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Original Article

Drought Effects in Somalia and Solution Proposals

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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 characterised 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.

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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.

DROUGHT

Drought is a complex disaster that may have significant effects on human activities and the environment (Tigkas et al., 2013). It is very difficult to determine its cause and range of development (Aadhar & Mishra, 2017). It does not have a universal definition, develops over time, and its effects are not obvious (Wilhite, 1992). Drought is defined by the World Meteorological Organization WMO (1986) as "a sustained, prolonged lack of precipitation," while the Food and Agriculture Organization FAO (1983) defines it as "the percentage of years in which a crop has deteriorated due to a lack of moisture." Somali elder living in the areas hit by the recent drought was described as 'Drought occurs when there is no rain, the land dries up, pastures are destroyed, and livestock die' (SADO, 2021).

The difference between droughts from other natural disasters is that it is difficult to determine its beginning and end. While the impacts of natural hazards like floods and earthquakes can be felt and measured quickly, Drought is a natural disaster that starts slowly, progresses over months or even years, affects large areas, and can last for years after it ends. Generally, drought is related to high wind, high temperature, and low relative humidity (Alwesabi, 2012). Drought has a variety of effects on society due to the dependence of humans and their activities on water resources and often leads to serious impacts that spread over a larger area than the actually damaged region (Wilhite, 1992). Drought is now one of the world's most serious problems, affecting every stage of our lives,

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including the physical and natural environment, urban life, development and economy, technology, agriculture, food security, clean water, and health care (akmak & Gökalp, 2013).

Generally, there are four types of droughts used in the literature. Meteorological drought is a drought that occurs when there is no rain or the average precipitation lower than normal values over a long period of time. Agricultural drought refers to the scarcity of water in the root zone of crops resulting in a significant reduction in the yield of a crop. Hydrological drought is a drought that occurs when the lack of rain continues for a long time, which ultimately leads to a significant decrease in the amount of water in rivers, wells, ponds, and lakes (Kapluhan, 2013). Socioeconomic drought occurs when a lack of rain or water causes the demand for economic goods to exceed the supply (Wilhite & Glantz, 1985).

DROUGHT IN SOMALIA

Half of Somalia's population is highly dependent on pastoralism, which is influenced by precipitation amount and timing. Therefore, precipitation is the most important climatic factor in the country (Metz, 1992). Due to the country's arid, semi-arid climate and low annual precipitation, failure of the main rainy season in a given year can result in drought as soil moisture is depleted, pasture and vegetation growth are drastically reduced, and crop yield is significantly diminished. Severe drought occurs when rainfall decreases for two or more consecutive years in a certain area (UNCCD, 2020). A society's vulnerability to drought constantly fluctuates depending on the growing population, changes in land use, technology, government policies, and many other factors. Typically, in Somalia, societies that depend on the practice of pastoralism are vulnerable to natural hazards such as drought, especially when it comes to unstable political situations (Alwesabi, 2012). Somalia is highly vulnerable to drought effects as land tolerance to dry periods is reduced due to mismanagement and inappropriate land use practices, overgrazing and logging, and its heavy dependence on agriculture as a livelihood. Therefore, a small negative deviation from the long-term annual mean rainfall in any region within the country can cause drought. As according Kundell (2008), Somalia is recurrently vulnerable to drought, with moderate drought occurring every 3-4 years and severe drought occurring every 7-9 years. Droughts have disastrous effects on Somali communities and have been tagged severe droughts with unforgettable names, e.g., "Xaarama-cune, Harga-cuna, Dabadheer" (UNCCD, 2020). In the recent past, severe droughts occurred in Somalia in 1964, 1969, 1974, 1987, 1988, 2000, 2001, 2004, 2008, 2011, 2016/ 2017 and now 2021/2022. As a result, millions of people experienced famine, malnutrition, displacement, and death.

CAUSES OF DROUGHT IN SOMALIA

Drought is a natural disaster that afflicts people, but it is caused by a combination of factors, including; Insecurity or conflict in a country, as well as mismanagement in the management of water and environment, deforestation, and land degradation. The main causes of drought in Somalia:

Deforestation

Plants and Trees are important to the country's climate because they release moisture into the atmosphere, causing clouds to form and precipitation to fall, returning moisture into the soil. Unfortunately, humans are the most destructive of these natural resources (Conserve Energy Future, 2022). Deforestation to obtain charcoal and the destruction of natural forests into land or agriculture has serious environmental consequences leading to environmental degradation as well as soil erosion. When forests and vegetation are depleted, less water is available to feed the water cycle, increasing the vulnerability of all regions to drought. In the meantime, other poor land-use practises like deforestation and intensive farming deteriorate soil

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quality and reduce the soil's capacity to absorb and retain water. As a consequence, the soil dries out more quickly, resulting in agricultural droughts, and less groundwater is resupplied, contributing to hydrological drought.

