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Climate Change Effects on the Rivers of Afghanistan

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ABSTRACT

This study examines the profound consequences of climate change in Afghanistan, notably the detrimental effects on water scarcity and river capacity. Urban areas, agriculture, livestock, health, industries, and the environment as a whole have been adversely impacted by these transformations. Climate-induced phenomena such as droughts, erratic rainfall patterns, floods, and other natural disasters have resulted in population migration and posed significant threats to human lives. The agricultural sector, in particular, has experienced substantial repercussions, leading to diminished productivity. The primary objective of this study is to assess the impact of climate change on Afghanistan's rivers, which are witnessing a persistent decline in their capacity, while proposing effective mitigation strategies. Through the generation of valuable insights, and raise awareness and foster proactive measures among the scientific community and policymakers to safeguard water resources.

Keywords: Climate change, Rivers of Afghanistan, River basin, Water capacity

INTRODUCTION

Climate change refers to alterations in average hydrometeorological conditions over time (Safi, 2015). The most significant climatic elements include air temperature, air pressure, humidity, wind, and precipitation. Studies shows globally climatic elements are shifting, with average temperatures rising by 0.1 to 0.5°C (Bonan, 2008). Afghanistan has experienced a steady increase in temperatures, leading to hotter weather conditions (Faqiri, 2009). This rise in temperature has negative impacts, including water scarcity and increased water costs. Water resources are diminishing, creating a growing demand for water in cities and potentially leading to migration and massive displacements (Safi, 2014).

Climatical condation of Afghanistan has faced successive changes, resulting in water scarcity and attenuations of its rivers capacity all across the country. Climate change has led to droughts, erratic rainfall, floods, and other disasters, causing migration and threatening lives (Safi, 2015). Particularly the agricultural sector has been particularly affected, leading to reduced output and land degradation.This study intended to evaluate The sesnsitivity and negative effects of climate change on the water capacity of Afghanistan's rivers; based on hydrometeorological data and propose strategies to reduce them and to assess how much Afghanistan's rivers and water resources are affected by climate change. By providing insightful information to the scientific community, legislators, and regulators, this study seeks to increase awareness and encourage proactive efforts to conserve water resources. This study fills a part of the information gap and highlights the pressing challenges of climate and water resources (Rashtin, 2018; Faqiri, 2009; Safi, 2014).

MATERIALS AND METHODS

This study used reliable hydrometrological data sources like the Ministry of Water and Energy of Islamic Emarat of Afghanistan (MWEEA) and the Afghanistan National Aviation Office (ANAO).Time dependent statisticala averageing and trend analyzies is used to generate informative graphic moduls, providing valuable insights and recommendations for further climate anlysis. ArcGIS and originPro softwears are used for this regards.

RESULTS

The Climate of Afghanistan

Afghanistan's climate is diverse, with predominant climates including desert, steppe, Mediterranean, monsoon, alpine tundra, and mountainous/highland. Desert climates are prevalent in southwestern regions like Gerashk, Bakwa Desert, Margo Desert, Khashrud Dasht, and Sistan, with hot temperatures and low precipitation. Steppe climates are found in areas like Kandahar, Chaman, Herat and northern desert, at elevations ranging from 1000 to 2500 m. It is adjacent to the desert climate areas and experiences variable and harsh weather conditions. Temperature fluctuations of more than 20°C between day and night and significant variations of 30 to 50°C throughout the year are common. Rainfall predominantly occurs in winter, averaging between 250 and 300 mm/year (Faqiri, 2009; Nusrati, 2018). The Mediterranean climate is predominant in the eastern regions of Afghanistan, such as Nangarhar, Kunar, and Laghman. Summers are hot and dry, while the majority of rainfall occurs in the winter season. The average summer temperature exceeds 22°C, and annual precipitation surpasses 25 mm, with peak rainfall measuring around 35-40 mm. The monsoon climate is mainly observed in the southeastern regions, including Khost, Nangarhar, Laghman, Kunar, and Nuristan. Summer cyclones originating in the Indian Ocean bring significant rainfall to these areas, followed by a dry season. Heavy rains and floods can occur in certain areas. Humidity levels in these regions typically range from 80-99%, and the average annual rainfall ranges from 460 to 680 mm. The alpine tundra climate is primarily found in areas situated at altitudes ranging from 2,500 to 3,000 m above sea level (**Figure 1)**. Afghanistan's mountainous and highland areas, above 3,000 m, experience extreme cold winters and mild summers, with snowfall, low temperatures, higher humidity, and increased precipitation. Plains exposed to sunlight have milder conditions, while mountainous plains shielded from direct sun exposure experience colder weather.

