Sustainable Solutions to Reduce the Impact of Drought in Somalia

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ABSTRACT

Drought is a natural climatic phenomenon that occurs when rainfall is less than average for an extended period of time. It can occur at any time and in any location. Droughts are extremely difficult to predict at the start and end. It happens quietly, and the consequences can last for years after the event is over. Drought is a natural occurrence with economic, environmental, and social implications. Drought is characterized by a prolonged lack of precipitation that results in significant water scarcity in a region. Drought usually begins in agriculture and then spreads to other water-dependent industries. Due to its geographical location, fragile environment, volatile climate, political instability in the country, and the potential effects of global warming, Somalia is vulnerable to drought. Reducing the negative effects of drought is possible if precautions are taken prior to the drought and proper planning is made during the drought period. As a result, the measures to be taken before the drought and the steps that can be taken during the drought should be planned separately. Although we cannot increase water supply by ensuring the continuity of precipitation, we can mitigate the negative effects of drought.

Key-terms: Sustainable solutions and drought

INTRODUCTION

Drought is defined as "the natural event that causes adverse effects on land and water resources and deterioration of the hydrological balance as a result of recorded precipitation falling significantly below normal levels." (Kapluhan, 2013). Drought usually develops slowly and is the least estimated of all atmospheric hazards, but its effects are very wide. Drought occurs due to a decrease in the amount of precipitation in any season. Temperatures have risen and precipitation has decreased in many parts of the world as a result of global warming (Yu et al., 2019). As a result, climate change may cause more frequent and severe droughts in many countries (Al-Quraishi et al., 2020). Drought can cause serious economic, social, and environmental effects in a country (Çakmak & Gökalp, 2013).

Since Somalia has a semi-arid and arid climate and most of the population depends on the rainy seasons for their livelihood, climatically, the most significant factor in the country is precipitation (Metz, 1992). Moderate rainfall in the southwest and northwest is enough for rain-fed agriculture.

However, many other parts of the country have low rainfall, which is appropriate for pastoralism only (Alwesabi, 2012). Therefore, drought occurs when rainfall is not received during a normal rainy season or more than one rainy season and results in critical water scarcity for human, animal, and plant life leading to population displacements, unemployment, and migration to urban centres and to neighbouring countries and beyond (UNCCD, 2020). This review aims to provide a comprehensive understanding of drought recurring in Somalia and describes the extent of the drought, its causes and how it can be mitigated.

Background

Half of Somalia's population is highly dependent on pastoralism, which is profoundly influenced by the amount and timing of precipitation. Consequently, precipitation emerges as the most critical climatic factor affecting the

country (Metz, 1992). The arid and semi-arid climate, combined with low annual precipitation, creates conditions where the failure of the main rainy season in any given year can precipitate drought. This leads to the depletion of soil moisture, significantly reduces pasture and vegetation growth, and diminishes crop yields.

Severe drought conditions occur when rainfall decreases for two or more consecutive years in specific areas (UNCCD, 2020). The vulnerability of Somali society to drought is not static; it fluctuates based on various factors, including population growth, changes in land use, technology, and government policies. Communities that primarily rely on pastoralism are particularly susceptible to natural hazards, such as drought, especially during periods of political instability (Alwesabi, 2012). Somalia's vulnerability to drought is exacerbated by a reduced tolerance of land to dry periods, which is often a result of mismanagement, inappropriate land use practices, overgrazing, and logging. Consequently, even a slight negative deviation from the long-term annual mean rainfall can trigger drought.

According to Kundell (2008), Somalia is recurrently vulnerable to drought, with moderate drought events occurring every three to four years and severe drought events every seven to nine years. The impacts of these droughts have been catastrophic for Somali communities, often leading to severe conditions that have been labeled with unforgettable names such as "Xaarama-cune," "Harga-cuna," and "Dabadheer" (UNCCD, 2020). Notably, recent severe droughts occurred in 1964, 1969, 1974, 1987, 1988, 2000, 2001, 2004, 2008, 2011, 2016/2017, and the latest in 2021/2022. These events have resulted in widespread famine, malnutrition, displacement, and death among millions of people.

