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CLIMATE CHANGE AND WATER CRISIS IN AFGHANISTAN

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ABSTRACT

Though the negative impacts of climate change on water resources have become a severe social, economic, and environmental problem worldwide, especially in the arid regions of the earth, including Afghanistan, an inclusive and or conclusive review of diverse studies regarding the climate change and root causes of the water crisis in Afghanistan have not been carried out yet. This study analyses the negative impacts of climate change on water including the fundamental causes of the water crisis in Afghanistan, using analytical and descriptive approaches to review the related literature. The findings of this study show that although there is a strong relationship between climate change and water shortages, it can be a secondary factor in the case of Afghanistan. This is because the available surface water in Afghanistan is estimated to be about 50 percent higher than the country's water needs. In addition, the main factors involved in Afghanistan's water crisis are discussed in this study; factors that have not only caused the flow of about 67% of Afghanistan's surface waters to neighboring countries but also caused the wastage of about 40% of its surface water during irrigation. In addition, limitations and recommendations for further studies are also presented. The result of this study would create a clear insight for researchers and policymakers to regulate and manage the ever-increasing water crisis conditions sustainably in Afghanistan and similar contexts.

INTRODUCTION

The negative impacts of climate changes on freshwater resources caused severe water shortages in Afghanistan, a mountainous country with a desert or desert-steppe climate (World Bank, 2018a). The destructive consequences of climate change in Afghanistan can be studied more precisely based on its annual rainfall distribution, as more than fifty percent of the country has 100 to 300 mm of annual rainfall. The remaining parts, which include the high areas of more than 2000 meters, receive about 300 to 800 mm of annual rainfall (Saffi & Kohistani, 2013). For this reason, small climatic changes leave the worst negative impacts on water resources in Afghanistan.

The accuracy of ever-increasing climate changes, on the one hand, results in consecutive droughts and water shortages in the country, and on the other hand, causes heavy rains and destructive floods that threaten our society that already live in disastrous socio-economic conditions. In Afghanistan, severe drought is generally equivalent to two consecutive years of low winter rainfall, occurring at least once every 10 to 15 years (Favre & Kamal, 2004). Unfortunately, due to recent civil wars and political instabilities in the country, there is no accurate hydrometeorological data available in Afghanistan. However, the available climate trends data from neighboring countries show that the average annual temperature in Afghanistan increased by 0.6 degrees Celsius between 1960 and 2008. As a result, there has been a change in the amount of rainfall and snowfall, which are a fundamental sources of water resources in Afghanistan (World Bank, 2018b). The extent of glaciers in the mountains of Afghanistan has also decreased by nearly 40% during the last 40 years (Hagen & Teufert, 2009). Reriverrchs continues to show that the loss of life and displacement caused as a result of climate

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change (floods and rainfall events) in this country has increased between 10 and 25 percent in the last 30 years (Oskorouchi & Sousa-Poza, 2021). For example, in 2017 alone, climatic events affected the food security situation of 7.8 million people (FAO et al., 2018), while the average annual damage caused by floods is estimated to be around 54 million dollars. This figure increases to more than 500 million dollars in the occurrence of a large flood (Atlas of Risks). It shows that the negative impacts of climate change, whether it is drought or heavy rains that cause destructive floods, make our people more prone to socio-economic crises.

Meanwhile, Afghanistan needs sufficient water to develop agricultural, industrial, and electrical energy production sectors. So, under the ever-increasing impacts of climate change, all kinds of such developments would remain a dream for this country. Relevant studies also show that global water consumption has increased by approximately 300% since the 1950s, approximately 90% of it is used in agriculture (Pan, Wang, Bao, Chen, Akmalov, & Van de Voorde, 2023), and Afghanistan would also follow this trend.

Thus, this study aims to investigate the negative impacts of climate change in terms of water crises in Afghanistan to find out the root causes of water shortage in this country due to the periodically severe water shortage problems (GAO, 2014; Ward et al., 2013), Afghanistan faces destructive social and environmental hazards including deforestation, unsustainable land use, desertification (a drought has put about 2.3 of the country's area at risk of desertification) which leads to poverty, insecurity and migration crisis (Yıldız, 2017; Parthemore & Rogers, 2010).

Finally, keeping in mind the goals of this study's findings summarized in a logical order, it is expected that such studies will create a scientific discussion and a kind of discourse about water problems in Afghanistan so that we can develop a sustainable economic, social and political development in the country by managing, exploiting and saving water resources under different climate change scenarios.

LITERATURE REVIEW

Climate change and drought as, the foundamental causes of water resource problems have been broadly researched globally in recent years. Global warming has caused disturbances in the humidity and rainfall regime and has caused ever-increasing droughts in arid and semi-arid areas such as Afghanistan. In addition, studies on climate change scenarios also shown increasing floods (Whitehead, Wilby, Battarbee, Kernan, & Wade. 2009) in turn threaten climatic-prone areas encluding Afghanistan. In a related paper, Abu-Zeid and Shiklomanov (2003) examine water resource challenges in the 21st century and find that "even relatively small changes in temperature and precipitation can cause significant changes in water resources in regions with insufficient moisture. The flow of the rivers in arid and semi-arid areas is strongly dependent on presence of humidity and rainfall and is very sensitive to climate changes. If an increase in temperature of 1-2 degrees Celsius and a decrease of less than 10% of rainfall can reduce the flow of river water in the mentioned areas by 40-60%" (Hesse, Krysanova, Stefanova, Bielecka, & Domnin, 2015), and in general, negatively impacts quantity and quality of the river flows.

