Climate Change Impact and Mitigation in Somalia: Water Harvesting and Conservation

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Abstract

This article offers an overview of the impact of climate change in Somalia and proposes a sustainable water harvesting and conservation program as a solution. The article examines the far-reaching consequences of climate change in Somalia, highlighting the severe repercussions of annual flooding, droughts, and erratic seasonal rainfall, which have resulted in dire famine-like conditions among the population. Based on our thorough observations, we put forward a recommendation for a sustainable water harvesting and conservation program aimed at alleviating these effects and fostering resilience in both the land and the nation, thereby fortifying them against future disasters. The proposed program forms an integral part of a comprehensive ecosystem restoration plan specifically tailored for Somalia's arid and semiarid regions. By implementing this initiative, we can rejuvenate the land and bring tangible advantages to the local inhabitants, their livestock, and agricultural activities. Moreover, this program stands out for being cost-effective, sustainable, and manageable, aligning harmoniously with the United Nations' "Sustainable Development Goal (SDG) 15," which focuses on safeguarding and rehabilitating terrestrial ecosystems. To ensure the robustness and effectiveness of our findings and recommendations, we eagerly welcome feedback and insights from the expert community. By engaging in constructive dialogue, we aim to refine our approach and enhance the proposed solutions to address the pressing challenges posed by climate change in Somalia.

Keywords**:** *Climate change, droughts, water harvesting, conservation, Dams*

Introduction

This article explains the impact of climate change on Somalia and attempts to propose mitigation about the best prospects to confront this ever-escalating Somali and global problem. Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle (Majid et al. 2023). During the last decade, the change in the world climate due to the use of fossil fuels for energy generation and industrial production was felt and experienced in every continent. It became one of the most pressing topics of human discourse. Moreover, scientists have proven the continuous rise of global temperature, 1.01° C since the 1800s, and its adverse impact on human well-being while at the same time providing warnings and proposing methods of mitigation to avert severe climate change consequences (Adham, Riksen, Ouessar, & Ritsema, 2016). Thus, many international and national conferences

are convened to discuss the best ideas to curb rising temperatures and simultaneously mitigate global warming in the future. Climate change has adversely impacted some of the developing countries in Africa due to their fragile socioeconomic status. In Africa, Somalia is one of the most fragile countries geographically, economically, and socio-politically which has been adversely impacted by climate change.

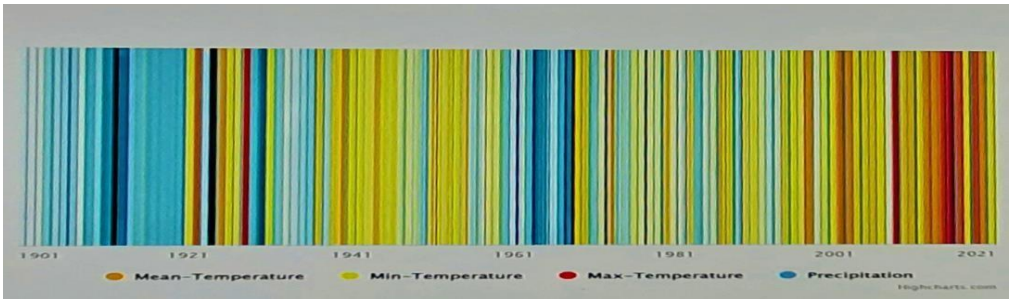
Climate Change Impact on Somalia

Somalia is a fragile country in various ways. About two-thirds of the country is geographically dry land, mainly dependent on erratic and unreliable rainy seasons. In addition, recovering from a long civil war and still suffering from insecurity, the current drought (2022-2023) looming for the last three years has made matters even worse (Kotikula, & Masaki, 2022). These are the complex conditions that further complicate the fragility of the economy and the sociopolitical state of the country. Today in Somalia, every single minute of every single day, a child is admitted to a health facility for treatment of severe acute malnutrition (UNICEF, 2022). The latest admission rates from August show 44,000 children admitted with severe acute malnutrition. That is a child per minute." In a related (UNICEF, 2022) Report, drought has influenced 7.8 million Somalis [out of a population of 18 million], with 213,000 in danger of famine. The COVID-19 pandemic burden compounded this, and now, the Russia-Ukraine war.