LITERATURE REVIEW

In Somalia, the deforestation rate is increasing at an alarming rate. According to a report in Puntland by the FAO/Somali Water and Land Management Information System (SWALIM), it is estimated that the annual rate of Bussei Acacia in Puntland has decreased by about 5%, and this rate appears to be applicable throughout Somalia (Oduori et al., 2009).

According to a WSP report, coal production in north-eastern Somalia in 1996 was estimated at 4.8 million sacks [each weighing 25-30 kg] (WSP, 2001). About 2.1 million acacia bussei trees had to be cut down to achieve such a volume. With an average density of 60 trees per hectare, this corresponds to a deforestation rate of 35,000 hectares per year. The production of 10 million sacks of coal [export only] in Southern Somalia in 2011 amounts to the felling of 4,375 million trees or the clearing of 72,916 hectares of land (UNCCD, 2020; Somalia Report, 2011).

Global Warming and Climate Change As the name implies, the planet is warming at an alarming level, potentially leading to severe drought. Global warming is frequently associated with human activities, including the use of fossil fuels, which emit greenhouse gas emissions that trap heat, causing global temperatures to rise. As the temperature rises, water from rivers, streams, lakes, and other bodies of water will evaporate, causing less of it to return as rain. As a result, there will be less precipitation and, of course, drought. Increasing temperatures cause wet areas to become wetter and dry areas to become drier. Warm air absorbs more water in humid regions, resulting in heavy rain events, whereas in arid regions, high temperatures cause water to evaporate quickly and cannot return as rain. Large-scale atmospheric circulation patterns are also changing as a result of climate change, causing storm tracks to deviate from their typical paths. Most of Somalia is a semi-arid region known for its hot climate and high temperatures. The average temperature in Somalia is estimated to be 27 °C per day. It is predicted that global climate change will have a major impact on the country.

Lack of Rainwater Harvesting In most parts of Somalia, people complain of a lack of rain and recurrent droughts, while when it does get wet, people also complain about the damage to rainwater when floods occur, when roads are cut off and other problems arise. For Somalis, rainwater harvesting skills are not popular. Every rainy season we neglect a lot of water, and in times of drought, our people are thirsty. With the rainy season getting shorter, we were unable to contain the floodwaters in our valleys that destroyed public property. If the water sources and reservoirs had been protected and their water had been utilised properly, there would have been no drought or at least a recurrence.

There is little rainfall in Somalia due to environmental factors, such as hot weather, which results in heavy evaporation (Madoobe, 2011). The average annual rainfall in Somalia is estimated at 282 mm, and the rainfall variability in the country is very large and very wide. The southern regions and small parts of the northwest receive moderate rainfall. The central and northern coastal regions receive very little rainfall.

The effects of the drought in Somalia were disastrous due to the presence of three factors: nature of livelihood (pastoralism), population density, and conflict in the country. The number of people affected by drought is not reliable and varies according to different sources. The reason for this is that there has been a civil war in Somalia for nearly three decades and during the civil war, government agencies lost their data records on drought, resulting in non-institutional functioning.

Effects of Drought on Livelihoods and Food Security Generally, the impacts of climate-related disasters on livelihoods and food security in Somalia are experienced through droughts and floods.

Droughts and floods are certainly the two most stressful elements of the climate crisis and have been emphasised as major drivers of food insecurity, hunger, malnutrition, famine, and population displacement. When drought strikes, food insecurity increases due to primarily loss or reduction in crop production, the death of livestock or declining milk and meat production, as well as greater and widespread shortages of drinking water. Droughts, which have reduced agricultural production to extremely low levels, have severely increased food prices, such as grains, beans, vegetables, fruits, meat, and milk, causing severe food insecurity, malnutrition, and even hunger and famine.

