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Climate Change's Impacts on Water Paucity: Brief Study

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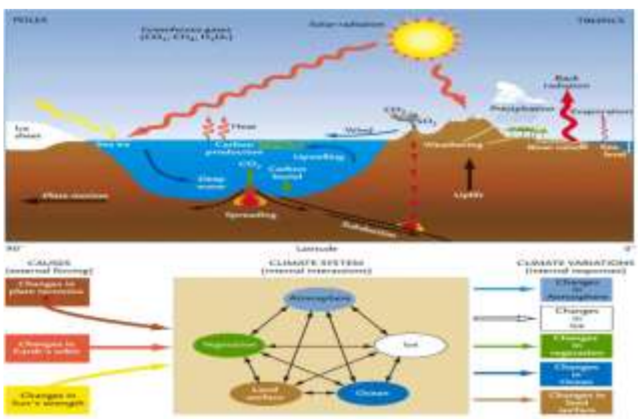
Abstract*: The impacts of changing climate on water resources may be exacerbated when they occur in areas with already scarce water supplies, experiencing frequent droughts, and disparities between water requirements and convenience. Wherefore, water resources in Sub-Sahara Africa will and is been negatively wedged by changes in climate, conferring to current climate change models by Intergovernmental Panel on Climate Change. These models predict the effects in Africa and other regions of the world, including Latin America. A further 10% decrease in rainfall is anticipated in Sub-Saharan Africa by 2050, which will result in a 17% decrease in surface water and subsurface water bodies. Population growth has increased the demand for food and fresh water for domestic and industrial use; however, the majority of freshwater resources have already been depleted, and agricultural productivity has decreased globally, especially in Sub-Sahara Africa. In dry and semi-arid states, a global decline in crop yields, or agricultural productivity, results in food shortages and a sharp rise in food price inflation. Water shortage has worsened due to the changing climate and climatic variations in most parts of the world, which directly and indirectly affect human and animal health. This brief study highlights how climate change has an impact on water scarcity and other related issues.*

Keywords: Agriculture, Air, Animal, Consequences, Effects, Precipitation, Pollution

1. INTRODUCTION

Water is essential for both long-term growth and life on Earth, access to clean drinking water and proper sanitation is one of the fundamental human rights. Water is the most common and crucial component of an ecosystem (Arakawa, 2017; UN-Water, 2019). Water moves from one area to



another as part of the water cycle, which is aided by changes in climate and other hydrological processes. The atmosphere, land, sea, and subsurface all contain water (IPCC, 2013; IPCC, 2014) continuous flow of liquid, solid, and vaporized water across the seas, cryosphere, land surface, and the atmospheric reservoirs.

Earth's Climate System: The climate system is the collective name for the five components of the geophysical system—the atmosphere, hydrosphere, geosphere, cryosphere, and biosphere. The climatic system is continuously changing as a result of the interplay between these components and external factors. As a result, see the illustration in figure 1 below, there is an interchange of moisture and energy between these spheres.

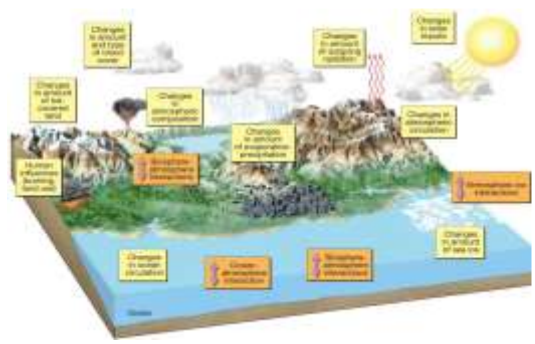


Figure 1: Earth's Climate System. Adopted and modified from Pearson. Inc.

Evaporation, condensation, precipitation, infiltration, runoff, and subsurface movement are the main physical elements of the water cycle. Life on land depends on water movement in the climate system because a substantial proportion of the water that falls as precipitation (UN-Water,2019). Precipitation maintains soil moisture and drives river flow as it evaporates from the ocean and is transported to land by the atmosphere. As it gives soil moisture in the spring and river flow in the summer, snowfall that is important for both natural and human systems (IPCC, 2013). Freshwater exchange between the atmosphere and the oceans can affect oceanic salinity, which plays a key role in ocean density and circulation.

