

The Climate-Resource-Food Security Nexus: Analyzing the Cumulative Impact of Recurrent Disasters on Somali Communities' Livelihood Sustainability

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Received June 05, 2026; Revised July 07, 2026; Accepted July 14, 2026

Abstract Somalia exemplifies the destructive synergy between climate, conflict, and resource shortages, which severely impede economic and social progress. This manuscript examines key weather events, trends, and humanitarian interventions. The temporal pattern of drought occurrence in Somalia has undergone a significantly alarming shift over recent decades. The recurrence interval has contracted from an historical average of once per decade to approximately two to four episodes per decade, progressively diminishing the adaptive capacity of agro-pastoral communities to withstand consecutive environmental shocks. Similarly, frequency and intensity of floods have increased, and due to increased population density in flood-prone areas and land degradation (deforestation, soil erosion), large number of people have become internally displaced. This paper concludes that recurrent disasters have ravaged the very foundations of Somali livelihoods, obliterating crops, inundating farmlands, and decimating livestock, which are essential for both sustenance and economic survival.

Keywords: Conflict, Drought, Floods, Food security, Human mobility

Cite This Article: Abdirashid Elmi, and Abdisalaam Elmi, "The Climate-Resource-Food Security Nexus: Analyzing the Cumulative Impact of Recurrent Disasters on Somali Communities' Livelihood Sustainability." *Journal of Food Security*, vol. 14, no. 2 (2026): 46-52. doi: 10.12691/jfs-14-2-2.

1. Introduction

Despite the increasing global recognition of the connection between climate change, conflict, and food insecurity, Somalia, a nation acutely affected by the triple crises, has received comparatively little attention. Somalia, located in the Horn of Africa, has experienced three decades of vulnerability to security and environmental stressors, namely droughts, water shortages, and land degradation, leading to significant food insecurity and adverse effects on livelihoods and human well-being. The nation's struggles with food insecurity have been shaped by a complex combination of factors, including prolonged conflict, climate variability, weak governance, stalled economic development, and resultant abject poverty. The outbreak of the civil war in 1991 and the subsequent three decades of violent conflicts made Somalia one of the most fragile states in the world [1]. Furthermore, Somalia is considered among the world's most vulnerable countries to climate change. The nation's vulnerability to the adverse impacts of climate change is alarmingly high, consistently ranking among the lowest in readiness and highest in susceptibility globally. According to the most recent data compiled by University of Notre Dame's "Global Adaptation Initiative" index (ND-GAIN, 2024),

Somalia is highly vulnerable to climate change, ranking 182 out of the 187 countries assessed [2]. Recurrent droughts and floods interact with other critical challenges, including environmental degradation, lack of governance, and ongoing conflict, to worsen local conditions. Consequently, these combined factors drive widespread poverty and mass displacement.

Climate change is not just an environmental disaster but also exposes humans to extreme weather events, putting food security at great risk and placing sustainable development goals (SDGs) out of reach. Droughts/floods are meteorological conditions whose ecological and social impacts can be devastating on countries with weak or lack of mitigation capacity. Decades of civil war have battered basic physical infrastructure and governance systems, disrupting food production and distribution networks. Alternating droughts and floods have decimated crops and livestock, exacerbating food scarcity. Consequently, the period between 1992 and 2022 witnessed some of the worst humanitarian crises in modern history, with Somalia often at the center of international attention due to its vulnerability to famine, resulting in high rates of malnutrition.