In general, for the last 12 years, the highest acute food and livelihood crises and humanitarian emergencies were often recorded in Galgaduud, Mudug, Hiiraan, Bay and Bakool. Sool, Sanaag and the coastal communities in Somaliland are known to be among the most vulnerable to droughts (UNCCD, 2020). In Somalia, food insecurity is a major issue. There has been a devastating drought in Somali regions linked to low rainfall in 2011, 2015/2016, and 2017, which severely affected rural communities and destroyed their own crops, livestock production, and livelihood opportunities in general (Abdi-Soojeede, 2018).

In 2017, more than 2.9 million people faced a food insecurity crisis and emergency because of the 2016 drought (UNCCD, 2020). Women and children are disproportionately affected by the effects of drought as they are more vulnerable to drought. During periods of severe drought, deaths and malnutrition occur in children and women. The importance of taking these two social groups into serious consideration and inclusion in any drought management strategy and drought plan cannot be overemphasised. Food security and livelihoods are not expected to improve significantly in the short term, as climate change models anticipate an increase in the frequency of severe weather events such as droughts, floods, and heat waves. During the 2011 drought, there were more than 1.1 million people who left their homes and did not return. A further 1.6 million people left their homes due to drought in 2016 and 2017 (Fanning, 2018).

Drought remains the most important risk, leading to critical food insecurity, mass starvation, and internal displacement of local populations. Effects of Droughts on Agriculture Drought's effects are typically felt first in agriculture and then expanded to other water-dependent sectors. Drought has a different meaning in agriculture than it does in other sectors. Because during the growth periods of the plant, the water in the root zone is more important to the plants than the total precipitation throughout the year. For this reason, the lack of water in the soil that plants need during their germination and development period is called agricultural drought (Kapluhan, 2013).

The first economic sector affected by drought in agriculture. The greatest impact of the drought in the agricultural sector has been on crop production losses due to both reduced area of cultivated land and very low yields at harvest. Rain-fed agriculture and rangelands respond early to soil moisture depletion, particularly through crop failure and significant plant biomass decline, which then results in loss of livestock and crop yields with deterioration of food security. Droughts, which have reduced agricultural production to extremely low levels, have severely increased food prices, such as grains, beans, vegetables, and fruits causing severe food insecurity, malnutrition and even hunger and famine (UNCCD, 2020). As the drought worsens, river and stream flow, as well as underground water, are reduced, resulting in a loss of productivity on irrigated farms.

Farmers in the river region of southern Somalia who practice crop production under irrigation systems were less vulnerable to droughts than those relying on rainfall for livestock and crop production. In Somalia's semi-arid regions, which experience highly variable and low precipitation, even a short dry period during the cropping season can lead to significant yield reductions or total crop failures. Such agricultural droughts disproportionately affect rain-fed farmers. During a recent drought, Somalia incurred over $1.6 billion in agricultural losses and damages, accounting for nearly half of the total drought-related damages (UNDP, 2018). Severe or prolonged droughts resulted in significantly reduced river flow and lower harvestable crop yields in the Juba and Shebelle regions.

Drought had the most severe impact on rain-fed food crops such as sorghum, cowpea, and sesame in Bay and Bakool, which had experienced multiple seasons without precipitation since early 2016. Losses in sorghum in these regions reached as high as 73%, while losses for corn and sesame were reported at 52% and 84%, respectively. In the Shebelle Valley, losses under both rain-fed and irrigated conditions were significant, with reductions of up to 60% for sorghum, 36% for corn, and 80% for sesame. Overall, Somalia's total production volume loss was estimated at 50% for sorghum, 34% for corn, 83% for sesame, and 59% for cowpea (World Bank, 2018).

Drought reduces crop production by decreasing the amount of cultivated land, leading to harvest failures. In 2017, droughts cost Somalia $71 million for the four main crops planted, including $35 million for maize and sorghum, $9 million for cowpea, and $28 million for sesame (World Bank & FAO, 2018). Rising temperatures contribute to this problem by causing drier conditions and increasing evaporation, which reduces soil moisture and water availability for irrigation, ultimately leading to plummeting crop yields. As a result, Somalia has faced frequent droughts in recent years, disrupting its agricultural sector.