In addition, the study of climate change by GIS in Iraq indicates a severe shortage of water resources and its negative socio-economic impacts that led to internal displacement crises for the local community (Ethaib, Zubaidi, & Al-Ansari, 2022). Because water scarcity issues are strongly related to agriculture, food production, and people's livelihoods, global warming would cause a decrease in water availability in semi-arid areas where the large agricultural area is found, which needs relatively more water for agriculture practices (Kanae, 2009). Water scarcity affects 1 to 2 billion people worldwide, and most of them live in arid regions (Stringer, Mirzabaev, Benjaminsen, Harris, Jafari, Lissner, & Tirado-von Der Pahlen. 2021)

In other similar studies, impacts of climate change on water have been well clarified (Estrela, Pérez-Martin, & Vargas, 2012; Biswas, Sharma, & Gyasi-Agyei, 2022; Mapani, Shikangalah, & Mwetulundila, 2023; Omotoso, Letsoalo, Olagunju, Tshwene, & Omotayo, 2023), and their findings show that, especially the areas that are currently facing water shortages will face severe water crises as a result of climate change in upcoming decades. Darwin (1995) has raised the possibility that agriculture will be affected due to global warming and changes in the rainfall pattern during the next century. The vulnerability of the agriculture sector, which consumes the most water, has been well documented in a study by Gujja et al. (2015).

Specifically, other findings show that as a result of climate change, arid and semi-arid Asian regions would face more severe water crises; among these, Afghanistan's water resource affected due to a decrease in precipitation and humidity and subsequently melting of the glaciers in the coming years (Hayat & Elçi, 2017). Consequently, water scarcity, agriculture, and resource management problems will be worsening (Aich et al., 2017).

Research shows that changes in the amount and quality of water resources in Afghanistan are more related to the effects of climate change (Mehrad, 2020). As World Bank showed, Afghanistan is highly exposed to hydro-metrological events and ranked second among low-income countries in the case of casualties from natural disasters such as drought and floods between 1980 and 2015 (World Bank, 2018b).

According to World Food Organization (WFP), the direct and tangible result of climate change in Afghanistan is frequent droughts, which reduced water resources, desertification, and land degradation (Savage et al., 2009). Also, other available information indicates that Afghanistan is currently witnessing a significant increase in temperature and less rainfall (Shokory, Schaefli, & Lane, 2023; Rafiullah, 2018; Mehrad, 2020)

Brown (2019) indicates that "many Afghans are more vulnerable to the impacts of climate change due to their exposure to drought, floods and other natural disasters and decades of instability, as well as their reliance on climate-sensitive livelihoods such as agriculture and livestock."

Sidiqi et al. (2018) found that "the average annual temperature of the Kabul River basin may increase by 1.8°C, 3.5°C, and 4.8°C in the 2020s, 2050s, and 2080s, respectively", which makes drought and lack of water resources in this

area more likely. A preliminary study estimated that for a one degree selcius increase in mean annual air temperature, the amount of glacial meltwater in Afghanistan's rivers would likely decrease by 14% (Lebedova 1997).

The Afghanistan Public Policy Research Organization show that "Afghanistan exposed to a decrease in crop production due to the melting and retreat of natural glaciers, floods, droughts, irregular rainfall, and other effects of climate change" (Parto, 2014). According to Afghanistan's water sector strategy, severe floods and droughts may occur in the country in the coming decades, which would cause social and environmental disasters (Hayat & Elçi, 2017). Finally, drought caused by reduced rainfall is the worsed climate risk for Afghanistan's livelihood (Akhtar & Shah, 2020; Khalily, 2022) and needs to manage and cope properly as soon as possible.

MATERIALS AND METHODS

Recently, climate change and its adverse impacts have become a foundamental problems of economic, social, and even political development. For this reason, the study of the negative empacts of climate change on water resources is a priority to be researched, particularly in arid regions like Afghanistan. In this article, we reviewed the relevant literature utilizing Science Direct - Elsevier Journals, Springer Nature, and Google Scholar databases using the research terms climate change, negative impacts of climate change on water resource, water crisis in the arid region, water crisis in Afghanistan, adverse impacts of climate change on water resource in Afghanistan. The reference list of each article, was also searched for additional articles. We obtained more than 50 articles from 2018 to 2021 through these search engines.

DISCUSSIONS

Afghanistan's climate has arid characteristics (World Bank, 2018a), with a large amount of precipitation in the form of winter snow. Spatial and temporal changes in temperature are also high. For example, "in winter, the temperature in the Hindu Kush mountains reaches minus 50 degrees Celsius, while in the summer, the temperature rises to more than 50 degrees Celsius in the desert areas, especially in the Margo plain" (Hayat & Elçi, 2017).