Alternating droughts and floods lead to herders selling off more of their livestock than usual for survival, driving down market prices and, consequently, leading to a rapid decline in rural incomes. The lack of economic

alternatives motivates people to take part in illicit activities like charcoal production, leading to large scale deforestation and land degradation, which in turn makes the local population increasingly vulnerable to negative impacts of climate hazards on food security, the vicious cycle. For societies with weak institutions and security challenges, like Somalia, it would be difficult to break this vicious cycle. For example, a recent report from Inter-governmental Panel on Climate Change (IPCC [3] estimates with high confidence that people who directly depend on natural resources for subsistence and income are especially vulnerable to land degradation effects. Furthermore, predicted changing climate in the next decades, accompanied by a comparatively rapid population growth and increasing pressure on natural resources, means that the population and the number of regions affected by the impacts will continue to grow. This will have direct effects on key life-support systems: food systems, water resources, health, infrastructure, and service delivery. These changes will be especially detrimental to vulnerable communities and marginalized groups in drought and flood prone regions.

Recent research has established a strong link between climate change and security, particularly in conflict-prone and fragile states such as Somalia [4]. The confluence of natural, political and social factors has created an exceedingly complex crisis in Somalia, which demands a critical analysis to map out options and priorities that can pave the way towards recovery and resilience. The objectives of this study are to 1) examine the past (30-years' average) rainfall patterns in order to understand the drought trends and be able to predict future scenarios, 2) analyze how recurrent floods had affected Somalia, using Baladweyne District, Hirshabeele State, Somalia, as a case study, 3) examine how weak governance structures, localized conflict, and environmental decline interact with climate disasters to worsen community vulnerability, 4) recommend practical, community-led strategies and policy recommendations that can strengthen food security and protect livelihoods against future climate shocks.

2. Literature Review

2.1. Climatology and Brief History of Droughts and Floods in Somalia

Somalia is generally arid and semi-arid with bi-modal rainfall seasons (Figure 1). The annual mean temperatures are close to 27°C but vary greatly across the country and throughout the year. Average monthly temperatures reach their maximum from June-September in the north, while December-March marks the hottest weather for the south. Nights can be cooler and windy, while the daily maximum temperature often ranges from 30-35°C. Rainfall in Somalia is generally low and erratic, and it has a high temporal and spatial variability. Mean annual rainfall in Somalia ranges from less than 100 mm in the coastal arid and semiarid area to 600–800 mm at higher elevations along the Juba and Shabelle river systems in the south and in some parts of Awdal region in the most westward part of Somalia [5]. The rainfall pattern is divided into two

cropping seasons: the Gu season (April–June) and the Deyr season (October–December). However, the increasingly unpredictable nature of rainfall, in both time and geographic distribution, represents a much stronger challenge for agriculture production and rural livelihoods than previously [5].

Charcoal is currently the second-most important export from Somalia after livestock, with up to 250,000 tons of charcoal produced annually (Global Forest Watch, 2023).⁶ Between 2001 and 2021, Somalia lost 429,000 hectares of tree cover, the equivalent to a 4.9% decrease in tree cover, which represent the loss of approximately 20-40 million trees [6]. Consequently, flash floods during rainy seasons and devastating droughts afterwards have become more frequent and more intense, putting the livelihoods of large portions of Somali people at constant risk. In 2006, for example, a severe drought affected much of the Horn of Africa, causing food shortages that exacerbated the humanitarian crisis in Somalia.

The rise of the militant group al-Shabaab in the late 2000s further complicated the situation, particularly in rural areas, where they often imposed harsh conditions on humanitarian food distribution. The presence of Al-Shabaab who controls large swaths of the country has made large parts of the country inaccessible, hindering humanitarian and major economic activities. Moving forward, the most catastrophic famine of the 21st century in Somalia occurred in 2011, when a combination of severe drought and ongoing conflict pushed the country to one of the most distressing famines in 60 years. An estimated 260,000 people died, more than half of them being children under the age of five [7]. The 2011 famine caused a profound shift in the demographic landscape of Somalia [8]. Over a million people were displaced, creating a large refugee population in neighboring countries, particularly Kenya and Ethiopia. Just five years later in 2017, another near famine hit large parts of the country, particularly in the north (Somaliland). By 2022, Somalia once again faced severe food insecurity, exacerbated by the worst drought in several decades. The country was on the brink of another famine, with an estimated 7.8 million people in need of humanitarian assistance [9]. The situation was made worse by the conflict in Ukraine, which disrupted global grain supplies, further driving up food prices globally.