On the other hand, Somalia has been affected by climate change's impact, which results from a century-long accumulation of global warming. The reduction of Somalia's annual precipitation and the increase of climatic warming between 1901 and 2021 are depicted in the following chart (High Charts, World Bank Group, 2021). In the diagram, the high precipitation (blue) is replaced by high temperature (red). The chart indicates how the temperature has been warming for the last 100 years, resulting in precipitation loss. Hence, one can relate the real impact of climate change on Somalia, practically attested by the current drought, which has put the country on the edge of famine.

Chart 1: The Somali loss of precipitation and increase of temperature from 1901 – 2021

Source: HighCharts.com, in World Bank Group 2021



In this fragile setting, the climate change impact on Somalia is evident, where natural calamities are annually alternated between droughts and floods. After every drought, flash floods submerge towns and villages, destroying properties and washing away whatever harvest or livestock are salvaged from the drought. By comparison, before the Civil War, droughts and floods used to be decennary incidents that occurred once in a decade or two.

According to (World Bank, 2020) data, while the water dependency of Somalia is estimated at 59%, the country loses 4 billion (cubic meters) m3 of fresh water per year. This large amount of water could be harvested and utilized during the dry seasons to avoid droughts.

Table 1: Somalia water information

Renewable water resources	15 billion m3/year
Water use per capita	997 m3/year
Annual water loss	4 billion m3/year
Water Dependency	59%

Source: World Bank, 2020

Moreover, the continuous felling of trees since the collapse of the Somali state in 1991 has barred the land from its protective layers of plants and good soil, transforming it into a barren land. Compounded with insecurity, the previously fertile regions in the proximity of Juba and Shebelle Rivers are today abandoned by the farmers displaced by recurrent droughts, floods, and insecurity. More than 53% of the Somali population live in rural areas and depend on farming and livestock as their livelihoods (World Bank, 2020). Nevertheless, those two occupations depend on the mercy

of climate, and as the Somali economy relies on agriculture and livestock, both are sustained by seasonal rains. Hence, the dependency of livelihoods and the national economy on seasonal changes, weather patterns, and meteorological thermal shifts places the country captive to climate change. Hence, these climate-resultant conditions necessitate mitigation actions to minimize or alleviate the current and future environmental impacts. In the following segments, we explore the water stress of Somalia and the most appropriate mitigation options to utilize in this situation, concurrent to the UN's Sustainable Development Goal (SDG) 15. (Mundondo et al. 2018) argue that this aims to protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss.

Somalia Water Stress

The overuse of water due to the increase in the Somali population and livestock over the years has created water stress, where the usage has increased, and the overall precipitation has decreased. The traditional seasonal rainfall (depicted in the following table) is no longer regular and reliable, where the rains are delayed at best and missed at the worst conditions. Practically speaking, since 2018, seasonal rains have been either missed or insufficient in most regions of the country, thus creating the worst drought in the last four decades. On the other hand, the most crucial seasonal rain of Somalia is the GU' (see the table below), which provides 75% of the annual rains, but if this rain season is missed, which usually happens nowadays, then the *dayr* season with just the 25% annual is not enough, and that results in a drought in the country.

Table 2: Somalia average seasonal rainfall

Seasonal Average Rainfall		
Gu' rains	April – June	75%
Dayr rains	Oct. – Dec.)	25%
Total	April – Dec.	100%

Source: World Bank (2020)

Options of Climate Change Impact Mitigation

The environmental degradation of Somalia, apart from climate change, ensues from deforestation and desertification, on the one hand, and prevalent scarcity of water and water resource mismanagement, on the other hand. These two conditions, which are somehow interrelated, have put the country into a fragile situation prone to a climatic predicament. Thus, confronting these two elements takes the principle of ecosystem restoration, which includes environmental protection and conservation, specifically forests and water. However, in this section, we discuss the importance of water harvesting and conservation, more so on water damming, which is the answer to the recurrent droughts in the country.

The two concepts of water harvesting and conservation are interconnected: Harvesting is the first step, and conservation is the second. Nonetheless, conservation encompasses preserving harvested water and the already naturally existing bodies of water. The mitigation concept contends to mitigate climate change's impact on vulnerable communities, intending to achieve climate resilience through the following approaches: the construction of water dams of various capacities along the fragile arid and semiarid drylands.