Increasing temperature in Afghanistan leads to severe drought and water shortages, which affects our society in every way. In this country, a severe drought is generally equivalent to two consecutive years of low winter rainfall, occurring at least once every 10 to 15 years (Favre & Kamal, 2004). The findings show that in the last five decades' droughts have occurred in Afghanistan every three years. The latest consecutive years that drought occurred in this country was 1964-1963, 1967-1966, 1970-1972, 1999-2001, and also in 2002 (in the south of the country) and the 2011 drought (Favre & Kamal, 2004), among which the 2011 drought was the worst that affected more than 2.6 million people in more than 14 provinces of the country (Hayat & Elçi, 2017) and currently Afghanistan is also struggling with ever increasing drought.

The people of Afghanistan, having experienced four consecutive years of severe drought from 1998 to 2001, are more worried about the possible negative consequences of climate change in this country (Hayat & Elçi, 2017). Because nearly 70% of Afghan farmers lost their livestock during the drought periods, especially at the end of the 2000 drought, the number of domestic animals had decreased by more than 50%, as "the drought affects food production, transportation, and labor. The majority of farmers forced, to migrate to urban areas and abroad" (Watkins & Development Programme United Nations. 2006). The severity of the drought in Afghanistan can also be assessed regarding the decrease in cereal production: "During periods of drought, Cereal production shows a decrease of 40 to 55 percent compared to an average year. Most importantly, Lalami agriculture has suffered the most and shows a decrease of more than 80%" (Watkins & Development Programme United Nations, 2006). The effects of climate events on people's lives are tangeble in dayly live. The drought has led to the widening gap between the capitalist class and the poor class in society.

More specific explanations of the different aspects of climate change in Afghanistan and the relevant issues are summarized in the following order.

Change in temperature

Spatial and temporal changes in temperature are one of the distinctive characteristics of a dry climate like Afghanistan, which is more prone to climate change. For example, in the Hindu Kush regions, the temperature reaches minus 50 degrees Celsius during winter. In the summer, it increases to more than 50 degrees Celsius in the desert areas, especially in the Margo Plain in the southwestern part of Afghanistan (Hayat & Elçi, 2017). Despite the lack of adequate and long-term climate data records in Afghanistan, available data from neighboring countries show that the average annual temperature of the country increased by about 0.6 degrees Celsius between 1960 and 2008, with an average rate of 0.13 degrees Celsius per decade. As a result, there has been a decrease in the amount of rainfall and snow as the fundamental source of water in this country (World Bank, 2018b).

The increase in temperature since 1960 in arid and semi-arid countries such as Afghanistan has led to consecutive droughts, an increase in dry land, and agricultural vulnerability. Research shows that "Afghanistan's average annual temperature has increased by 1.8 degrees Celsius since 1950, with the highest temperature increase in the southern plateau (2.4 degrees Celsius), followed by the northern regions (1.7 degrees Celsius), the central highlands, and the Hindu Kush mountains (1.6 degrees Celsius) and the eastern region is 0.7℗" (Shokory, Schaefli, & Lane, 2023). Accepted climate change scenarios show that the average annual temperature in Afghanistan may increase between 1.4 and 4°C by the 2060s and between 2 and 6.2°C by the 2090s (Figure 1), and spring and summer seasons of the country will uniformly experience the fastest warming rate (Savage et al., 2009).

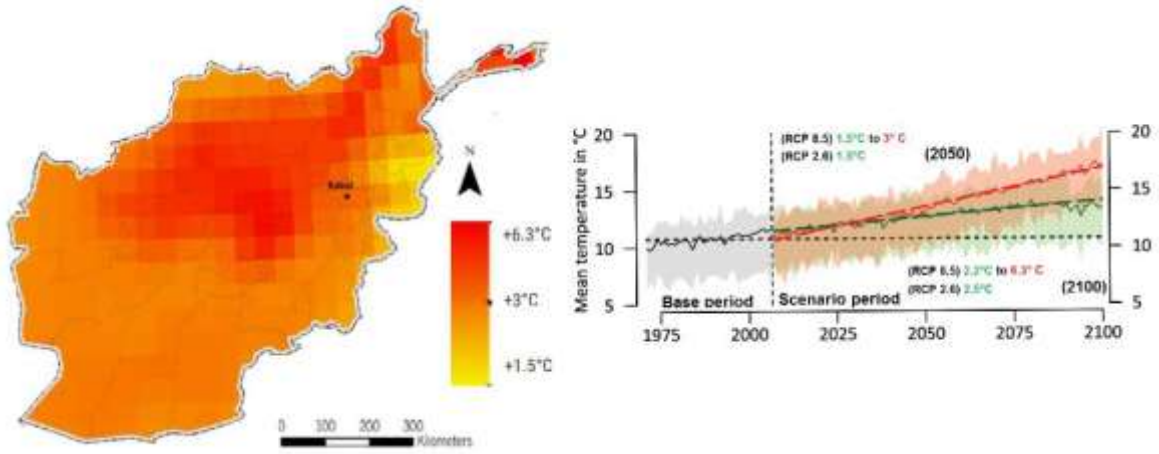

Figure 1. Represents the projected increase in temperature of different regions of Afghanistan
Source: Shokory, Schaefli, and Lane (2023)

Recent studies show that increasing the temperature in spring and summer is very fast, while this is alarming in the north and central regions of Afghanistan (Savage et al., 2009). In addition, the World Bank also indicates that due to temperature changes, hot days and nights will increase in all seasons of the year. This trend may continue in the future, and the frequency of hot days and nights will increase in the middle and late parts of the 21st century, and the entire country will be affected (World Bank, 2018a).