The timing and duration of drought events significantly influence their impact on agriculture. Economic losses are most pronounced during the sowing months or during critical growth phases like flowering and fruit formation. Food security in Somalia is closely tied to the success of agricultural production, as the sector is the main source of livelihood and employment for the majority of the population (UNCCD, 2020).

In terms of livestock, pastoralism remains the primary source of income for most Somalis. Species such as camels, sheep, goats, and cattle are raised by both nomadic and sedentary pastoralists (Encyclopaedia Britannica, 2011). The livestock sector is among the most vulnerable to drought due to its complete dependence on rainy seasons. Severe droughts in recent years, including those in 2011, 2016, and 2017, have resulted in significant livestock losses. Estimates indicate that Somalia lost over $6.4 million of its total livestock population, valued at more than $350 million, during these droughts, alongside productivity losses of approximately $1.2 billion in terms of milk yield and body weight. Livestock losses for poorer families can be extremely high, averaging 40-60% in northern regions and 20-40% in central and southern areas (UNDP, 2018).

Throughout the 2016-2017 drought periods, economic losses included 52% in sheep and goats, 42% in camels, and 6% in cattle (World Bank, 2018). The failure of rains to replenish animal feed and water supplies heightened the vulnerability of pastoralists during these dry seasons. Reports indicated significant livestock losses from regions such as Bay, Bakool, Gedo, Middle Juba, and Lower Juba. The animals that survived often experienced deteriorating body conditions, thereby increasing their susceptibility to diseases, reducing productivity, and ultimately leading to less milk and meat production. Consequently, pastoralists struggled to support their families (FAO, 2017).

Land degradation in Somalia has increased alarmingly over the past two decades, primarily driven by unsustainable land-use practices such as overgrazing, charcoal production, and deforestation. The northern regions, in particular, have seen considerable vegetation damage, with the destruction of most forest land, including significant loss of mangrove forests in the south (UNCCD, 2020). Drought exacerbates land degradation by making land more vulnerable to erosion through the loss of vegetation cover and soil moisture reserves. Urbanization and agricultural expansion into rangelands also contribute to accelerating land degradation.

Frequent droughts in Somalia have diminished the land's capacity to sustain plant and animal life, resulting in increased soil erosion, reduced soil moisture retention, and decreased soil fertility levels. During drought years,

water shortages become critical, particularly affecting pastoral communities. Access to domestic water remains challenging for rural populations even during normal years, and during droughts, women and children must often travel long distances to obtain water. Increased evaporation rates, along with droughts and precipitation variability, are likely to exacerbate water shortages. Additionally, water sources may become more polluted due to increased sedimentation. Livestock deaths during droughts are often attributed to both pasture scarcity and insufficient drinking water (UNCCD, 2020).

Moreover, drought reduces plant biodiversity by halting regrowth, limiting dispersal and survival, and altering plant species composition in favor of more resilient but less palatable varieties. Prolonged drought conditions can lead to the extinction of vulnerable species, particularly those that are less tolerant to dry periods. Together with overgrazing, drought contributes to the extinction of many grasses and forbs, leading to pronounced reductions in land carrying capacity and further exacerbating land degradation (Abdullahi, 2018).

The decline in biodiversity affects the soil seed bank, restricting plant regeneration and density and limiting species diversity. The combination of rising temperatures and frequent droughts is expected to further aggravate land degradation unless significant interventions are implemented, which remains difficult due to Somalia's limited financial and technological resources. Without appropriate actions, declines in biodiversity will likely continue, compounded by the adverse effects of invasive species on both biodiversity and forest productivity. Frequent droughts may increase the risk of extinction for vulnerable plant and animal species, particularly those already endangered. Protecting Somalia's endemic and rare species will necessitate concerted efforts from various stakeholders, including international biodiversity conservation organizations, the government, NGOs, universities, and local communities (UNCCD, 2020).