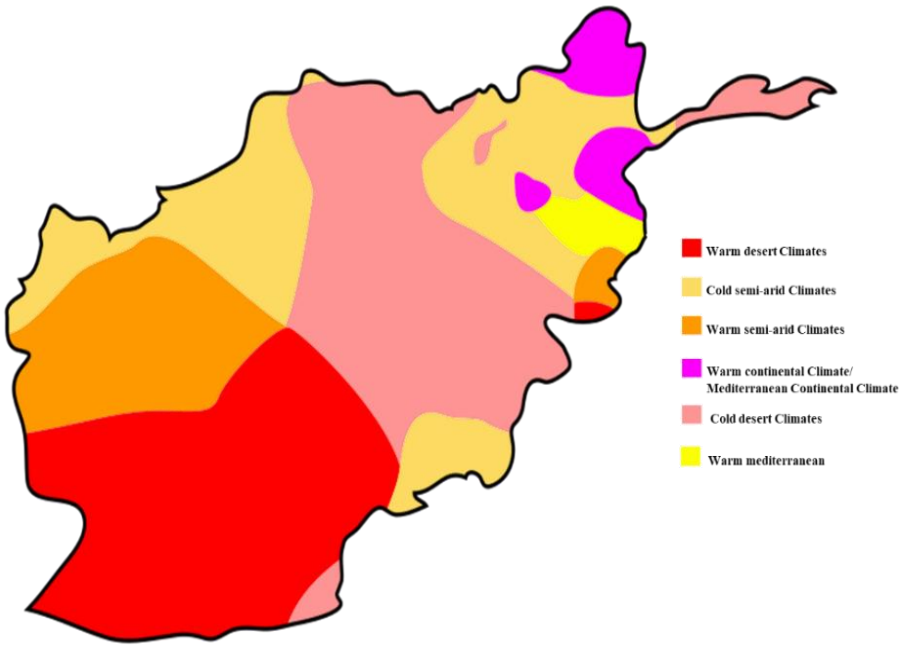

Figure 1. Climate of Afghanistan according Köppen Classification (Beck et al., 2018)

Afghanistan's River Basins

Afghanistan has five major river basins including; Amu, North, Harirod Marghab, Helmand, and Kabul covers 14%, 11%, 12%, 41% ,36% percent of country area respectively. These basins contribute varying percentages to the country's water resources, agricultural land, and population (**Figure 2)**. The Kabul basin, in particular, is significant, covering 36% of the river basins, with a population density of 90 people per square kilometer and an estimated annual discharge of 19.25 billion m^3 (Faqiri, 2009; Rashtin, 2018).