Finally, all projections show an increase in day and night temperatures, particularly in the summer season. It would be warmer relative to the current climate. Of course, until the 2030s, the increase in temperature in this country will not be very noticeable. Studies estimate that the average annual temperature will increase until the 2060s compared to the average of 1999-1970, and this trend will continue.

Changes in humidity and rainfall

Changes in humidity and rainfall are more hazardous impacts on water resources in Afghanistan. Studies show that "The annual distribution of rainfall (Figure 2) in Afghanistan shows the picture of a dry country, where more than half of the country has 100-300 mm of annual rainfall. About 50% of the remaining area of the country, which includes high areas of more than 2000 meters, receives about 300 to 800 mm of rain per year. Also, about 50% of the precipitation in this country occurs in winter (January to March), most of which is in the form of snow, about 30% is mostly in spring (April to June), and the remaining 20% in it occurs in summer and autumn" (Saffi & Kohistani, 2013). The Food and Agriculture Organization (FAO) found in (1996) states that the average amount of water obtained from melting snow in Afghanistan is about 150,000 million cubic meters and from rainfall about 30,000, and the amount of total rainfall in the country is calculated in the range of 180,000 million cubic meters (Qureshi, 2002).

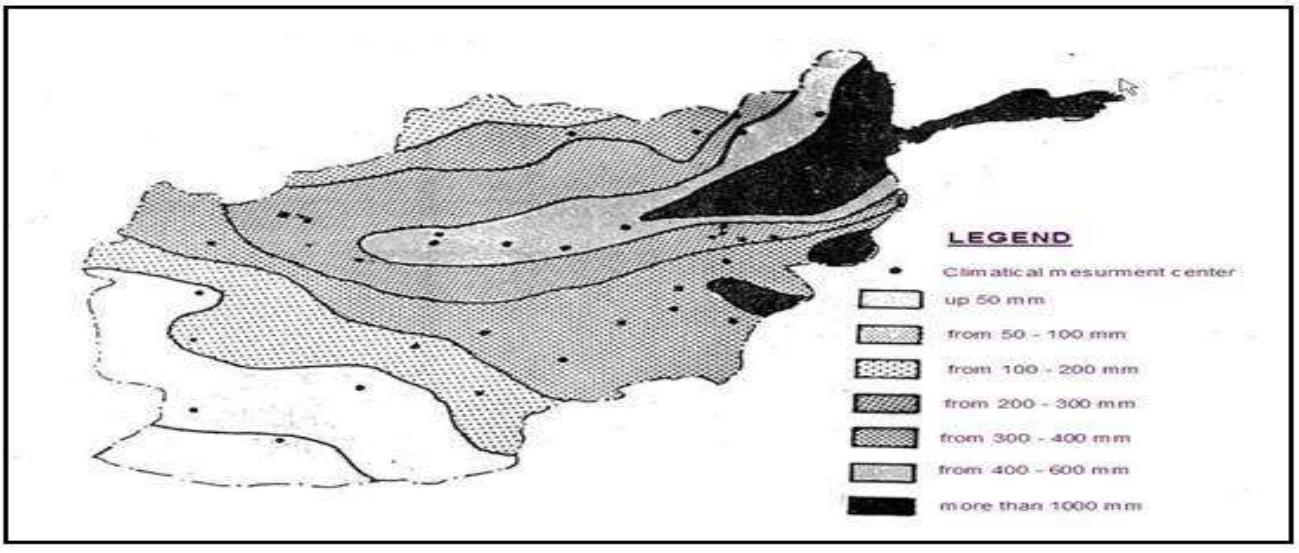

Figure 2. Shows the average annual rainfall in Afghanistan
Source: Saffi and Kohistani (2013)

On the other hand, water distribution in Afghanistan is unequal in various ways. For example, the average rainfall in Afghanistan is between 250 and 310 mm, about one-third of the average rainfall in the world (Fahim, 2016). In the short term, rainfall in Afghanistan would increase slightly, an average of more than 10 to 20 mm. However, the average annual

rainfall changes in the 2090s show that conditions will become drier in most parts of Afghanistan (Figure 3). Because rainfall in the country will decrease from 10 to 40 mm on average, the winters will be significantly drier in the southern parts of the country (Hayat & Elçi, 2017). Study shows that "Projection of annual rainfall in Afghanistan vary greatly across the country (figure 3), decreasing by 12 to 25 mm by 2050 and by 15 to 50 mm by 2100. Also, the southeastern regions' winters in the past five decades have become drier due to high evaporation, and this trend is expected to continue. The Pamir and Wakhan glaciers, as the source of rivers in northern Afghanistan, have shrunk by 18 percent by 2019 and are projected to decline by 18 percent by 2019, respectively. 2050 by 15.9% and in 2100 by 27.3%".

