

The Effect of Global Warming on Water Resources in Africa

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Abstract

The occurrence of greenhouse effects is a result of the accumulation of specific gases covering the planet human reside, and the general term for these gases refers to greenhouse gases, such as carbon dioxide, methane, nitrogen oxide, and fluorinated gases. Sunshine radiates from the effects of greenhouse gases into the planet Earth's surface, and the heat from the sun is ensnared and radiates back into the surface of the Earth. The negative impacts of global warming have resulted in hydrological cycle instability, which has led to water scarcity because it determines the availability of water for the community's many uses, most notably agricultural purposes. Africa is one of the most sensitive continents that are prone to climate change and variability. Climate change's direct implications on the water-food-energy nexus are expected to pose a growing quantity and variety of dangers to life and livelihood in Africa. This research examines the consequences of global warming on African water resources, focusing on four regions of the continent: West Africa, North Africa, East Africa, and South East Africa, all of which are experiencing water insecurity in their respective locations. This review aims to describe the relationship between global warming and water resources in Africa.

Keywords: Global warming, Climate change, Water resources, Africa

Review article

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INTRODUCTION

Global warming refers to a progressive increase in the mean temperature of the world, it occurs due to the activities of people and this has been in play for several years. Global warming can modify the hydrological cycle in varied ways, including increased cloudiness and latent heat fluxes, resulting in more intense and frequent precipitation extreme events (such as droughts, storms, and floods). These extreme events have garnered significant attention in recent decades as a result of the related economic losses, deaths, and a slew of other serious effects on the human environment (Wang and Liu, 2023). Climate change has become the focus of constant attention of living things and civilizations take into account the climatic parameters determined their lifestyles. Climate increasing or decreasing in changes affect living things negatively. Decrease in productivity, especially in agricultural production causes (İstanbulluoğlu et al., 2013).

Soil temperature decreases, plants that are not suitable for climatic conditions and resistant to cold will be affected by root and cause drying. As a result, a constantly increasing soil temperature will adversely affect plant life. It will decrease the efficiency (Bağdatlı and Ballı, 2020). The atmosphere is unsuitable for microbial growth because of high light intensity, drastic temperature fluctuations, low concentrations of organic matter, and minimal water content (Aydin et al., 2020).

Their effects have been measured and seen formed dangerous consequences on the ecosystem such as melting of ice, upsurge of sea and ocean, drought, salinity which is a result of aggregation of salts in the soil, continuous desertification, and several others. Water quality is crucial for various water uses. The pollution of drinking water sources, such as lakes and reservoirs, is significant for both individual and public health. Numerous strategies have been developed to protect watersheds from contamination (Bayhan et al., 2017). The warming of the earth is determined by the greenhouse which results from the progressive discharge of gases like carbon dioxide, nitrous oxides, methane, hydrocarbons, and water vapor, all these serve as hindrances to the dissipation of the heat formed through solar (Mella, 2022). Increasing the necessary studies and measures to minimize the emissions of carbon emissions should be taken all over the world and measures that will minimize the greenhouse gas effect will play an important role in reducing the effects of global warming (Bağdatlı and Arıkan, 2020). Global climate change affects the world negatively day by day and reveals negative results in agricultural product yield. In particular, it is inevitable to evaluate the regional temperatures and to review the product pattern in parallel with the increasing global climate change (Bağdatlı et al., 2014).

Changes in the Climatic conditions have led to an alteration in the atmospheric conditions, Hence, an alteration in the standard duration and range of rainy and sunny seasons, and this invariably resulted in increased oceans. Water resources are a crucial native asset that is essential to human life, they encompass people's daily activities and other forms of creature. A good environment is assessed based on the accessibility and characteristics of secured water. Availability of secured water has been identified to be the most constraint for rural dwellers in nations undergoing development, with almost 2.5 billion people living in inadequate surroundings. About seventy percent of clean and clear water is utilized for agricultural purposes, therefore, clean water is essential to people living in an environment for consumption, agriculture, and several uses (Ayanlade et al., 2022). Practices like conserving agricultural biodiversity, efficiently managing water resources for irrigation, and minimizing agricultural waste establish a framework for eco-friendly sustainable development, thereby protecting natural ecosystems (Unlukal and Erguven, 2024) Climate change and global warming are reducing the available water resources almost everywhere in the world (Uçak and Bağdatlı, 2017). The decrease over time of the changes in the surface of the water is noticeable. This also shows itself as the effect of disorder in the vaporization and current precipitation regime in the water sources dependent on climate change (Albut at al., 2018). The increase in the impact of global climate change will cause global water crises between countries. Necessary measures and measures should be taken in advance to reduce the impact of global climate change (Bağdatlı and Arslan, 2019). Changing climate conditions will be an important factor in the current situation and the problems that may arise in the coming years. For this reason, solutions are needed for global warming and reduction of greenhouse gases that cause climate change (Bağdatlı and Arslan, 2020). Africa is one of the most sensitive continents that are prone to climate change and variability. Climate change's direct implications on the water-food-energy nexus are expected to pose a growing quantity and variety of dangers to life and livelihood in Africa (Tedla et al., 2022).