Somalis, being predominantly agro-pastoralists, are directly impacted droughts more severely than floods. Therefore, there are rich references to severe drought occurrences in their mostly oral literature. They gave names to the most notable droughts, typically signifying duration, intensity, and ensuing impacts. For example, one of the most celebrated poet in Somali culture, who lived till early 20th century, composed a famous poetry in which he counted the most serious droughts and the harm they inflicted on pastoralists' livelihoods: Gaag-ma-reebto (wiped out nearly all living organisms), Gaatamo (flash drought), and Dabadheer (long tailed because it lasted longer than previously known droughts). These droughts which led to massive scale of famine are estimated to be at least 30 years apart, compared to 4-5 years apart presently. The following are the most notable droughts during the past 30 years.

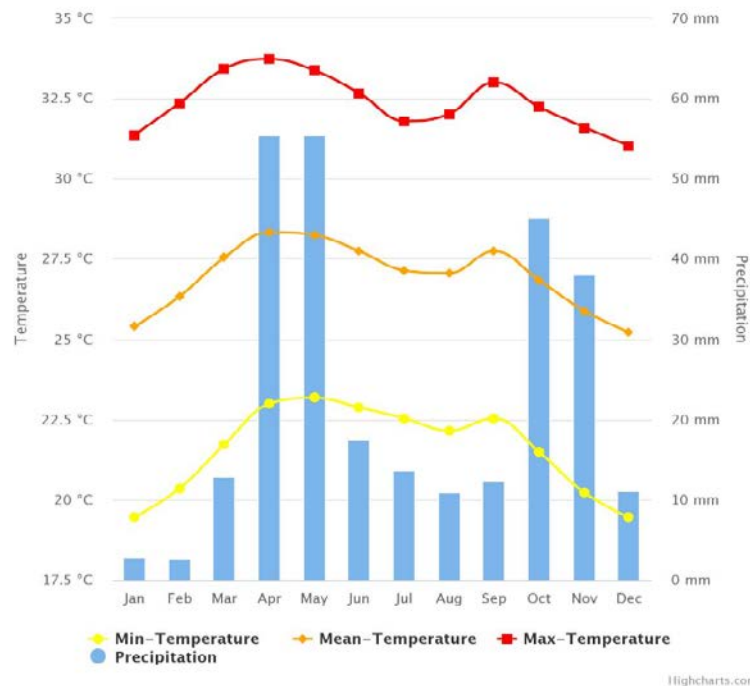


Figure 1. Somalia's long-term monthly min, max, mean temperatures, and rainfall 1991-2020. Source: World Bank Climate Change Knowledge Portal (2022)

1992-1993 Famine: International Intervention: In 1992, Somalia experienced a devastating famine exacerbated by ongoing civil conflict. The United Nations intervened with Operation Provide Relief (OPR), delivering food and other essential supplies. Despite this intervention, challenges such as security issues and logistical constraints hindered effective aid distribution, resulting in 300,000 deaths, mainly because of the breakdown of law and order. The level of preventable death toll drew global attention, leading to the deployment of U.S.-led humanitarian missions (Operation Restore Hope) which aimed to secure emergency food aid delivery blocked by armed militia supporting various clan-based warlords, and stabilize the region. Despite these efforts, food aid distribution was often hindered by conflict and insecurity, demonstrating the challenges of delivering assistance in a failed state. To date, Somalia continues to be heavily dependent on food aid, with a significant portion of its population relying on external assistance for survival and large portions under Al-Shabab control remain out of reach.

2010-2011 Severe Drought: Less than ten years from 1992-1993 disaster, another severe drought in 2010-2011 led to another famine, this time affecting close to 4 million people [10]. The United Nations declared a famine in several regions, prompting a global appeal for aid. However, again, access restrictions in areas controlled by militant groups complicated relief efforts, forcing many people to become internally displaced.