Overview of the Earth's Climate System: The climatic systems of the Earth demonstrate how various factors, such as internal and external pressures, interact to alter the environment.

Figure 2: Interactions between external and internal forces on Earth. Adopted from globalchange.gov.

Due to the oceans' immense size and dependence on water, they would eventually dry up, which would cause an immediate extinction of all species and bring an end to life on Earth. The fact that the water issue is both a subject and an item in the regulator's life makes it particularly serious (Sonia et al., 2014). Climate change has a wide range of consequences on water, one of the most vital resources in the planet. There is no doubt that the climate system is warming at a rate unheard of and seen in millennia. Snow and ice cover have decreased, the temperature and waters have warmed, and greenhouse gas concentrations have increased (IPCC, 2013). These changes will have an effect on the world's drinking water resources, food output, and real estate pricing (UCAR, 2015).

Generally speaking, rising temperatures make the atmosphere more capable of retaining moisture, increasing the hydrological cycle (Denicola et al., 2015). Along with the rise in air temperature, the water's temperature also rises. The hydrological cycle is expected to alter significantly, as are other climate factors like global warming and atmospheric greenhouse gas emissions (Schewe et al., 2014, Denicola et al., 2015). Many aquatic habitats may suffer as a result of growing concerns about water contamination brought on by rising water temperatures.

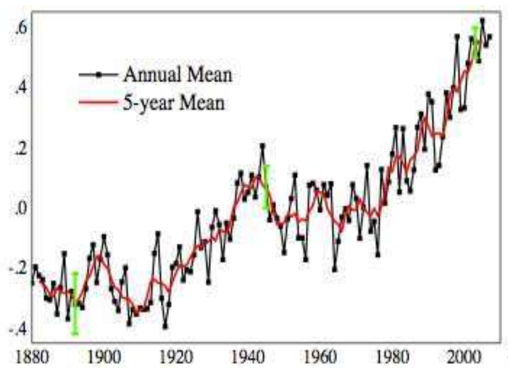


Figure 3: Rising global temperature.nasa.gov/gistemp/graphs

This important alteration in the hydrological system has an effect on the seasonal distribution, intensity, and duration of precipitation and evapotranspiration. This could lead to modifications in the surface runoff, soil moisture, seasonal snow loads, and glacial mass balance (Anders et al., 2014). Due to weather events and shifting temperatures, the distribution of snow and rain changes (Chavula and Chilumpha, 2022). The Intergovernmental Panel for Climate Change Report (2014) predicts that changes in precipitation and atmospheric moisture will occur after an increase in the global average temperature.

The average annual precipitation will rise globally in the twenty-first century, per climatic estimates (Takeuchi, 2002; Arnell, 2004; IPCC, 2013), yet this will have different effects on the water cycle internationally. However, mean precipitation is predicted to increase in high latitudes and in mid-latitude wet areas, according to current climate estimates, whereas summer precipitation is projected to decrease in mid-latitude and sub-tropical dry areas (Ashton, 2002; IPCC, 2013). Due to increasing seasonal flow, rain-dominated catchments had higher peak flows, lower low flows, and longer dry periods (Burket et al., 2001; IPCC, 2014). In addition, according to one prediction, 65% of Africans will be at risk of water stress and scarcity by 2025, up from 47% in 2000.

2. EMPIRICAL REVIEW

2.1. Climate Change on Water Scarcity

The water cycle is becoming more unpredictable due to global climate change, which concerns global sustainable development since it makes it harder to predict when water will be available and in demand (Adhikari, 2011; Denicola et al., 2015). The effects of rapid sea level rise, which take longer to materialize in coastal areas, directly endanger small, low-lying island states. As the demand for water for electricity, agriculture, manufacturing, and human use rises, especially in areas of the world where water scarcity already exists, more trade-offs are being made for this precious and scarce resource (UN-Water, 2019).