Water reserves in Africa's semiarid regions have been exposed to different distress for the past 40 years, with caution levels almost at the critical points of water tension. The activities of climate change have increased water instability in Africa and some other places which has led to observed controversy on water value such as its usage, accessibility liberty, and water sustenance. Characteristics of water insecurity are as follows: Insufficient clean water, and a higher need for water than its quantity (Dinko and Bahati, 2023).

This research examines the consequences of global warming on African water resources, focusing on four regions of the continent: West Africa, North Africa, East Africa, and South Africa, all of which are experiencing water insecurity in their respective locations. This review seeks to describe the relationship between global warming and water resources in Africa. This review article is carried out based on a rapid review pattern of articles about the effects of global warming on water resources of Africa and this has strengthened the review article. The method of this review is categorized as a rapid review because it does not follow all the standards of a systematic review which involves the application of two reviewers for the assessment of all involved articles (Bezner Kerr et al., 2022) I employed different search techniques for resources related to my topic paper in writing this review such as Google Scholar, Springer, and Elsevier Science. I concentrated on research articles, short notes, and review articles that are practically and theoretically published. I read the abstracts, results discussion, and conclusion to determine the suitability of the articles. Search engines are employed in searching keywords like Global warming, Climate change, water resources, and Africa. The keywords made it possible to have a more extensive quality and quantity of articles. During the search for resources from several databases about 50 articles were found related to the topic and keywords searched. 17 articles were selected and used based on the following points of reference: Global warming effects, water resources, and Africa. Double-searched techniques were used for Google Scholar in the selection of the reference method of the article correctly. I ensured that I selected the most recent article with a recent publication date of less than 10 years.

CASE of EAST AFRICA

Ethiopia Awash River Basin

The Awash River basin in Ethiopia is exposed to considerable climate variability, with periodic floods and droughts. The basin is already under water stress, with more demand than supply. For example, research predicted an average annual runoff of 4640 MCM (million cubic meters), whereas the average annual demand is 4670 MCM. The basin experiences significant intra-annual variability, with the Awash Basin Authority recognizing dry season water scarcity as a barrier for diverse activities such as irrigation and domestic water delivery. There are examined projected irrigation expansion and demand satisfaction in the basin and discovered that, under the existing 'business-as-usual' scenario, the dry season faces unmet water demand, with the driest month (January) facing about 15 MCM of unmet water demand. Population growth, agricultural expansion, industrialization, and urbanization are all expected to drive up water demand. Climate variability has already had a significant impact on population and economic output in the Awash basin. Severe droughts in the basin have reduced crop output and killed animals, increasing food insecurity. A minor (5%) decrease in rainfall was expected to reduce the basin's GDP by 5%, with a 10% decrease in agricultural production (Taye et al., 2018; Mersha et al., 2018). Food production is a major concern that might be affected by climatic fluctuations (Bağdatlı et al., 2023; Elsheikh et al., 2023).

A similar report was obtained from the research by Orke et al., (2022) Evaluating the impact of climate change on hydrometeorology and droughts in the Bilate Watershed, Ethiopia and their findings revealed that Climate change effects on variables are expected to increase due to a significant rise in projected temperature, resulting in water storage depletion, which may lead to water scarcity, affect the length of the growing season, crop development, crop evaporation, and the amount of irrigation water used, and reduce crop yield. It might also result in significant droughts and the loss of livestock.

According to the assessment carried out by Tadese et al., (2020), the report that area's expanding population may be potentially detrimental to crop yield and food security. The loss of water supplies combined with population growth, will intensify droughts and food insecurity in the Awash Basin Authority (ARB), particularly in the Lower and Middle Awash. Likewise, the study by Guyasa et al., (2024) projected that climate change will affect the balance of water elements and drought between thirty to sixty years in the river basin, and their result revealed water accessibility could be remarkably and negatively impacted.

CASE of NORTH AFRICA (EGYPT)

Egypt is located around the northern eastern part of North Africa, surrounded by the Mediterranean Sea and the Red Sea on the northern and eastern coasts. Approximately over 95% of the fresh-water assets of Egypt are from the Nile River source, another source of water resource in Egypt is recycled water from effluents. Mostafa et al., (2021) studied on Potential climate change impacts on water resources in Egypt. The study was carried out in the Middle Egypt environment. The outcome of their research indicated that an increase in temperature on the region part could amount to 2.12 by 2050 and 3.96 by 2100 due to increased accumulation of discharge of world greenhouse gases which will negatively impact the mean temperature of the atmosphere and lead to negative impact on future irrigation system for crop production due to alteration in climatic condition.

CASE of WEST AFRICA

West Africa is rich and abundant with several water sources which are restored by the medium of the standard hydrological cycle (Coulibaly et al., 2018).