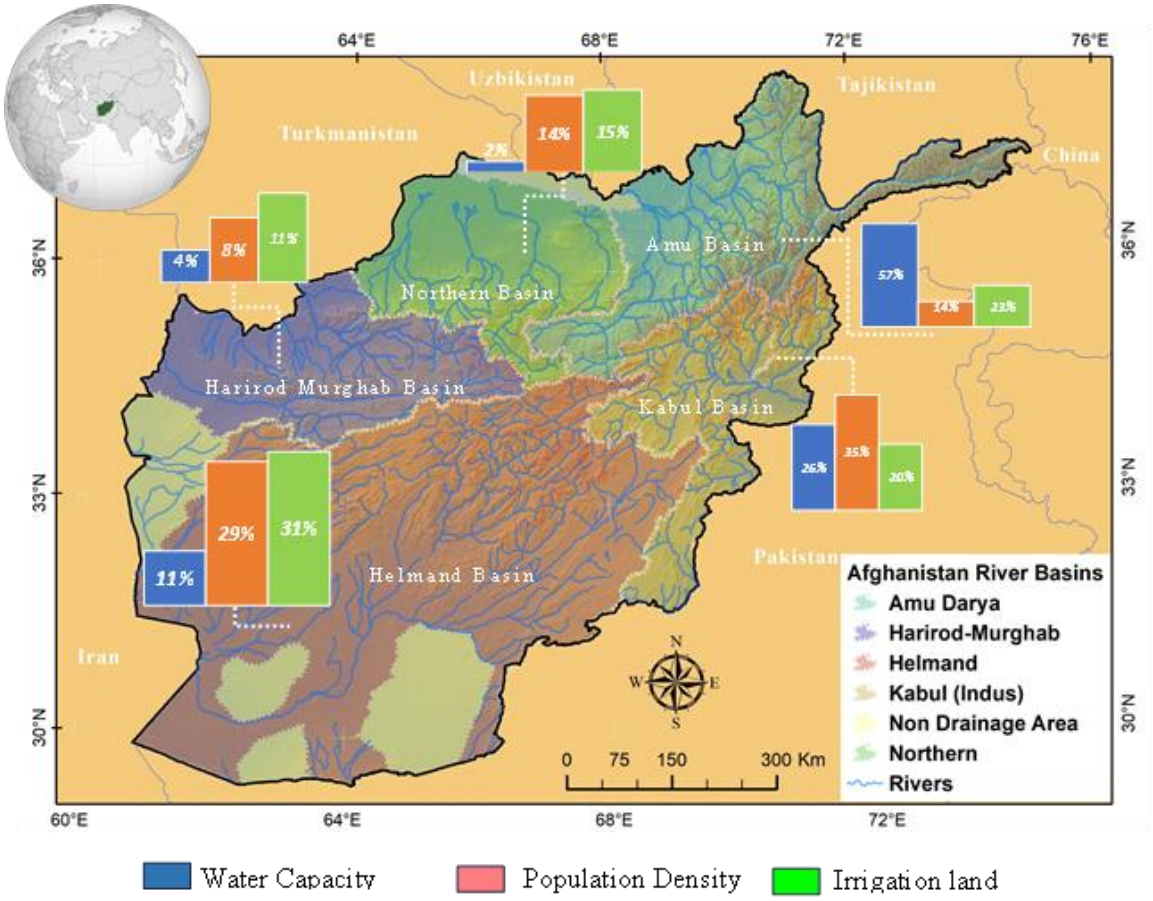

Figure 2. Afghanistan rivers pattern, their adjacent basis and natural capacities (Safi, 2013).

Water Assessment of Afghanistan's Rivers

Afghanistan is home to major river basins like Amu, Kabul, Helmand, Harirud, and North, which are formed by multiple rivers. These basins have the highest water resources and have experienced significant population growth in the surrounding areas. The Kabul, Helmand, Amu, North, and Harirud river basins have witnessed the highest population growth rates. The Helmand, Amo, Kabul, Northern, and Harirud river basins are home to significant agricultural areas, but recent decades have seen a decline in water capacity in Afghanistan, despite the country's historically abundant water levels (**Figure 3)**. Climate change and inappropriate water management practices are causing water levels to decline in Afghanistan's hydrological stations, including Fuladi, Doab, Sangnawishta, Naghlu, Klokh Tapa, Khawaja Ghar, Khawabgah, Dakah, Khoshe, and Gulbahar. Afghanistan faces significant environmental, economic, political, and social challenges due to its sixth-ranking vulnerability to climate change and global warming. Effective water management strategies and climate adaptation are crucial to protect water resources and mitigate these challenges. (MWE,1965-2016).