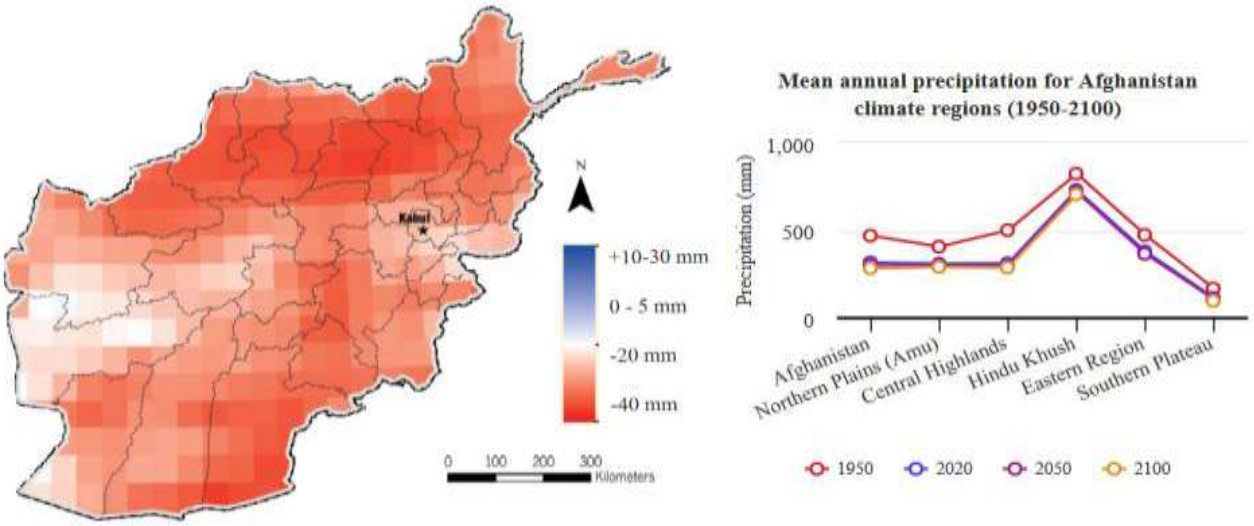

Figure 3. Project the change in Afghanistan precipitation pattern under different scenarios.
Source: Shokory, Schaefli, and Lane (2023)

The analysis of precipitation trends in Afghanistan from 1950 to 2019 shows the occurrence of heavy precipitation in the spring and winter seasons. January, February, and March had the most rainfall, while September and July had the least. At the same time, in the spring, the precipitation significantly decreased by 32% but remained unchanged in the winter. Since 1950, rainfall in Afghanistan decreased significantly, and this trend will continue in upcoming years (Shokory, Schaefli, & Lane, 2023).

Evapotranspiration

The annual evaporation and transpiration rate in the Hindu Kush highlands is relatively low (about 1,000-1,300 mm) because of long winters. But in the relatively flat areas of the north, it varies between 1300 and 1500 mm, and in the plains of the south and southwest of the country, it reaches 1800 mm. However, summer evaporation and transpiration rates are high everywhere, with a daily peak of 6-8 mm in July/August. Due to the strong wind, especially in Mazar-i-Sharif and Herat (120-day Herat wind), the maximum amount of daily evaporation and transpiration is 9 mm and 10 mm, respectively (Mahmoodi, 2008). In general, with the increase in temperature and decrease in rainfall in the country, the annual rate of evaporation and transpiration in Afghanistan will increase. Also it will cause severe problems to the country's agriculture and vegetation.

Negative impacts of climate change on water resources in Afghanistan

Although Afghanistan is located in a dry region, it is still relatively rich in water resources due to high mountain ranges such as Wakhan, Hindu Kush, and Baba, which covered with snow and glacier deposits. The origin of more than 80% of the country's water resource formed by the Hindu Kush mountain range and altitudes above 2000 meters, and it creates a permanent flow in all rivers by melting snow during the summer (Mahmoodi, 2008). Water resources in this country flow into five river basins: Amu, North, Harirud-Morghab, Helmand, and Kabul. Recent estimates indicate that the country's annual water resource capacity is about 75 billion cubic meters, of which 57 billion cubic meters are surface water and 18 billion cubic meters are underground water (Mahmoodi, 2008).

The annual volume of water resources used for irrigation is estimated at 20 billion cubic meters, which forms 99% of the total water consumption in the country. The total amount of groundwater extraction is estimated at 3 billion cubic meters. About 15% of the total volume of water used annually is underground water, and approximately 85% of it is water from rivers and streams (Watkins & Development Programme United Nations, 2006).

This country has access to more than 2,300 cubic meters of water per capita per year to surface water, which is 50% higher than the amount required for a country, theoretically, enough water to meet its domestic, agricultural, energy, industrial and environmental needs (Thomas, Azizi, & Behzad, 2016). Afghanistan is the source of many rivers, and its geography provides significant opportunities to exploit these waters (Fahim, 2016; King & Sturtewagen, 2010). However, the ratio of various factors in this country can use about 33% of the 57 billion cubic meters of surface water available every year (Thomas et al., 2016).

Hydro-metrological surveys show that Afghanistan as a landlocked country has limited water resources. The average annual amount of rain is estimated at 222 mm, which is different in different parts of the country and is about one-third of the average rainfall in the world (Fahim, 2016). The annual amount of rain varies from 1222 millimeters in the high altitudes of the northeast to 112 millimeters in the southwest parts of the country (Ministry of Irrigation, Water Resources & Environment, 2004).