The effects of climate change on streamflow and water quality in freshwater ecosystems threaten the safety of drinking water even with routine treatment (Wada et al., 2016). According to Chavula and Turyasingura (2021), dangerous elements include increased warmth, higher sediment, fertilizer, and pollution loadings brought on by heavy rain, inadequate pollutant dilution during droughts, and treatment system interruption during floods. The following environmental processes are affected by climate change:

Evaporation: The rise in global temperature caused by climate change directly affects the demand for atmospheric water (potential evapotranspiration). The rate of evapotranspiration depends on the extent of terrestrial biophysical functionality and is a crucial component of the water cycle (Djebou and Singh, 2016). Warmer air can store more moisture than cooler air can. As the Earth heats, more water from the oceans, lakes, soil, and plants will be absorbed by the air. By causing drier conditions, this air may significantly impact agriculture and drinking water sources (Denicola, 2015). On the other hand, the warmer, wetter air may put human life in peril in some places by blocking the cooling effects of our perspiration.

Precipitation: When the highly warm, extremely moist air cools down, more rain or snow will fall. the earth's warming causing more rain and snowstorms to occur. Depending on the latitude band of the area where severe weather has increased the greatest in both intensity and frequency, different patterns can be noticed in the yearly precipitation scenarios (Yasmin, 2017). Thunderstorms, on the other hand, have arrived more frequently and have generated more precipitation. Some locations will get drier as the air temperature and movement change.

In the interim, it's likely to rain more heavily in the neighborhood. On the other hand, precipitation patterns' high level of unpredictability is likely to have an impact more frequently. For instance, climate change has been connected in recent years to the recurrence of typhoons in the Asia-Pacific region (Tu et al., 2009).

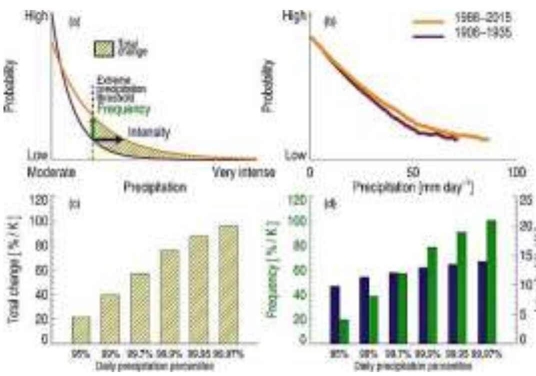


Figure 4: Precipitation frequencies and simulation. Scientific reports.

The impact of global mean surface temperatures on precipitation is therefore bigger than their influence on the intensity of exceptional precipitation, as is generally accepted. Figure 4 shows how both natural and man-made events, such as global warming, have a substantial impact on the global frequency of extreme precipitation and the event of rarity. Studies on the frequency of daily heavy precipitation bouts have been conducted in the interim (i.e. rainfall per unit time, temperature increase over time, increased rate in water vapor). Myhre et al. (2019) found that existing earth system model simulations of increases in the annual maximum precipitation intensity are largely compatible with observations while having low bias.

2.2. Impact of Climate Change on Groundwater

Due to changes in the precipitation system (annual precipitation concentrated in a few precipitation events) and deteriorating land cover, climate change has a considerable impact on groundwater recharging. Over short periods of time, unexpected discharge peaks and runoff spikes happen within regions (Sharma et at., 2015). Streams face a long-term issue with water availability since groundwater is not fully recharged. When groundwater is directly extracted for domestic, commercial, or agricultural uses, the issue becomes considerably worse. Groundwater can now be used to make up for a water shortage (Djebou and Singh, 2016). Sharma et al. (2015) predicted that under the high-end scenario, annual replenishable groundwater will decline by 4.6% and 17.8% in 2021 and 2051, respectively, based on temperature increases of 0.32^0 C and 1.28^0 C from the reference period. According to the low-end scenario, 0.6% and 2.4% improvements in recharge levels in 2021 and 2051, respectively, would occur from an increase in annual average precipitation of 1.6% and 6.4% from the reference period. In the worst-case scenario, due to the anticipated changes in climate factors (temperature and precipitation), groundwater availability will decline from 24 litres per capita per day (lpcd) presently to 23 lpcd by 2021 and 20 lpcd by 2051 (Lubembe et al., 2022).