2016-2017 Drought: The 2016 - 2017 drought threatened the lives and livelihoods of millions. The United Nations and partners launched a comprehensive response plan, focusing on food security, nutrition, and health services. The World Bank approved a \$50 million emergency project to scale up drought response and recovery efforts, implemented through the Food and

Agriculture Organization (FAO) and the International Committee of the Red Cross (ICRC) [11].

2021-2023 Prolonged Drought and Flooding: From 2021 to 2023, Somalia endured a prolonged drought, leading to a humanitarian emergency and fueling conflicts over scarce resources. In 2023, devastating floods further disrupted lives and further exacerbated the already bad situation. This time, however, important lessons were learned from previous disasters, and early warning systems were activated, which enabled humanitarian organizations to prepare and respond, providing a more targeted aid to the affected communities. While drought is the major driver of food insecurity, flash floods can also be an equally serious cause of food insecurity for inter-riverine regions. For example, food security at the household level in three regions (Bay, Hiran and Galguduud) was severely impacted in both 2017 and 2022, but for diametrically opposite reasons; for Hiran (the focus of the current study) it was due to flooding, whereas in Bay and Galguduud (Galmudug) it was due to drought [12].

2.2. Impacts on Food Security and Livelihoods

Climate change, manifested through extreme weather events such as prolonged droughts, recurrent floods, and rising temperatures, significantly reduces agricultural productivity, and severely damages the agricultural sector [13]. In Somalia, where 60% of the population relies on herding and 15% on agriculture, millions of livestock have perished due to drought, directly impacting the nation's food security. Data from Somalia reveals that female-headed households experience greater food insecurity compared to male-headed households. Climate-driven displacement disproportionately affects women and actively exacerbates pre-existing gendered vulnerabilities

[14]. This study will be beneficial examine how climate change may threaten food security and increase the hardships faced by vulnerable populations of the society (e.g., women in Somalia, particularly those in rural and drought-prone areas.

3. Research Design and Methodology

The study was carried in Beletweyn district, Hirshabeele State, Somalia (Figure 2). The town is located in the Shabelle valley, some 330 km north of Mogadishu near the Ethiopian border. Beletweyn was used as a case for three main reasons: 1) The Shabelle River flows through the city, and the area is prone to flooding historically, 2) rapid urbanization caused many people to move from rural areas (displacement) to settle flood-prone areas of the city, and 3) Subsistence farmers, because of their meager resources and limited technological capacity, are the least able to cope with the changing climate. Beletweyn is considered as one of the priority regions (Figure 3) in relation to floods. Seasonal heavy rains, both within Somalia and upstream in neighboring Ethiopia, contribute to increased water volume in the river, leading to flooding. The increase in frequency and intensity of floods, however, is only partly due to the increase in heavy rainfall events. Other important factors include land degradation and

increased population density in flood-prone areas and.

The study draws on primary, qualitative data collected through a survey in Beletweyn, the capital city of Hirshabelle regional administration in Somalia, conducted between August and November 2024. Cross-sectional design covering 120 households was used in this study. Cross-sectional designs help determine the *prevalence* of a phenomenon, food security in this study. Repeating cross-sectional surveys over time can help track changes in food security indicators and identify emerging trends. This can be useful for evaluating the effectiveness of food security interventions and informing policy decisions. Compared to other designs, longitudinal, for example, which follow the same individuals over time, cross-sectional studies are generally quicker and less expensive to conduct. In our study, with limited resources and time constraints, cross-sectional study was the most practical option. A survey questionnaire was distributed to a representative household sample in all four sections of the capital city. The survey questionnaire consisted of sequential questions designed to dissect household opinion on food security and likely triggers, drought or floods. Officials of federal and regional governments with food security portfolios were interviewed to examine the policies in place to mitigate climate change and its impact on food security. Separate data collection was carried out in Baidoa, Bosaso, Garowe, Galkayo, and Kismao for comparative purposes.