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.

Less Rainfall

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.

EFFECTS OF DROUGHT IN SOMALIA

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

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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.

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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 with highly variable and low precipitation, even a short dry period, often during the cropping season, results either in significant yield reduction or total crop failure. Such agricultural droughts are frequently felt by rain-fed farmers. During the drought, Somalia suffered over $1.6 billion in agricultural losses and damages, accounting for nearly half of total drought damage and losses (UNDP, 2018). Severe or prolonged droughts result in greatly reduced river flow and reduced harvestable crop yields in the Juba and Shebelle regions. Drought had the biggest effect on rain-fed food crops (sorghum, cowpea, and sesame) in Bay and Bakool, which had been without precipitation for multiple seasons since early 2016. Sorghum losses in these regions were as high as 73% and 52% and 84% for corn and sesame, respectively. Shebelle valley regions in both rain-fed and irrigated conditions suffered losses of up to 60%, 36%, and 80% for these three crops, respectively.

Total production volume loss in Somalia was 50% in sorghum, 34% in corn, 83% in sesame, and 59% in cowpea (World Bank, 2018). Drought reduces crop production by decreasing the amount of cultivated land, resulting in harvest failures. Droughts throughout 2017 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). On the one hand, the rising temperature is having a negative impact on Somalia's agricultural production. It causes drier conditions and rain failures by increasing evaporation and decreasing soil moisture. This will eventually reduce the availability of water for irrigation, causing crop yields to plummet. As a result, Somalia has faced frequent droughts in recent years that have disrupted its agricultural sector.

The scale of a drought's impact on agriculture largely depends on the timing and duration of drought events. Drought causes the heaviest economic losses during the sowing months or during the crop flowering and fruit formation stages. Food security in the country is closely related to the success or failure of agricultural production, as agriculture is the main source of livelihood and employment for the majority of the population (UNCCD, 2020).

Effects of Droughts on Livestock

Pastoralism is the primary source of income for the vast majority of Somalis. Camel, sheep, goats, and cattle are raised by both nomadic and sedentary pastoralists (Encyclopaedia Britannica, 2011). The livestock sector is one of the most vulnerable to drought in Somalia because it is entirely dependent on the rainy seasons, which may explain the country's severe drought effects. Pastoralists suffer great livestock losses during severe droughts; some of these have been experienced in more recent droughts, e.g., 2011, 2016 and 2017 droughts (UNCCD, 2020). According to estimates, Somalia lost more than $6.4 million of its total livestock population, valued at more than $350 million, during the drought; it also suffered productivity losses of approximately 1.2 billion dollars in terms of milk yield and body weight. Livestock losses among poor families are extremely high, averaging 40-60% in the north and 20-40% in the centre and south (UNDP, 2018). During the 2016-2017 drought periods, the economic losses of animals were 52% in sheep and goats, 42% in camels and 6% in cattle (World Bank, 2018). Pastoralists became increasingly vulnerable during the 2016-2017 dry seasons as rains failed to replenish animal feed and replenish water supplies. From the north (Somaliland and Puntland) to the south, large livestock losses have been reported (Bay, Bakool, Gedo, Middle Juba, and Lower Juba). When the animals' body conditions deteriorated, the surviving animals became weaker, more susceptible to disease, less productive and valuable, and produced

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less milk and meat. Furthermore, pastoralists were increasingly unable to support their families (FAO, 2017).

Effect of Drought on Natural Resources

Land degradation has continued at an alarming and increasing rate over the last two decades. In Somalia, land degradation is primarily caused by unsustainable land use, such as overgrazing, charcoal production, and deforestation. The vegetation in northern Somalia has been severely damaged. The majority of the forest land in the southern region has been destroyed, particularly the mangrove forests (UNCCD, 2020).

Drought plays an important role in land degradation as it renders land more susceptible to soil erosion by reducing vegetation cover and soil moisture reserves. Urbanisation and expansion of farming into rangelands are also important factors in the accelerating land degradation. Drought is also a major driver of desertification in Somalia's environment, which has negative effects on the rural population. Frequent droughts have reduced the capacity of the land to support plant and animal life due to increased soil erosion, reduced soil moisture retention and decreased soil fertility levels. During drought years, critical water shortages occur, with pastoral communities suffering the most from a lack of water supply for both humans and livestock. While access to domestic water is difficult for rural populations even in normal years, rural women and children must travel long distances to obtain water during droughts. Water resources are likely to decrease due to increased evaporation rates, droughts, and greater precipitation variability. Water sources may also become more polluted due to increased sedimentation. Livestock deaths during drought periods are probably equally due to pasture scarcity and lack of drinking water (UNCCD, 2020).

