to humanitarian actors' needs. Such attempts are necessary to avoid contributing information that is unusable and move toward developing products in communication with next users, informed by an understanding of the complex contexts that humanitarian decisions address. Similar new approaches can help to ensure that weather-related information effectively facilitates humanitarian action and prevents loss of lives and livelihoods.

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