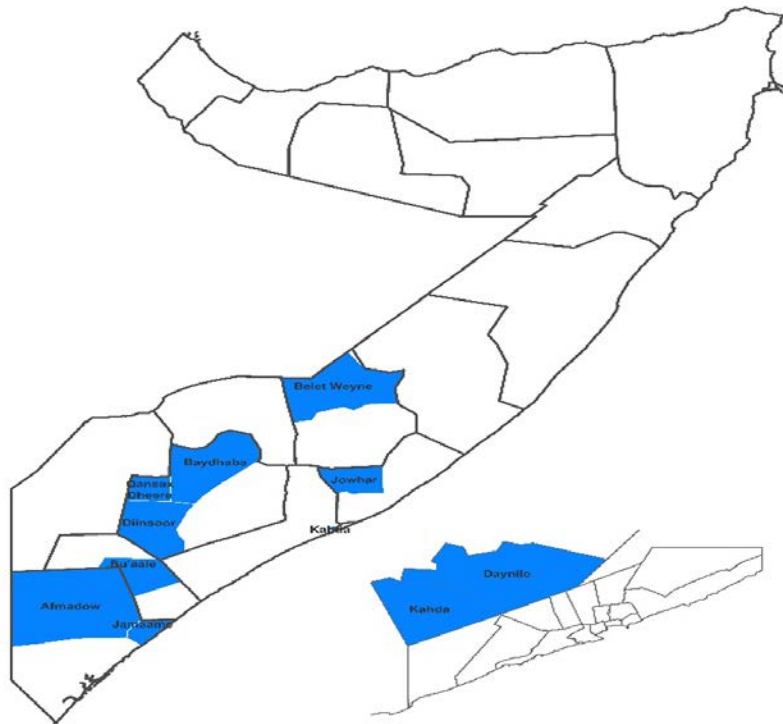


Figure 2. Projected priority regions in Somalia for humanitarian need in 2025 as a result of alternating flood-drought cycles. Adopted from OCHA 2024 (Somalia | OCHA)