In addition, the water resources of this country also have a disproportionate distribution; The Amu River basin, including the Harirud and Marghab basins and other related areas, covers about 37% of Afghanistan's land but contains about 60% of the water flow. The Eastern Kabul River basin covers about 12% of the area of this country. It contains about 26% of the water flow, but the Helmand basin covers about 49% of the land of this country and only 11% of the water flow (King & Sturtewagen, 2010). Also, Afghanistan's water resources are highly dependent on rivers and unstable rain and snowfall. Glacier retreat and early snowmelt have effects on seasonal water availability. In addition, Afghanistan currently has the lowest water storage capacity per capita in the region (King & Sturtewagen, 2010). For example, when the country experienced a drought from 1999 to 2005. The majority of residents in villages with limited water resources were forced to abandon their land and move to larger cities (Yildiz, 2015).

Groundwater is an important source of drinking water for millions of citizens of this country. Traditionally, this resource is used in agriculture. About 16 to 22% of the total water needs in Afghanistan are provided through underground water sources, including springs, wells, and sinkholes. Currently, the lack of a comprehensive information system and extensive monitoring systems has caused the lack of management, monitoring, and healthy use of this resource in the country. A study in 1996 estimated the amount of underground water available at approximately 18 billion cubic meters throughout the country. However, recent studies in the river basins of Afghanistan have estimated it at 10.6 billion cubic meters. Water is extracted more than it is reabsorbed (Beekma & Fiddes, 2011). For example, underground water is extracted through deep and shallow wells, wells, and springs.

However, drought is not the only reason, why wells and wells are drying up. Recently, Afghans have begun drilling deep wells and extracting groundwater more widely to extract water for irrigation have resulted in lowering water levels and drying up by nearby shallow wells and karis (Beekma & Fiddes, 2011).

Climate change in Afghanistan hurts the pattern and amount of rainfall and will make the country's water resources more vulnerable. As a result, "this will hurt the hydrological cycle, affect agricultural productivity and change the pattern of cultivation in the highlands and lowlands, and also challenge access to water resources in general" (Akhtar & Shah, 2020).

Reduction of winter snowfall and the melting of natural glaciers hurt the probability of summer drought in the lowlands of Afghanistan. A preliminary study estimated that for a 1°C increase in mean annual air temperature, the amount of glacial meltwater in Afghanistan's rivers would likely decrease by 14%.

People's experiences show that, in the past decades, the country's climate has become warmer, and rain has become rarer and more unpredictable. UNEP and NEPA stated that "Drought occurs due to reduced rainfall, reduced river flow due to reduced spring snowmelt in the highlands, and the greatest climatic risks for Afghanistan's livelihood, as the predicted decrease in spring rainfall (March to May) for North, Central Highlands, and East have between 5 and 10% from 2006 to 2050" (Akhtar & Shah, 2020).

In 2016, the Department of Energy and Water reported an average 13 percent decline in river flow in five major river basins between 1980–1969 and 2007–2016, based on measured hydrologic data (Table 1; Bromand 2017). By 2030, all these reductions were expected to continue to strengthen. Bromand (2015) studied future flow changes in the Kabul River basin, focusing on the effects of climate change. The results show an average temperature increase of 2.9°C in 2064-2046. Kabul River basin will face a severe summer water shortage with a decrease of about 24% in water availability. It is caused by two processes. The first is an 18% increase in potential evapotranspiration. The second is the decrease in rainfall in spring and winter (Savage et al., 2009).

Therefore, warming with changes in precipitation has led to a sharp decrease in river discharge for snow basins in Afghanistan. Therefore, warming in combination with changes in precipitation has led to a sharp decrease in river discharge for snow basins in Afghanistan.

Table 1. Surface water volume in five Afghanistan river basins between 1969-1980 and 2007-2016. BCM: billion cubic metres.

River Basin	**Surface water volume in (CBM)**	**Surface water volume in (CBM)**	**Decrease in (%)**		
	(1969-1980)	(2007-2016)	(2007-2016)	Projected by 2030 (CBM)	Decrease by 2030 (%)
Kabul - RB	19.271	17.1	-11%	15.3	-21%
Panj-Amu – RB	21.5	18.7	-13%	16.2	-25%
Helmand - RB	10.4	8.4	-19%	7.1	-32%
H.Murghab - RB	3.4	2.53	-26%	1.7	-50%
North - RB	2.1	2.2	-5%	2	-5%
Total	57	49	-13%	42.3	-26%

Source: Shokory, Schaefli, and Lane (2023)

Climate change, on the other hand, causes the reduction of underground water (Shokory, Schaefli, & Lane, 2023). For example, according to the USGS report, the level of underground water in Kabul has decreased by an average of 1.5 meters per year from 2004 to 2012. Afghanistan's National Disaster Management Authority has warned that groundwater

reserves in Kabul will dry up in the next decade due to over-exploitation, requiring deepening or replacement (Akhtar & Shah, 2020).

One of the bitter facts is that due to Afghanistan's strategic location, it has recently become a political, strategic, and economic battlefield between empires that resulted in countless victims (Ahmadzai & McKinna, 2018). Among the other negative impacts of political instability in the last few decades, Afghanistan's water infrastructures, such as dams, water reservoirs, irrigation and water supply networks, water measurement and metrology stations, sewage disposal and sanitation systems, and water information collection and analysis systems has severely damaged and also it caused a reduction in the capacity, lack of management and healthy development of water resources and intensified the migration crisis (Fahim, 2016; Gleick & Iceland, 2018; GAO, 2014; Yildiz, 2015; King & Sturtewagen, 2010).