These water facilities could be dams, reservoirs, and canals, among other things. The opportunity to harvest and conserve water in Somalia is available because the average countrywide rainfall is estimated at 200mm (see the table below). While some dryland regions are 50-200 mm., others get 400- 600mm. of rainfall annually. In addition, even when seasonal rains are missed, the upstream water basins from the Ethiopian highland provide enough water worth conserving. These upstream waters flood Somali regions every other year along the banks of Juba and Shebelle basins. Most of those flood waters could be harvested and conserved for flood control and future use during the dry seasons.

Table 3: Countrywide average rainfall

Regional Average annual rainfall		
Northern coastline	50 mm	
Sothern (regions)	400 mm	
Southwest	600 mm	
Total average rainfall	200 mm	
Average annual %	April - Dec.	200mm

Source: World Bank (2021)

Water Harvesting

Water harvesting is simply a process in which rainwater, runoff, or seasonal rivers and spring waters are collected into pre-prepared water catchments or dams for the purpose of water conservation and management. Harvesting and conservation are interconnected and treated as a holistic "method for inducing, collecting, storing and conserving local surface runoff for [livestock and] agriculture in arid and semiarid regions (Adham et al., 2016). The objective is to collect water at the time of abundance and use it during scarcity.

Historically speaking, African nations have long recognized the importance of water harvesting and have audaciously started implementing man-made or artificial lakes in the 60s and 70s.
These African countries have since benefited immensely from these development projects, ecologically and economically, which is something we can learn from them. In the following table, we listed five of the major artificial lakes in Africa, their locations, and sizes:

Table 4: African man-made lakes

Africa		Location	Size
1	Lake Nasser	Egypt	7,502 square miles
2	Lake Kariba	Zambia /Zimbabwe	2,150 square miles
3	Lake Volta	Ghana	3,275 square miles
4	Lake Kainji	Nigeria	772 square miles
5	Cahora Bassa	Mozambique	1,752 square miles

Source: Flash Uganda media (2023)

Hence, in Somalia, we often see springs and rivers flooding the land during the rainy seasons and then drying up as soon as the dry season starts. During the rainy seasons, we have to harvest the flush water to use it during the drought times. In some cases, there are low-budget water harvesting systems designed to satisfy the needs of a household. At the same time, at other times, there are medium and large projects, such as reservoirs and dams, designed to satisfy the needs of entire communities. For example, the Gabiley Dam, about the size of one Km2 and with a volume of 1 million m3 of water, was built in 2021 with a budget of less than two million dollars and was implemented in just six months. This dam is an excellent example of an efficient water project in terms of its low budget, period of implementation, and capacity to serve the whole region of Gabiley. That is one of the reasons that we advocate for the implementation of more Gabiley-like dams in Somalia

Integrated Water Harvesting Systems

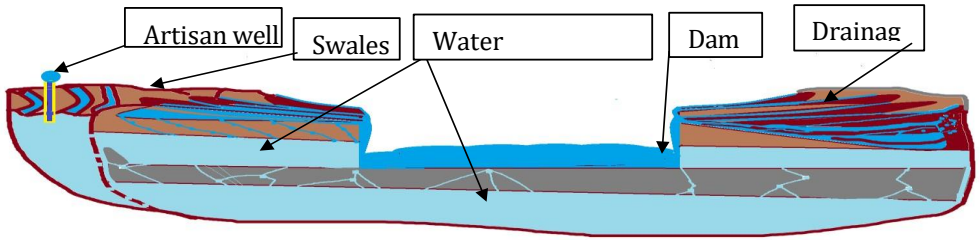
In rural and semi-rural areas, the integrated water harvesting system is most appropriate, where water catchments or dams are combined with artisan wells built in the same area, with the deliberate intention of benefiting from the dam permeation process to replenish the subsurface water systems, even after the dams dry up. It was realized that the Gabiley Dam had replenished the subsurface water of 10 km^2 area. Integrated water harvesting requires excavating swales around the integrated catchment to slow down runoff water for water permeation purposes in the nearby land. This process is primarily suitable for rural and semi-urban dry lands. However, there are different kinds of water catchments based on the nature of the land topography.

Harvesting water around highland areas is easy, where watersheds drain rainwater into the underlying valleys to form seasonal rivers and springs. A watershed is formed when several spring-like water collectors drain runoff water into a central water system. Some significant watersheds create rivers, while the minor ones become seasonal or temporary springs that dry up after several days or weeks. The latter one is usually selected for harvesting before it dries up.