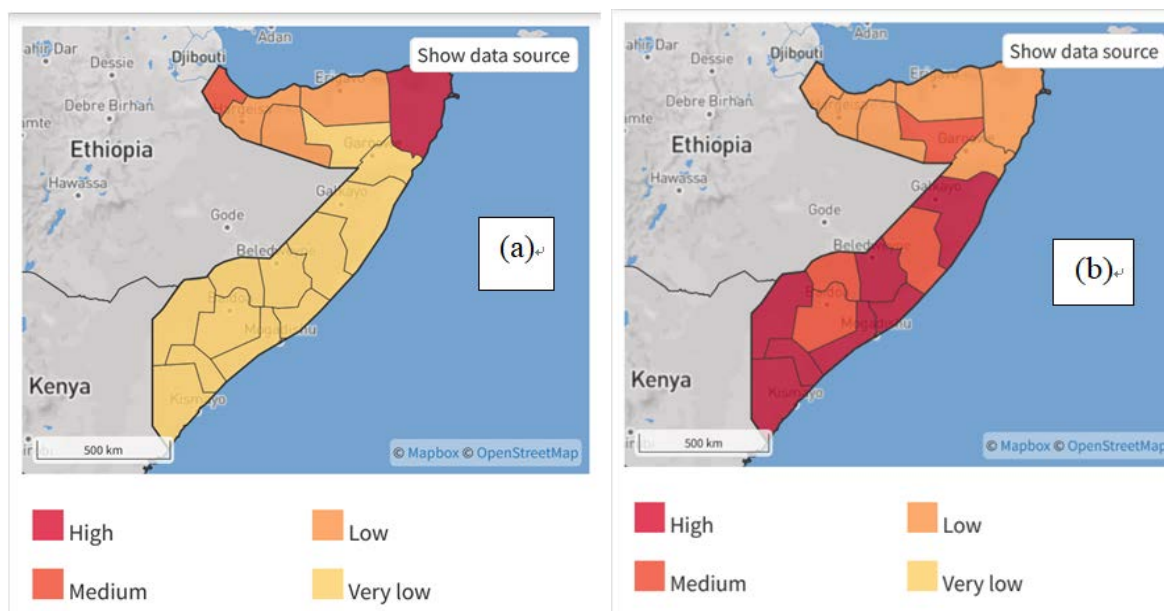


Figure 3. Map of areas with high flood risk: (a) show regions with high and medium risks of flash floods and landslides in Puntland and Awdal region neighboring Djibouti, (b) regions with high risk of river floods around the main rivers Juba and Shabelle

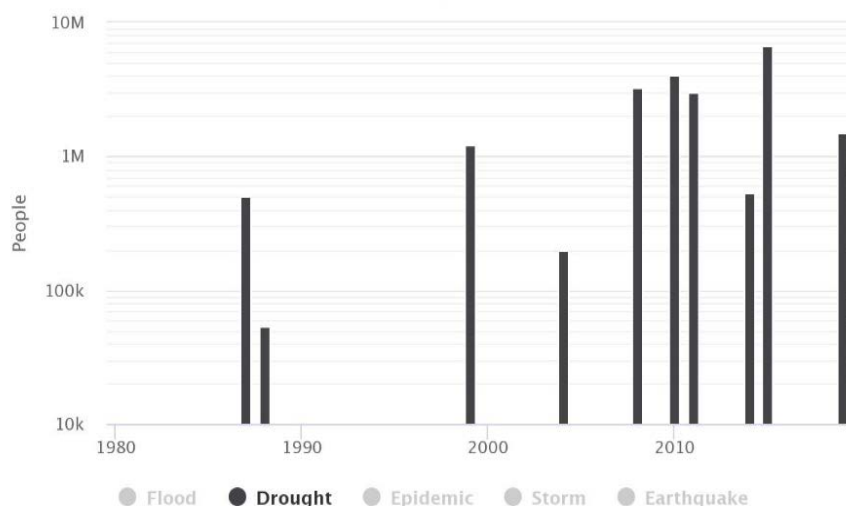


Figure 4. Frequency and intensity of droughts from 1980 to 2020, number of people affected (World Bank Climate Change Knowledge Portal)

4. Results and Discussion

Droughts and floods, both of which are serious natural disasters, have a common cause: shifting rainfall patterns. Somalia experiences two types of flooding: Riverine floods that occur along the Juba and Shabelle rivers in Southern Somalia, and flash floods that are common along the intermittent streams and dried-up riverbeds (known in Somali as Wadis) in many parts of the country, especially around the two rivers and in the northern mountainous regions (Figure 4). Whereas flash floods are characterized by high flow-peaks of short duration generated by heavy rainfall events (Figure 4a), river flooding along the Juba and Shabelle rivers are primarily due to drainage from catchment areas located in the Ethiopian highlands (Figure 4b), which normally experience heavier and more frequent rainfall than what occurs in Somalia (FAO: Somalia Water and Land Information Management). In 2024, riverine floods affected about 40,000 people in 30 villages in Beletweyn District alone, displacing over 14,000 people

and inundating thousands of hectares of farmland [9]. Similarly, Drought frequency has increased from 1-2 times/decade to 3-4 times /decade. Shorter intervals, giving people less time (opportunity) for recovery. The intensity and frequency of droughts have increased since 2010, with several droughts compounding the effect of the previous, as the intervals between have become shorter (Figure 4). Previously, droughts that might have occurred only once in 10 years now tend to happen more frequently, once every 3-4 years, with greater impacts. Looking forward, drought intensity (e.g., decrease in soil moisture content) is likely to increase due to increasing temperatures, increased evaporation, and decrease in rainfall during Gu' season. Other important factors that need to be considered include land degradation and population pressure on natural resources. One of the farmers included in the survey in Beletweyn remarked that the rains were once a blessing, but now we fear them; "we're caught between two disasters: if drought spares us, flood will not".