Studies show that the poor performance of the Afghan government in managing the country's water resources has weakened the economic and social situation of the people. As a result, a small natural disaster can cause huge losses to the people. For example, during periods of drought, crop production decreased by 40 to 55% compared to an average year, especially lalmi agriculture decreased by more than 80% (Beekma & Fiddes, 2011).

The study by the United States Department of Homeland Security shows that the transboundary situation of Afghanistan's rivers has caused several problems for the communities related to the shared river basin's domain. For example, Amu Darya (which includes the basin of the Panj Amu and northern Afghanistan) and Indus (which includes the Kabul river basin in the territory of Afghanistan) are highlighted and include these rivers. "Before 2040, the Indus Basin (i. e. Kabul River Basin in Afghanistan) will face chronic food insecurity and reduced resilience to floods and droughts due to poor water management, inefficient agricultural practices, soil salinization, and greater variability in water availability, while the Amu Darya River Basin is likely to face degraded food security, and increased regional tensions over water sharing before 2040 as a result of inadequate water sharing agreements, poor water quality and disrupted flows, as well as poor water management practices" (Akhtar & Shah, 2020).

Though studies confirm a strong relationship between climate change and water scarcity and water crisis, in the case of Afghanistan, the available water resource is theoretically much more than the current water needs of this country. In addition, drought as a consequence of climate change is somehow a natural process that occurs once every 10 to 15 years in Afghanistan. Therefore, considering climate change as the root cause of water shortage in Afghanistan can be only a claim. Because the available water in this country is more than 70 billion cubic meters (surface water 57 billion cubic meters and underground water more than 10 billion cubic meters) (Saffi & Kohistani, 2013). These figures show that the per capita water in this country is more than 50% higher than the water stress index. So, despite the effects of climate change, Afghanistan theoretically has enough water to meet its domestic, agricultural, energy, industrial, and environmental needs (Thomas & Warner, 2015).

This study descibes differnet aspects of effects of climate change on Afghanistan's water resources. As in most parts of Afghanistan, people currently faces severe water shortages. On the contrary, according to global standards, access to sufficient water, which is necessary to meet all domestic, agricultural, industrial, energy, and environmental needs, is calculated at about 1700 cubic meters per capita, but Afghanistan has about 2775 cubic meters of water per capita (Thomas & Warner, 2015). If so, why is there a water crisis in this country? The following highlights the nature of the water crisis in Afghanistan, which is becoming increasingly severe due to inequitable power relations, weak institutions, lack of capacity, and inadequate and unreliable infrastructure:

- Approximately 16.8 million people in Afghanistan drink unsafe water.
- Approximately 23 million people have inadequate access to improved toilets and waste disposal facilities.
- Increasing population growth rate means more competition for less per capita water
- Droughts and floods increasingly cause premature deaths, injuries, property destruction, food shortages, and lost incomes.
- The risk of national and international disputes over water resources is growing.
- Environmental degradation exacerbates water scarcity.
- People suffer more in terms of life, livelihood and well-being" (UNEP & NEPA, 2008)).
- Thus, in these regards, the first concern is the disproportionate distribution of water in Afghanistan (figure 4) (King & Sturtewagen, 2010) very year, most of the water-scarce river basins of this country face severe water shortages, and these problems multiply during drought.

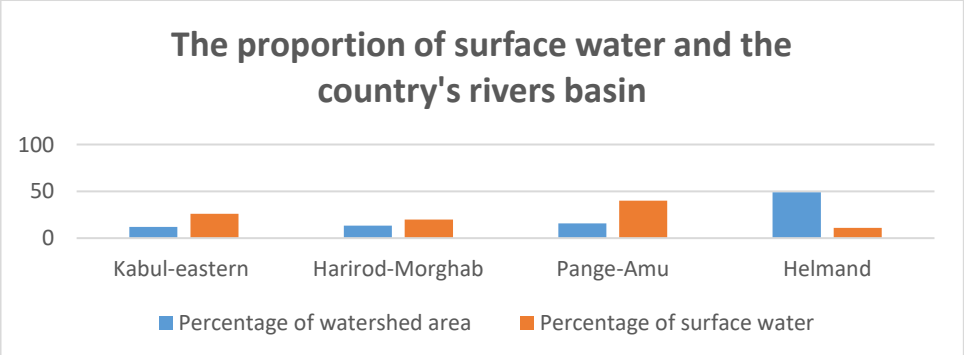

Figure 4. The proportion of surface water and the country's rivers basin
Source: Alim (2006)

The second problem, which is very fundamental, is the lack of sufficient water storage capacity (figure 5) at the national and local levels, which reduces the government's ability to store water during the rainy seasons and the melting of glaciers, and sometimes the abundance of water causes catastrophic floods in the country and bears huge loss of life and financial losses to the people of this country. In Afghanistan, in addition to the lack of water storage facilities, even the existing infrastructures are either destroyed or damaged, which causes unstable conditions (Thomas & Warner, 2015) and, according to the World Bank (2005), Afghanistan's water storage capacity is 140 cubic meters per capita, which is among the lowest countries in the world Figure (5).