Effect of Drought on Biodiversity

Drought undoubtedly decreases plant biodiversity by reducing plant regrowth, dispersal, and survival and often changes the composition of plant species in an area in favour of hardy but less palatable species. Droughts can accelerate the extinction of endangered species, especially those that are less tolerant to prolonged dry periods. Drought combined with overgrazing is driving many grasses and forbs to extinction have led to pronounced reductions in the carrying capacity of the land, and have further added to the scale of land degradation (Abdullahi, 2018).

Drought reduces the soil seed bank, thereby restricting subsequent plant regeneration and density and limiting species diversity. The combination of raising the temperature and frequent droughts will continue to contribute to a larger scale of land degradation in the country unless unprecedented interventions are implemented, which are highly unlikely given the country's limited financial and technological capacity. Without appropriate interventions, biodiversity decline will proceed unabated. The spread of invasive exotic species will further impact biodiversity and forest productivity. Frequent droughts may result in the extinction of vulnerable plant and animal species, particularly those already endangered. The protection of the country's endemic and rare species will require a concerted effort of various players including international biodiversity conservation organisations, government, NGOs, universities, and local communities (UNCCD, 2020).

SOLUTION PROPOSALS FOR DROUGHT IN SOMALIA

Although we are not able to increase rainfall, we can minimise the negative effects of drought. Allah has given us the ability to find solutions and manage what we have. The solution to the drought in Somalia is summarised as follows:

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Rainwater Harvesting

Rainwater harvesting is a simple 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 the roof and storing it in reservoirs. The primary goal of rooftop rainwater harvesting is to hold the water for future use. Rainwater capture and storage is especially important in dry land, hilly, urban, and coastal areas. Rooftop rainwater harvesting is used to reduce runoff that clogs drains, reduce soil erosion, and keep roads from flooding.

Ground surface rainwater harvesting: The most difficult way to collect rainwater is through ground or land surface catchment areas. Ground surface rainwater harvesting techniques provide more opportunities for collecting water from a larger surface area than rooftop rainwater harvesting techniques. During dry periods, this technology can meet water demands by capturing flows (including flood flows) from small streams and streams in small storage reservoirs (surface or underground) created by low-cost dams. This method is best suited for storing water for agricultural purposes.

Planting More Trees and Combating Deforestation

Planting trees is the most effective way to reduce drought damage, enhance the environment's quality, and increase precipitation success. Many countries, including Israel, have begun their efforts by planting trees and saplings and reforesting barren lands (Brand et al., 2011). If the trees are well protected until maturity, it can also reverse the drought and arid conditions of an area. Another option is to avoid cutting existing trees unless more are planted.

Switching to Renewable Energies

For a long time, we relied on non-renewable energy sources such as fossil fuels. The extraction and use of these energies results in the release of more greenhouse gases into the atmosphere, which causes global warming and, of course, drought (Environmental and Energy Study Institute, 2022). The alternative is to change. The alternative is to use renewable energy sources such as wind and solar, which have no environmental impact and will not cause droughts.

Water Conservation

A large amount of water is required for agricultural use globally. Moreover, water is often used inefficiently. Drip irrigation systems are a widely used method for more efficient use of agricultural water. This slowly feeds water directly to the base of the plant, reducing water loss through evaporation and reducing the total amount of water required (Kumari & Singh, 2016). The advantage of such a system is that it does not waste water. Today many companies have come to the fore by providing cost-effective and intuitive drip irrigation systems to the market.

Soil Conservation

Soil conservation is a set of practises used to keep soil from deteriorating. Soil conservation, in particular, entails treating the soil as a living ecosystem. This means that organic matter is constantly recycled back into the soil. Organic matter improves soil structure and water retention capacity, promotes infiltration, and protects soil from erosion and compaction. Crop rotation, mulching, no-till farming, reduced tillage, cover cropping, and contour farming are all soil conservation practises (Kumari & Singh, 2016).

Monitoring of Soil Erosion

Soil erosion is caused by issues such as tree cutting, the migration of rural people and their livestock, and rainwater that flows like a flood. So it is imperative to protect the land from erosion and overgrazing and

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to find a way to stay rural and keep livestock. To do this, you must have people who are knowledgeable about grazing, its management, and learning about grazing in general (Madoobe, 2011). To prevent land degradation, the following steps should be observed:

- The politics of the country should give greater consideration to the environment on which our lives depend.
- To obtain experts in land degradation to prepare studies on how to deal with it.
- To increase public awareness of environmental protection, enact strong laws to protect the environment, and prosecute any individual or group that violates it.
- To protect against soil erosion, they establish forestry plantations, planting drought-tolerant and fast-growing plants.
- To have people who are knowledgeable about grazing, its management, and learning about grazing science in general.
- To separate agricultural and pastoral lands, as well as grazing lands and drinking water sources. This means separating the water point and grazing land.