Nigeria Case

Nigeria is situated in the tropical zone, on West Africa's Atlantic Coast, between latitudes 40 N and 140 N and longitudes 20 21 and 140 301 E. Nigeria has a total size of 923,800 square kilometers. According to the Nigeria Water Resources Master Plan, Nigeria's population is 183,523,432 people, with a projected increase to 380,394,709 by 2030. Nigeria is abundant with vast water resources. Water is essential and beneficial to various sectors of the economy, including manufacturing, agriculture, cattle rearing, water transportation, and hydropower generation (Ezra et al., 2023). The analysis of Ezra et al., (2023) indicates a reduction in the average yearly precipitation and evaporation progression between -9.682 and -0.1709 , appropriately. The reduction in the precipitation of and evaporation calls for action as these elements are major influences and forces behind hydrological activities and ecological services. The decrease in the elements projected a low rate of rainfall and evaporation which are capable of negatively affecting water accessibility and agricultural production in the environment. Their observation suggests an increased level of heat due to low rainfall and precipitation and this eventually abates soil dampness and a decreased flow. This climatic alteration will result in continuous and extreme droughts, reduction in crop production, and water shortage.

Another study by Ogunrinde et al., (2022) evaluated the impact of climate change and drought attributes in Nigeria, the trend of their data suggested that Nigeria's drought frequency and severity would grow from 2035 to 2100. Projections of the change in drought frequency based on the assessment models are expected to be higher than estimates, indicating a higher atmospheric water demand due to global warming.

In general, studies on quality characterization can provide insights into the time-dependent variation of polluted water parameters. The results of these studies indicate that polluted water bodies exhibit temporal and spatial changes. If it is necessary to determine the composition of receiving environments from a specific site, conducting water analyses is essential. The duration of these analyses should be extended to capture seasonal variations, especially due to rainfall (Yildirim et al., 2018).

Drought frequency is expected to decline in the near and distant future, whereas drought occurrence is expected to rise. The decreased frequency of droughts suggests that precipitation will increase, particularly as the twenty-first century comes to an end. Drought frequency and severity will increase during the twenty-first century as a result of climate change.

Senegal Case

Senegal is situated in the western part of Africa, and according to history, the country is the entrance to West Africa. Agriculture is the major source of finance in Senegal, especially the income from produce such as peanuts and cotton, and this aspect is greatly affected by drought and the lower cost of items. The fast increase in populace size has placed huge pressure on Senegal's small land assets, agricultural produce, and water assets. More than eighty percent of the populace resides in the western part of the nation, and almost seventy percent are involved in the farming business meanwhile, the city populace experiences an increase continuously. Mbaye et al., (2019) Assessed Impacts of 1.5 and 2.0 °C Global Warming on the water balance Components of Senegal in West Africa. Their findings indicated that Senegal has the possibility of experiencing a reduction of year and season-average precipitation due to the influence of global warming. Meanwhile, there is a prediction of future evapotranspiration which will increase the rate of water dissipation through topsoil, oceans, and vegetation, this event will lead to water scarcity in the years to come.

CASE of SOUTH EAST AFRICA (MALAWI)

Climate change threatens Malawi's economic development and the living conditions of the impoverished and susceptible populace. Malawi's sensitivity to climate change stems from the point that agriculture, which provides 80% of Malawians' incomes, is non-irrigated. Furthermore, Malawi's industrial first line is primarily farmers, making the entire economy extremely sensitive to the effects of climate change. Malawi is ranked 171 out of 189 wealth and poverty nations, with a Human Development Index (HDI) of 0.477. Despite a 40% increase in HDI between 1990 and 2017, more than half of the population (50.7%) lives below the poverty line, with a quarter (25%) experiencing chronic poverty. More than 90% of the population relies on rain-fed agriculture, Climate extremes, such as droughts and floods, have the potential to reduce production and, as a result, food security (Dinko and Bahati, 2023). Similar work by Mtilatila et al., (2020) Indicated that Changes in precipitation and temperature have a significant impact on lake levels and the associated lake outflow. Temperature increases and precipitation decreases, affecting both lake level and lake discharge from Lake Malawi.

Lake outflow does not stop even with a 5°C temperature increase or a 20% drop in precipitation. The impact of combined temperature and precipitation fluctuations on river flows and resulting hydropower generation. Climate predictions concur that rising temperatures and decreasing precipitation result in lower mean lake levels, outflow, and Shire River discharge.

It is possible to come across many studies in the literature to reveal the effects of global climate change on agriculture and water resources. These studies have attempted to reveal the causes of global warming and the dimensions of the factors that cause climate change (Afreen et al., 2022; Bağdatlı and Belliturk 2016a; Elsheikh et al., 2022a; Bağdatlı and Can 2019; Bağdatlı and Belliturk 2016b; Elsheikh et al., 2023; Bağdatlı et al., 2015; Elsheikh et al., 2022b; Bağdatlı and Can, 2020).

CONCLUSION

This review has revealed the relationship between global warming and water resources in Africa. From the four regions that have been examined which include: West Africa, North Africa, East Africa, and South East Africa, It has been established that global warming is a key driver of water insecurity in the parts of Africa examined, and this lack of water invariably affects other aspects of life such as social, ecological, political, and economic aspects of life.

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