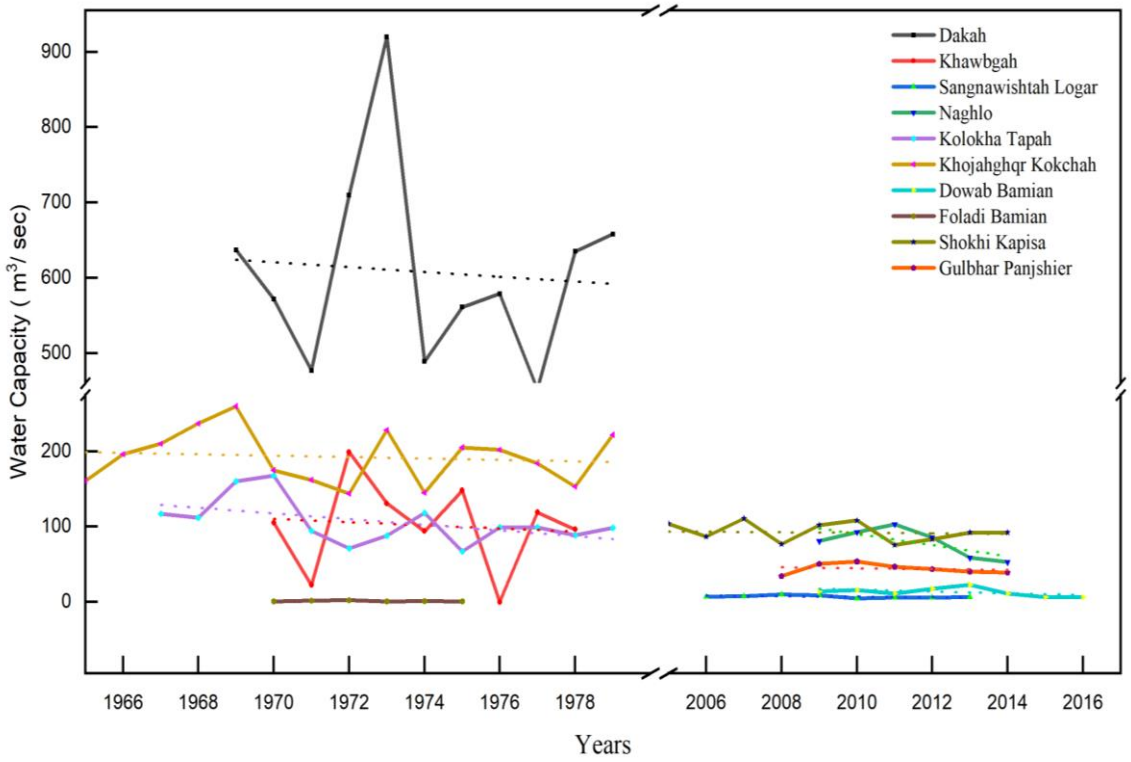

Figure 3. Average annual discharge capacity of Afghanistan's main rivers (MWE, 1965-2016).

DISCUSSION

Afghanistan is facing numerous natural disasters due to climate change and global warming, including droughts, rising temperatures, reduced rainfall, river's water capacity depletion, shifts in rainfall patterns, severe storms, vegetation loss, desertification, arid land development, declining groundwater levels, and population migration, causing significant economic ramifications across its regions, particularly in terms of flooding. The United Nations Development Program reports that floods in Afghanistan result in 4.3 deaths per 1000 people, making it the second-highest country in terms of flood-related fatalities (NEA, 2015). Flash floods, caused by heavy rainfall, are a significant issue in Afghanistan, causing significant damage to the economy and individuals. Hail and snow also contribute to these floods. Since 1960, Afghanistan has experienced frequent droughts, causing extensive destruction of crops and livestock, affecting millions of people and animals. For example, data published by the National Environmental Protection Agency reveals that the drought in 2008 resulted in a 3-5-million-ton decrease in agricultural production compared to previous years, leading to a 100% increase in the prices of agricultural products, especially wheat and corn. Conversely, there was a 40-70% decrease in animal prices, as farmers sold their livestock at significantly reduced rates due to food shortages (NEA, 2015). The decline in rainfall in Afghanistan has led to significant climatic challenges, including land degradation, deforestation, and desertification, largely due to global climate change (Safi, 2014; Safi, 2013). With increasing temperatures, the demand for water rises in all aspects of life. Snow and glaciers are melting earlier, leading first to floods and then water shortages (Safi, 2013; Safi, 2018). Figure 3 shows a decreased discharge capacity in Afghanistan's rivers, including the Bamiyan, Panjshir, Kapisa, Kabul, Logar, Helmand, Kunar, Kunduz, and Badakhshan rivers, due to the unfair use of water resources. This has resulted in water shortages in many cities and surrounding areas, highlighting the country's water scarcity. The country must prioritize precise water resource management, particularly groundwater, to avoid environmental problems and ensure the well-being of future generations, as neglecting this issue could lead to significant environmental damage.

CONCLUSION

Water resource management is crucial for Afghanistan due to its diverse climate conditions. However, global warming and climate change have led to decreasing river capacities, leading to rising temperatures and droughts in mountainous regions. Small rivers have run dry, while large rivers face significant water shortages. This has resulted in financial and personal losses for residents, forcing migration and causing floods to damage lives. Therefore, water resource management is essential for Afghanistan's survival.

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