Theoretical review

Vulnerability Theory, as articulated by the United Nations Convention to Combat Desertification (UNCCD, 2020), serves as a foundational framework for understanding the multifaceted impacts of drought on Somali communities. This theory posits that vulnerability to environmental hazards, such as drought, is not merely a consequence of natural conditions; instead, it is deeply influenced by social, economic, and political factors. In the context of Somalia, where a significant portion of the population relies on pastoralism and rain-fed agriculture, the theory underscores how systemic issues—such as political instability, conflict, and poverty—exacerbate the susceptibility of communities to the adverse effects of climate change. The study illustrates how these factors contribute to heightened vulnerability, thereby providing a comprehensive understanding of the challenges faced by the Somali population during drought events.

The relevance of Vulnerability Theory to this study can be observed through its emphasis on the interaction between environmental conditions and socio-economic dynamics. In Somalia, the failure of the main rainy season can lead to immediate crises, such as food and water shortages, which are further compounded by longer-term factors like population growth and land mismanagement. This theoretical perspective is crucial for explaining the recurrence of severe drought events in the country. By using this framework, the study highlights the cyclical nature of vulnerability, where each drought not only impacts immediate food security and livelihoods but also creates a layering of vulnerabilities that can persist across generations. The insights drawn from Vulnerability Theory provide a roadmap for identifying the root causes of susceptibility and inform the development of more effective interventions.

Finally, this theory facilitates a deeper understanding of the long-term effects of drought in Somalia, which are often overlooked in analyses that focus solely on climatic data. By framing the discussion of drought within the context of vulnerability, the study brings attention to the need for holistic approaches that consider not just the environmental factors but also the socio-political landscape that shapes community resilience. As Somalia faces increasing climate variability, applying Vulnerability Theory becomes essential for policymakers and practitioners aiming to mitigate the impacts of drought, enhance adaptive capacity, and promote sustainable development strategies that prioritize the most vulnerable populations. This comprehensive approach is critical to fostering resilience and ensuring that communities are equipped to withstand the challenges posed by future droughts.

METHODOLOGY

The study employs a qualitative analysis to assess the socio-economic impacts of drought on different populations, focusing on pastoralists and agropastoral communities. This approach highlights the human experience of drought, allowing for an in-depth exploration of adaptive strategies and community resilience.

Secondary data from government and non-governmental organizations, including historical rainfall records, drought impact assessments, and reports on food insecurity, are used to support the research findings. Data is collected from various sources to ensure a comprehensive understanding of the drought crisis in Somalia.

Case Studies: Specific instances of drought events are examined as case studies, detailing their effects on local populations, agriculture, and drinking water supplies. By focusing on historical events, the study aims to identify patterns and recurring challenges faced by communities.

Findings

Although we cannot increase rainfall, we can minimize the negative effects of drought. Allah has given us the ability to find solutions and manage what we have. The potential solutions to the drought in Somalia can be summarized as follows:

Rainwater harvesting

Rainwater harvesting is a straightforward process for collecting, conveying, storing, and treating rainwater for later use (Kumari & Singh, 2016). As an engineer, I classify rainwater harvesting systems into two types: rooftop harvesting and ground surface harvesting.

Rooftop Rainwater Harvesting is a method of collecting rainwater from roofs and storing it in reservoirs. The primary goal is to hold the water for future use. This method is particularly crucial in dry land, urban, hilly, and coastal areas. Rooftop rainwater harvesting helps reduce runoff, which can clog drains, minimize soil erosion, and prevent road flooding.

Ground Surface Rainwater Harvesting involves collecting rainwater from land surfaces, which allows for gathering water from a larger area compared to rooftop systems. Techniques in ground surface rainwater harvesting can capture flows from small streams and store them in reservoirs, either surface or underground, created through low-cost dams. This method is ideally suited for agricultural water needs.