Regarding flood occurrences in the study area, nearly

three-quarters of the households surveyed in Beledweyne (87 out of 120) (73%) indicated that floods are a yearly occurrence during periods of heavy upstream rain. Farmers in the study area engage in mixed agriculture, primarily growing fruits and vegetables (71% of crops) with a smaller portion dedicated to cereals (28%). Livestock is an important factor in all agricultural activities. Respondents stated that these recurring river floods have caused significant crop damage, with approximately 54% of cultivated land in the area being washed away. Beyond the devastating impact on crops, the recurrent seasonal floods have also inflicted substantial losses on livestock, a vital component of the local economy and food security. Respondents reported alarming rates of mortality, indicating that approximately 39% of their sheep, 28% of their goats, and 26% of their cattle were lost due to the floods. This significant reduction in livestock numbers not only represents a direct economic blow to households reliant on animal husbandry but also exacerbates food insecurity by diminishing access to meat, milk, and other animal products. The sudden loss of such a large portion of their herds leaves families vulnerable and struggling to recover, further compounding the challenges posed by the recurrent flooding.

Households in five other cities were included in the study for comparison purposes (Figure 5). It showed that the population in those regions, which typically represent Somalia as a whole, face tough food security challenges because of changing weather patterns. For example, when asked did you or any household member go to sleep at night hungry during the past 3 months because there was not enough food, 73 households (61%) in Beletweyn said yes, followed by Kismao (46 households, about 40%). When asked to estimate how frequently they faced food insecurity for the past 3 months, 77% of the people surveyed stated that either frequently (> 3 days a week) or mostly (> 15 days a month) combined. According to IPC food security classification, this could mean phase 3 or higher, where households are only marginally able to meet minimum food needs or are employing emergency livelihood strategies. To determine if households could identify the cause of food insecurity situation, we asked about the main causes of household food shortages; 56% and 61% in Belet-weyn stated it was because of drought (Figure 5a) and floods (Figure 5b), respectively. The intensity of food insecurity caused by drought was greatest in Kismao (Figure 5a), whereas flood-caused food insecurity was greatest for Beletweyn (Figure 5b). The most important takeaway message from this analysis is that food insecurity episodes becoming common occurrence and that shifting weather patterns are to blame. Flood relief and rehabilitation measures are minimal or non-existent. The volatile security situation severely restricts the ability of the international community to provide emergency assistance.

Projections of future river flood events are subject to substantial uncertainty, but more flash flood events are likely to result from increases in heavy precipitation events in mountainous northern regions of the upstream Ethiopia. Specifically, the frequent floods in Beletweyn create a vicious cycle of food insecurity. Each flood (or drought) event sets back recovery efforts, destroys livelihoods, and worsens the existing food security crisis.

The cumulative effect of these recurring disasters makes the population increasingly vulnerable and less resilient to future shocks.

Globally, a significant number of people, roughly 250 million, suffered from acute food insecurity globally in 2022, largely driven by situations of conflict and insecurity [15]. Although climate change acting as a trigger of violent conflicts is still a hotly debated subject, and not yet completely understood, a recent study showed that countries that are vulnerable to climate change are more likely to experience civil unrest and risks of political volatility [16]. Food security/armed conflict nexus, and the resultant humanitarian challenges, have developed over the past decade but remain contested [17].