Thus, it is easy to harvest water from highlands and even from low-lying hilly vicinities. However, even in plains (flatland areas), landscaping designated to form water drainage sources that drain runoff water into the dams is created. This landscaping happens while excavating the dam or the

catchment, where the removed sand is emptied into a water drainage arrangement that collects water into the dam. Moreover, it is also possible to design grounded aqueducts around the catchment area to channel water into the required direction of the dam.

Fig. 1. Integrated water harvesting layout



Source: Digital diagram by the Author

This cross-sectional drawing indicates how the excavated sand or soil is arranged as water drainage to collect water into the dam. Swales are also shown at the left corner of the dam to slow down runoff water and replenish the water table.

The Rationale Behind Water Harvesting

During droughts, rivers and springs dry up, and water wells, traditionally the ultimate water resources, either dry up or become semi-dry. Only the deep-water boreholes become the only source of water. This scarcity of water creates a large number of people and livestock competing for this limited water resource, resulting in a conflict. For the last few years, the Ministry of Energy and Water Resources and numerous other nongovernmental agencies, including Qatar Charity, have shown reluctance to invest in water wells unless it is a deep-water borehole with an approximate depth of hundreds of meters. However, investing in deep-water wells compared to water dams is not viable because of the multipurpose added value of water dams. While the water wells provide water to a limited population and their livestock, dams are more reliable and provide more water with other value-added resources.

Climate Change will create a decline in Somalia's water resources over time. In an interview with people aged 55 - 75 years who were born on the riverbanks of towns along the Shebelle River, they unanimously indicated that the current follow of the river is well below what they used to see during their young lives, especially in the last 40 years. The same thing is happening to the

neighboring countries, and each country is anxious to conserve its share of water resources. This condition puts Somalia in a precarious situation since the country is downstream, and thus, 59% of the national water resources come from Ethiopia. This situation is worsened because the two countries have no water-related agreements, and every time Ethiopia develops a water development project upstream, this adds up to more decline in the downstream water sources.
This water stress, again, necessitates the importance of water damming and conservation on the part of Somalia to reserve enough water for its population.

The Importance of Water Damming

In this article, we strongly advocate for investment in dams, highlighting their numerous benefits. Some of the key advantages of dams include:

1. Irrigation: Dams enable the irrigation of land, allowing the area people to irrigate their land to grow crops and fodder for their livestock during the dry seasons.
2. Ecosystem restoration and water table replenishment: Dams help replenish the water table in their vicinity, ensuring a sustainable water supply for both human and ecological needs and restoring the surrounding ecosystem.
3. Ecotourism attraction: Dams can serve as attractive tourist destinations, promoting ecotourism and contributing to local economies through increased visitor traffic.
4. Fish farming opportunities: Dams provide a favorable environment for fish farming, offering a valuable source of food and income for the local population, particularly during drought seasons.

Given the current situation of climate change-induced droughts, we strongly urge governments and international agencies to invest in small and medium-sized multipurpose dams. Such infrastructure is crucial in addressing the water scarcity challenges faced by rural communities. By harnessing the potential of these dams, we can effectively alleviate the adverse impacts of droughts on vulnerable populations. Moving forward, we will now outline in detail the various benefits associated with water dams.

Water Dam Irrigation

Irrigation plays a crucial role in promoting agricultural practices that enable individuals to cultivate crops necessary for sustaining their livelihoods. For nomadic communities, this means transitioning from solely relying on livestock to adopting agro pastoral methods, thereby combining agricultural and livestock activities to enhance their overall productivity. By diversifying their income sources through farming, these communities can establish a more sustainable way of life.

In addition to cultivating crops, nomads can leverage the byproducts of their traditional produce, such as corn, sorghum, and sesame, as fodder for their livestock. This agro pastoral practice of producing fodder not only ensures a steady supply of feed for the animals but also fosters resilience within the community. By integrating crop farming and livestock rearing, the community becomes better equipped to withstand challenges and adapt to changing circumstances.

Fish Farming

Fish farming is a crucial economic activity that brings significant benefits to Somalia's low-income and rural communities. This viable economic venture can be undertaken in nearly any region with a permanent or semi-permanent body of water. The livelihoods of these rural communities are heavily reliant on seasonal rains, which, unfortunately, have become increasingly erratic and unreliable as a result of climate change. Consequently, the construction of a water dam that could support fish farming would greatly enhance the well-being of these communities. It would enable them to sustain their livelihoods during dry seasons, thus mitigating the risk of famine and ensuring a more secure future.