Planting more trees and combating deforestation

Planting trees is one of the most effective strategies for mitigating drought damage, improving environmental quality, and enhancing precipitation success. Many countries, such as Israel, have initiated tree planting and reforestation projects in barren lands (Brand et al., 2011). Protecting trees until maturity can reverse drought and arid conditions in affected areas. It is essential to limit the cutting down of existing trees unless replacement planting occurs.

Switching to renewable energies

Historically, we have relied on non-renewable energy sources like fossil fuels, which release greenhouse gases that contribute to global warming and, consequently, drought (Environmental and Energy Study Institute, 2022). Transitioning to renewable energy sources such as wind and solar offers a sustainable alternative that does not negatively impact the environment or exacerbate drought conditions.

Water conservation

A significant amount of water is required globally for agricultural use, yet it is often used inefficiently. Drip irrigation systems, which slowly deliver water directly to the plant base, represent a widely-used method for conserving agricultural water. This approach minimizes water loss through evaporation and reduces overall water

requirements (Kumari & Singh, 2016). Numerous companies are now providing cost-effective and intuitive drip irrigation systems.

Soil conservation

Soil conservation encompasses practices designed to prevent soil deterioration. It treats soil as a living ecosystem, ensuring that organic matter is continually recycled back into the soil. Such practices improve soil structure, enhance water retention, promote infiltration, and protect against erosion and compaction. Techniques include crop rotation, mulching, no-till farming, reduced tillage, cover cropping, and contour farming (Kumari & Singh, 2016).

Monitoring of soil erosion

Soil erosion stems from factors like tree cutting, rural migration, and rainwater flooding. Protecting land from erosion and overgrazing is vital, as is helping local communities maintain sustainable grazing practices (Madoobe, 2011). To prevent land degradation, several steps should be prioritized:

- **Environmental Policy**: Greater political consideration should be given to the environmental issues crucial for livelihoods.
- **Expert Studies**: Engage experts in land degradation to conduct studies on mitigation measures.
- **Public Awareness**: Increase community awareness of environmental protection and enact robust laws to safeguard the environment, with penalties for violations.
- **Plantations for Protection**: Establish forestry plantations with drought-tolerant and fast-growing plants to protect against soil erosion.
- **Grazing Knowledge**: Ensure that individuals knowledgeable about grazing management are engaged in local communities.
- **Land Separation**: Clearly separate agricultural and pastoral lands from grazing areas and water sources to optimize usage.

Drought monitoring and early warning system

Drought monitoring and early warning systems are essential for managing crop losses, preventing famines, and reducing associated risks. Currently, Somalia lacks a national drought monitor (Said et al., 2019). As drought impacts increase, so does the need for effective monitoring and prediction. Scientists have developed various indices to identify and monitor the onset, duration, and severity of droughts, which assist decision-makers in mitigating the effects (Mishra & Singh, 2010).

Meteorological Drought Indices can provide regional decision-makers with insights into drought risks, helping them take preventive measures (Said et al., 2019). Index examples include the Palmer Drought Severity Index (PDSI), Standardized Precipitation Index (SPI), and Effective Drought Index (EDI). However, there currently is no standard drought index employed by the Government of Somalia. An automatic weather station under the Ministry of Agriculture generates weather-related data, but effective usage for forecasting remains limited (UNCCD, 2020).

The FAO has developed a combined drought index for Somalia, primarily used by its Somalia office, with findings shared with the government. Current FAO-SWALIM combined indices include the Precipitation Drought Index (PDI), Temperature Drought Index (TDI), and Vegetation Drought Index (VDI), which define droughts based on various environmental factors (UNCCD, 2020).

Remote sensing

Recent advances in remote sensing have made it a crucial tool for regional and global drought monitoring. Satellite data provides a comprehensive view of environmental changes that are invisible at the Earth's surface. Remote sensing is especially important when meteorological data is incomplete or unreliable, such as in Somalia, where basic information is often lacking. The MODIS Normalized Difference Vegetation Index (NDVI) is widely used to study vegetation changes, detecting greenery with high frequency and accuracy (UNDP, 2018).