2.3. Other Climate and Water-related Natural Disasters

The mid-continental regions are more likely to experience droughts while rising mean precipitation is expected to result in more intense precipitation events and flooding. Particularly in the subtropics, prolonged, relatively dry periods with higher evapotranspiration alternate with intense and severe episodic rainfall events with considerable runoff volumes (Lubembe et al., 2022). While this is going on, other complicated causes like urbanization, intensified agriculture, soil erosion, excessive groundwater extraction, and increased energy demand continue to pose a serious threat to freshwater systems all over the world (IPCC, 2014; Lubembe et al., 2022).

Climate change adds to the complexity of these interactions. Forcible migration has historically been greatly influenced by

disasters with abrupt or slow onset tied to the hydrological cycle (Breedlove, 2016; UN-Water, 2019). In water-stressed areas, climate change makes people and ecosystems more vulnerable to decreasing precipitation and more irregular rainfall (OECD, 2014; IPCC, 2014). Ocean warming, which accounts for the majority of the increase in energy stored in the climate system, accounted for more than 90% of the additional energy accumulated between 1971 and 2010 (high confidence interval). In 1971 and 2010, as well as most probably between the 1870s and 1971, the top ocean (0-700 m) warmed (IPCC, 2013; IPCC, 2014). Sea species are having a hard time surviving due to rising temperatures and rising acidity of water (Lubembe et al., 2022). In most cases, as the winter snowpack melts in the spring, it gradually provides freshwater to rivers, streams, and other waterways helping to replenish drinking water supplies. However, as the air warms, many places experience an increase in the rain rather than snowfall. As a result, less water is being stored as snowpacks for future consumption (Wada et al., 2016). Wildlife, winter tourism earnings, and flood management are negatively impacted by changes in the snowpack at a slower rate.

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Effects on Water Scarcity

Development health problems

Acidification of the water may be directly influenced by drought and other climate change-related issues (Whitehead et al., 2009). Furthermore, more frequent and hazardous extreme weather events may have an impact on runoff. This could cause soil erosion, affect the flow and dilution of pollutants, alter the shape of rivers, and affect the movement of sediments in rivers (Arakawa, 2017; UN, 2006). However, water-related diseases such as schistosomiasis, filariasis, trachoma, and helminthes can be prevented with access to safe drinking water and adequate sanitation; these factors are responsible for 1.6 million annual deaths globally.

Loss of agriculture production and productivity

Increased evapotranspiration would result in significantly higher precipitation levels, while precipitation events would become heavier and less frequent and rainfall patterns would change geographically (Chavula and Chilumpha, 2022). In areas where important food production and hunger are big concerns, addressing climate adaptation, particularly through water-related implications, is necessary to reduce long-term and short-term food security challenges (UN-Water, 2019). Irrigation uses over 70% of the freshwater that people use worldwide.

Conflicts between ethnic groups and between countries

Only 3% of the water on Earth is usable by humans, and the majority of it is inaccessible. However, due to poor management and inefficient use, as well as fast population growth and climate change, these problems have gotten worse. Unrest, instability, and violence can start or be made worse by a lack of water. The world is more stretched in some places than others. The Middle East will be among the regions most affected by water shortages in the next years.

However, 33 nations would have extremely severe water stress in 2040, with 14 of those unexpectedly occurring in the Middle East, while nine (9) states can only receive a maximum score of five. According to a World Resources Institute report, this is the case (5). Indian and Pakistani tensions, as well as the Israeli-Palestinian conflict, are transboundary water control stressors. Similar numbers of responses point to Syria's civil conflict to climate change, linking the start of hostilities to the country's protracted drought from 2006 to 2011. Although Egypt's leader is concerned that long-term climate change may disrupt the water flow due to water captured in the dam, the controversy over the enormous Renaissance project on the Blue Nile River is a major political issue that affects Egypt's ability to use water.

Figure 5: Dried upstream. Geographical.co.uk

3. Conclusion

It is preferable to either adapt to the new reality or alleviate its cause by reducing greenhouse gas emissions globally given that climate change is already a fact. Ecosystem restoration, water harvesting, soil and water conservation, biodiversity preservation, and other associated activities must be implemented as part of the steps to improve water retention. Introduce livestock and crop kinds that can survive significant climatic change as well. Water resources should be managed effectively, without squandering them, when interventions like irrigation are used. To use water sustainably, there must be robust national and international policies to mitigate the water shortage brought on by climate change.

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