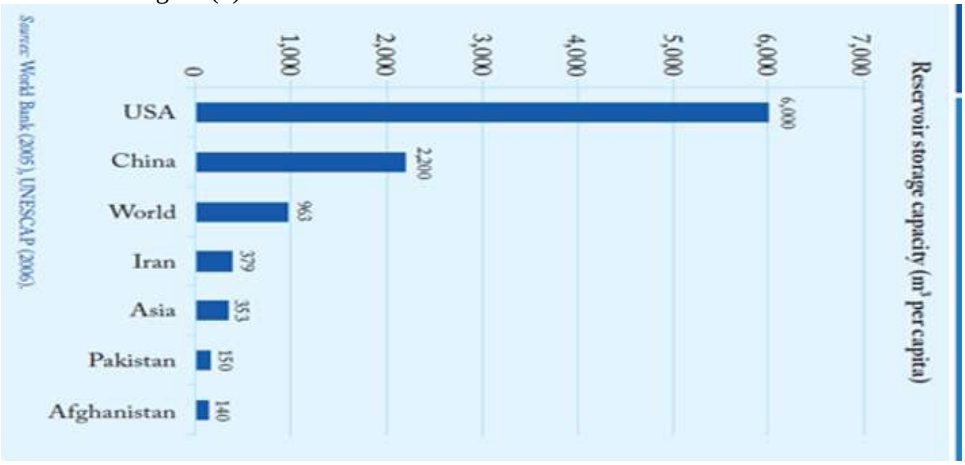

Figure 5. The water storage capacity of Afghanistan is among the lowest in the world
Source: Syedy (2011)

In addition, another problem that has caused the water crisis in Afghanistan is the problem of transboundary water management (90% of Afghanistan's surface water is shared with neighboring countries) (Thomas & Warner, 2015) and the hydro-political issues of this country (Ullah & Zulfiqar, 2017), which along with the permanent political instability and socio-economic problems, has made this country more prone against a small events including climate change, and thus, this country is only able to use about 33% of the 57 billion cubic meters of its surface water available every year (Thomas et al., 2016) and about 63% of Afghanistan's surface water goes to neighboring countries. About 40% of water is wasted during Irrigation (Beekma & Fiddes, 2011). However, in recent years, Afghanistan has started its efforts to manage water resources, control floods and droughts, and control transboundary waters of the country (Ahmadzai, 2016; Khan & Pervaz, 2014) but, infrastructural activities of Afghanistan to manage the transboundary water resources have caused the concern of neighboring countries, especially Iran and Pakistan, which may limit their current access to water (Mousazadeh & Abbaszadeh, 2016; Mokhtari et al., 2008; Hayat & Elçi, 2017), and therefore, they may continue by any means to prevent Afghanistan from effective and efficient management of its water resources.

This study was conducted based on the evidence and facts of Afghanistan's water resources, which still need more precise, comprehensive, and practical analysis in terms of precision and accuracy. As the available information up to date is more estimated than real, therefore this is recognized as one of the significant limitations of this study.

Finally, it is necessary to remind that those interested should investigate the various aspects of the water crisis and its evolved factors scientifically and practically, for example: (The role of climate change in the water problems of the country's river basins, the role of political instability in the management and conservation of water resources, the role of neighboring countries in Afghanistan's water resource management problems, Afghanistan's hydro political issues and solutions to water shortage problems in this country) so that we would be able to manage, use and preserve the country's water resources properly and witness the prosperity of our dear Afghanistan the regions and the world.

CONCLUSIONS

The main objective of this study was to analyze the impacts of climate change on Afghanistan's water resources, as well as other underlying factors, using descriptive and analitical methods to review related literature. It became clear in this study that the negative impacts of climate change on Afghanistan's water crisis are temporary and marginal. The fundamental causes of water crises in this country are first the disproportionate distribution of surface water in Afghanistan, which multiplies during drought. Secondly, insufficient water storage capacity at the national and local levels, and finally, mismanagement of transboundary water and hydro-political issues in the country, which, along with prolonged political and socio-economic instability, have made the people of this country vulnerable and defenseless against even the slightest problems including climate change. In addition, a lack of coordination among relevant institutions and ineffective policies, a lack of integrated water resource management, and development without considering scientific methods in the country have led Afghanistan to use only about 33% of its available surface water resources, and the remaining is being drained, into neighboring countries. In addition, about 40% of water is wasted during irrigation in Afghanistan. Finally, by enhancing the living standard of the ever-increasing population, their per capita water needs will increase comparatively. Thus, it is necessary to manage water crises at the national and regional level for sustainable development and to prevent hydropolitical tensions over water resources in the national and regional level.

As a result we suggest that interested researchers should investigate various aspects of the water crisis, including the role of climate change in the water crisis in the country, ways to construct water storage infrastructures at local and national levels, the role of political instability in managing and preserving water resources, the role of neighboring countries in managing water resources problems, hydro-political issues in Afghanistan

Finally, to cope with the water crisis in the Afghanistan, approaches such as integrated and cohesive water resource management, constructing water storage infrastructures at local and national levels, the use of scientific and innovative methods in designing and implementing water projects and using water-saving technologies (such as drip irrigation systems), developing water recycling technologies, and preserving groundwater and surface water resources as effective and efficien solutions in managing water resources in Afghanistan and other similar context.

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