Drought risk identification and early warning indicators

Effective monitoring and early warning systems are crucial in managing and mitigating drought crises at various stages. Somalia's early warning system should incorporate four key components: (i) Knowledge of risks, (ii) Technical monitoring and warning services, (iii) Clear dissemination of warnings, and (iv) Public awareness and preparedness.

Despite improvements in climate monitoring and forecasting, the country's early warning system remains inadequate. Early warning information from regional and international climate forecasting organizations has assisted in drought management, although establishing a robust early warning system faces various challenges, including funding, research, expertise, and infrastructure (UNCCD, 2020).

Somalia also benefits from indigenous knowledge in predicting droughts, with communities monitoring changes in animal and plant behavior to anticipate environmental changes. Observations regarding wind patterns and shifts in soil conditions serve as critical indicators for predicting droughts and rainfall patterns (UNCCD, 2020).

CONCLUSION

In Somalia, the vulnerable pastoral and agropastoral communities form the majority of the population. Therefore, even one dry year is a disaster, and when drought extends to a second year, the impact can be a devastating loss of life and famine. This fact emphasizes the importance of developing more objective measures that accurately reflect the severity of the drought. It is extremely difficult to take appropriate measures to mitigate the effects of drought or to move toward drought monitoring and early warning to manage crop losses and prevent famines without objective indicators.

Therefore, the most appropriate meteorological drought index is to be used. The availability of long time series data for some indicators, especially precipitation, temperature, soil moisture, and vegetation, is vital for determining an index and applying various statistical techniques. To prevent drought in Somalia, the following steps should be observed:

- To obtain experts in drought to prepare studies on how to deal with it.
- To conduct research on water resources across the country to prepare for any potential drought risks and develop water catchment projects.
- To find alternatives to coal fuel, such as the sun, wind, and so on.
- To the retrieval and transfer of data records from non-governmental organizations to the government, as government institutions lost data records during the civil war.

RECOMMENDATIONS

A combination of sustainable, institutional and community-based approach would significantly contribute to alleviating the effects of drought in Somalia. The following recommendations are thus proposed:

1. **Enhance water resource management:** Water resource management must be strengthened and improved at the government and stakeholder level. Investments need to be channeled towards a sustainable water resource management approach by promoting sustainable water storage systems like building and rehabilitating of reservoirs, berkads and dams and rain water harvesting systems at the household and community levels, controlling groundwater usage to avert overexploitation, and expansion of solar boreholes in the rural areas.
2. **Promoting climate smart agriculture:** Farmers should be sensitized and empowered to utilize climate smart practices. Drought-resilient crops such as sorghum and millet should be introduced and farmers trained in their production. There is also the need to scale up the use of irrigation technology such as the use of drip irrigation for optimum water use, and a strong link between extension services and farmers should be established.
3. **Establish efficient warning systems**: To accurately forecast drought conditions, there must be a strong and adequate investment in the meteorological infrastructure. Dissemination of information should be

through mobile platforms and local media channels to enable a community-level response at a suitable time.

4. **Investments in infrastructure development:** Infrastructure such as storage structures, irrigation systems, and rural feeder roads needs to be developed to enhance coping capacity. This infrastructure will greatly improve the access of water, food and relief aid to vulnerable communities.
5. **Strengthen governance and policy framework:** A comprehensive policy framework for drought management should be formulated and effectively enforced by the government. Coordination mechanisms among government agencies, non-government agencies and other partners must be reinforced for a cohesive response to the problem.
6. **Enhance awareness and build the capacity of communities:** Public awareness campaigns should focus on the conservation of water, and on sustainable land management practices. Environmental protection and reforestation programs must be promoted and supported to fight land degradation and desertification.
7. **Improve emergency preparedness and response systems :** The pre-positioning of relief supplies such as food and water is essential in the drought prone areas. Safety nets must be enhanced and expanded to support vulnerable populations, while additional support to livestock in the form of feed and veterinary services must be prioritized.

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