Drought Monitoring and Early Warning System

Drought monitoring and early warnings are essential tools for managing crop losses, preventing famines, and reducing associated risks. Currently, Somalia does not have a national drought monitor (Said et al., 2019). As the effects of drought increase, so increase the need to monitor and predicting of drought. Many indices have been developed by scientists to identify and monitor the onset, duration, and severity of droughts, providing information to decision-makers in order to reduce and mitigate the effects of drought (Mishra & Singh, 2010). These indices include meteorological and remote sensing indices, each with its own set of advantages and disadvantages.

Meteorological Drought Indices

The meteorological drought index can provide regional decision-makers with a full understanding of drought risk and help them take preventive measures (Said et al., 2019). Palmer Drought Severity Index (PDSI), Palmer Hydrological Drought Index (PHDI), Palmer Z Index (PZI), Crop Moisture Index (CMI), Surface Water Supply Index (SWSI), Standardized Precipitation Index (SPI), and Effective Drought Index are all globally used indexes (EDI). Morid et al. (2006) examined seven indices and discovered that SPI and EDI can detect the onset of drought, but EDI responds better. Mishra and Singh (2010) examined the evaluation of various indices based on scientific articles and discovered that regional performance influences index preference.

Currently, there is no pre-set drought index that is used by the Government of Somalia. There is an automatic weather station under the Ministry of Agriculture at federal and state levels that generate weather-related data, where the government uses forecasting (UNCCD, 2020). The data captured is recorded and analysed on the basis of historical rainfall records per agro-ecological zone and administrative region. Precipitation is measured over three thresholds: 1. normal precipitation, 2. above normal, and 3. below normal.

FAO has developed a combined drought index for the country, and despite its adaptation by only the FAO-Somalia office, the information and analysis reached through these indices are shared with the government. The current FAO-SWALIM's combined drought indices are the Precipitation Drought Index (PDI), Temperature Drought Index (TDI), and Vegetation Drought Index (VDI) (VDI). These combined drought indices define droughts based on rainfall deficits, dryness persistence,

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temperature excess, high temperature persistence, soil moisture deficit, and dry soil conditions persistence (UNCCD, 2020).

Remote Sensing

Recent advances in remote sensing data, both spatially and temporally, have enabled this data to be used for regional and global drought monitoring. Satellite data has become the primary source for detecting environmental changes in recent years. It provides a comprehensive view of changes that are not visible from the Earth's surface. Remote sensing is critical when meteorological data is incomplete, inaccurate, or difficult to obtain, especially in a country like Somalia where basic information is lacking. Remote sensing data, specifically MODIS Normalized Difference Vegetation Index (NDVI) data, are widely used to study vegetation change around the world. It is one of the most successful attempts in the world to detect vegetation greenery. Remote sensing consistently delivers global data every one to two days, outperforming any other known data source (UNDP, 2018).

Drought Risk Identification and Early Warning Indicators

Effective monitoring and early warning system are very important in managing and reducing drought crises in different stages. The monitoring system should focus on short, medium, and long-term cases and should continue with a timely early warning system. The government's early warning system should be based on four components: i) Knowledge of the risk faced ii) Technical monitoring and warning service, (iii) Dissemination of meaningful warnings to those at risk, and (iv) Public awareness and preparedness to act.

The early warning system of the country is poor nationwide despite the improvements in areas of climate monitoring and forecasting. The early warning information released by the regional and international climate forecasting organisations has greatly assisted efforts in managing droughts across the country (UNCCD, 2020). There are many obstacles to efforts to establish an effective early warning system (EWS) in the country. In order to build a well-integrated system, issues such as funding, research, expertise, robust technologies, infrastructure, institutional capacity, collaboration and integration, efficiency in response, advanced risk management, and communications infrastructure must be considered holistically.

In Somalia, there has been potential indigenous knowledge for predicting droughts. People have been predicting droughts for generations by observing changes in animal and plant behaviour. They also understand the different types of wind and make plans ahead of time to mitigate the severity of the environment. The behaviours of some indigenous flora and fauna species, the wind direction and soil changes have been relevant indicators to the community in predicting the likely droughts and rainfall patterns (UNCCD, 2020).

CONCLUSION AND RECOMMENDATIONS

In Somalia, the vulnerable pastoral and agro-pastoral 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:

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- 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.

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