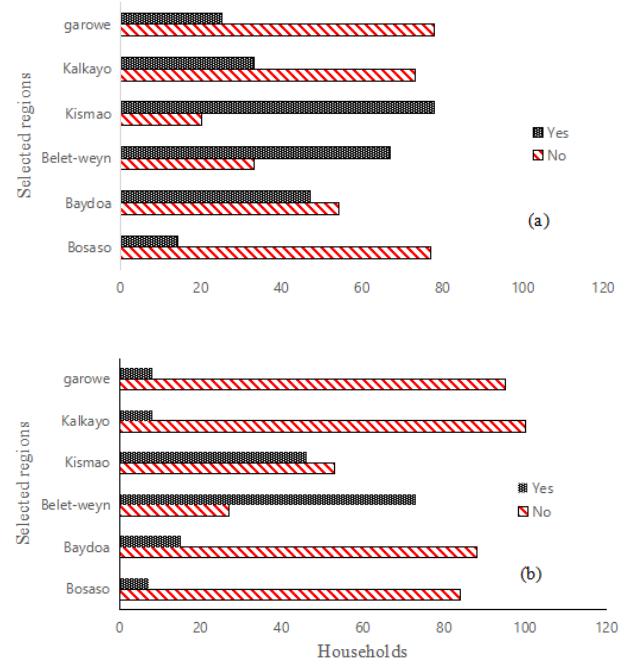


Figure 5. Household food shortages (insecurity) caused by (a) drought and (b) flood events during the past year

Recurrent shocks (successive failed rainy seasons paired with sudden flash floods) destroy the livestock and arable land, which are the base assets of Somali rural communities. Consequently, human mobility becomes a desperate survival strategy, causing a massive, irreversible shift from rural, nomadic agro-pastoralism to permanent urban settlement. Over time, displaced communities permanently settle in sprawling Internal Displacement Person (IDP) camps on the outskirts of cities. The influx of displaced populations puts pressure on receiving urban centers like Mogadishu, Baidoa, etc. Somali society heavily relies on traditional clan territories for resource allocation and security. Mass migration disrupts established local clan balances, potentially triggering political or inter-communal friction over scarce resources.

Moving forward, Somalia's enduring food crisis is a direct consequence of a complex interplay between frequent natural disasters (alternating flood/drought) and persistent insecurity, resulting in severely restricted humanitarian access in large parts of the southern regions of Somalia. The combination of insecurity and restricted humanitarian access creates a devastating synergy. This research expands upon the understanding of the intricate

relationship between food security, conflict, and the resulting strain on economic and social development. It emphasizes that food security is integral to achieving broader development goals, particularly in agriculturally reliant economies like Somalia. The findings highlight how addressing food security can stimulate economic growth and promote stability, while its absence breeds social unrest and conflict. Furthermore, this study challenges the traditional view of food insecurity as solely a result of natural disasters, particularly within conflict-affected regions like Somalia. We emphasize that when natural disasters strike, an insecure environment makes it difficult for aid to reach those in need. These insights offer valuable guidance for policymakers, peacebuilders, and humanitarian organizations.

Summary and Conclusion

Somalia, a nation ravaged by decades of conflict and environmental vulnerabilities, faces a persistent challenge of food insecurity. The complex interplay between decades of armed conflict and the intensifying impacts of climate change, characterized by devastating floods and prolonged droughts, has solidified a deeply entrenched food insecurity crisis in Somalia. These crises are not isolated events but rather interconnected forces that systematically erode the foundations of sustainable livelihoods. Conflict disrupts agricultural activities and trade, while climate shocks destroy vital resources, creating a compounding effect that hinders economic growth and perpetuates a cycle of vulnerability and dependence on external assistance. Despite extensive aid, Al-Shabaab's access restrictions and ongoing security challenges severely limit humanitarian effectiveness. Investing in flood defenses and integrating climate adaptation into security planning is more sustainable and cost-effective than solely relying on emergency aid. Two practical recommendations from this study are: 1) transitioning toward drought-tolerant, early maturing crop varieties (like sorghum, cowpeas, and mung beans), and 2) shifting livestock composition from climate-vulnerable cattle to drought-resilient camels and goats, which can survive extended dry spells and can better survive in degraded rangelands.

Statement of Competing Interests

The authors have no competing interests.

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