Ecotourism

Water dams offer an additional advantage by fostering the growth of ecotourism. By providing a source of water, they nurture ecosystems that support diverse flora and fauna, attracting a wide range of wildlife species. This flourishing ecosystem becomes a magnet for visitors, thereby generating ecotourism opportunities for local communities. Tourists are willing to spend on services such as transportation, accommodation, and tour guides, thereby stimulating the local

economy. In turn, this economic activity creates employment opportunities and fosters the development of small family businesses within a community.

Ecosystem Restoration

Considering the water stress situation in the country, it is essential to recognize the advantages of water dams. One significant benefit is the rejuvenation of the surrounding environmental systems. Through water permeation, the water table is replenished, leading to the restoration of shallow water wells and the irrigation of land around the dam. This active ecosystem restoration is crucial for maintaining a healthy and sustainable environment. Additionally, water dams provide a reliable water source for agricultural and industrial use, contributing to communities' overall development and growth. Therefore, Somali experts must continue exploring and expanding our knowledge of water dams' benefits and potential drawbacks to ensure responsible and effective management of this valuable resource.

Resettlement Initiative

As time passes and the various activities mentioned earlier begin to take place, human settlements tend to form in the vicinity of the dam. This is due to the fact that the dam provides a range of amenities that support human life. Over time, some of the pastoral communities that reside in these areas are able to explore new options and opportunities, such as becoming semi- rural farmers, agro-pastoralists, fish farmers, tour guides, and service providers for the tourism industry. These new opportunities allow these communities to expand their horizons and improve their standard of living, while also contributing to the local economy.

Possible Disadvantages

Waterborne diseases pose a significant threat in humid tropical environments where water is abundant. Malaria, bilharzia disease, and yellow fever exemplify the health hazards associated with untreated water. Nevertheless, these risks can be minimized through diligent monitoring of water sanitation and hygiene, along with strict adherence to regulations governing dam usage and maintenance. It is imperative for expert communities to comprehend the potential perils of waterborne diseases and the requisite preventive measures. Equally important is the dissemination of awareness about these issues to the general public, given the potential devastating impact of

waterborne diseases on communities. By fostering collaboration and implementing effective strategies, the communities can collectively tackle this challenge.

Dam Management and Maintenance

When it comes to managing dams, there are two main approaches: a government-led system under the Ministry of Energy and Water Resources, and a community-managed system under a government-set protocol. While both of these approaches have their pros and cons, we recommend the latter for its efficiency and cost-effectiveness. In Somalia, communities have a long history of effective water management systems spanning centuries. Typically, a committee of elders is selected by the community to manage water reservoirs, with subcommittees working with the elders to facilitate their recommendations and decrees. We can safeguard against the spread of waterborne illnesses and create a safer, healthier world for all.

By empowering local communities to manage dams, the cost of management and maintenance is absorbed by the community, making it a one-time investment project. However, it is important to note that dams cannot continue to function without regular maintenance and management. Maintenance may involve issues such as sanitation and silt derangement, which need to be addressed every few years. By establishing a community-led system for managing dams, the maintenance and management costs can be efficiently and effectively shared, making it a sustainable solution for ensuring the long-term success of these important infrastructure projects.
As researchers in this field, we understand the importance of effective dam management and are committed to expanding our knowledge and expertise in this area. By working closely with local communities and government officials, we can help to develop sustainable, community-led solutions for managing dams that are both environmentally and economically responsible.

Conclusion

The impact of climate change on Somalia is severe, and mitigation measures must be taken immediately. One of the best courses of action is the construction of multipurpose dams and reservoirs. As environmental and water resources researchers, we must understand that water wells are single-purpose, expensive, and often shallow, which causes them to dry up during the dry seasons when water is most needed. In contrast, dams are cost-effective, retain water during the dry seasons, and provide value-added economic significance as tourist destinations and fish farming opportunities for local communities. During droughts, fish consumption is life-saving when harvests fail, and livestock is unsuitable for consumption due to physical health conditions. Another compelling reason for water harvesting is the 4 billion m3 of freshwater Somalia loses yearly, necessitating water harvesting and conservation. Therefore, we know that the construction of dams allows for the growth of certain crops and the provision of fish meat during severe droughts. Hence, we highly recommend the construction of multipurpose dams and reservoirs in Somalia. Not only will they help mitigate the impact of climate change, but they will also provide economic benefits to local communities and ensure the conservation of freshwater resources.

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