

Article

Assessing the Resilience of Iraq's Climate Change Adaptation

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Abstract: This study investigates the resilience of Iraq's water sector to climate change, given the vulnerability of water resources to shifting weather patterns. Analyzing data from the National Center for Water Management, we examine annual and monthly variations in water supplies from the Tigris and Euphrates rivers. Results indicate significant fluctuations in annual income, ranging from 30 to 93 billion cubic meters, suggesting pronounced year-to-year variability. Moreover, disparities in river flow between the Tigris and Euphrates are observed, with implications for regional water availability. Temperature and precipitation trends in key cities—Mosul, Baghdad, Rutba, and Basra—are analyzed, revealing rising temperatures and declining precipitation across all regions. Notably, Mosul and Rutba experience lower temperatures but higher total precipitation compared to Baghdad and Basra. Despite these differences, overall precipitation is decreasing. With Iraq's population projected to grow by 1% annually, understanding the resilience of its water sector to climate change is critical for addressing future challenges in agriculture and food security. This study underscores the urgent need for adaptive strategies to mitigate the impacts of climate change on water resources in Iraq.

Keywords: Climate change, Adaptation, Resilience, Water resource, Iraq.

1. Introduction

The signs of climate change, like increasing temperatures and altered precipitation patterns, have made it clear that this is more than just a theoretical concern; as a result, scientists have introduced the idea of adaptation to climate change as a means to mitigate its impacts. Concerning these shifts, adaptation is characterized as the reaction of any system—natural or otherwise—to current and future climate stimuli, including changes in these stimuli.(1) The term "adaptation" can also mean taking action to mitigate the potentially harmful consequences of climate change.(2) Ever since the term adaptation was introduced, several ideas have been linked to it. One of these is resilience, which is the capacity of a system to resist remain its characteristics unchanged when faced with outside influences, in this case, climate change.(3) To ensure the continued sustainability of the food basket, adaption strategies in agriculture are seen as levels that start with the farmer's duty for growing his land to produce crops that can resist severe weather. After this, it's the duty of the local authorities to hear the farmers out and provide them with direction on how to address their issues. Extreme weather conditions that pose a threat to agriculture. To better service this industry, we must also pay attention to technology tools that are suitable for the intended goal.(4) When trying to predict how climate change will play out, one crucial factor is the availability and sustainability of water supplies in amounts sufficient to support human demands. Thus, water resources play a significant part in addressing the climate change adaptation file and showing how flexible the country's technical procedures and agricultural policies are in handling these conditions.(5) Climate change is already having an effect on water resources through

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higher average temperatures and more variable precipitation patterns; these factors will contribute to soil salinity increases, which will reduce agricultural yields. Groundwater levels have dropped in several parts of the world as a result of climate change.(6) In a study carried out in the USA, more especially in the state of Indiana, since this region is known for its high humidity and, consequently, its heavy winter and spring precipitation accumulations. The local government has chosen to collect the abundant water that comes from rain during periods of precipitation so that it can be used later after studying the expected future effects in this region. This is due to the fact that is possible that this region will face a scarcity of water, particularly during the summer.(7) Since climate change is happening all over the world, it will have an influence on many different areas. One of these areas is biological diversity, which spans from the tropics to the poles. As a result, this diversity will be impacted by the scarcity of water and agricultural crops, which will have an economic impact as well.(8) A correct adaptation strategy is the result of careful planning and the adoption of well-considered strategies, which differ depending on the target region. If the same conditions and causes are present in one country and another, then adaptation methods for one area can be used to another area as well.(9) High temperatures are an indicator of climate change; from 2004 to 2018, the governorate of Baghdad had a rise in maximum temperatures that was around 90% higher than the previous record.(10) In the same way, rising temperatures are another consequence of dense population growth.(11). One of the most noticeable greenhouse gases, carbon dioxide (CO₂) emissions are known to rise in parallel with the rate of transportation usage, which in turn rises in response to rising populations and civilizations. The rate of emissions in Iraq rose from 10% in 1970 to 30% in 2013(12). The northern part of Iraq is thought of as having a more rain-drenched climate than the southern part of the country, and vice versa. The southern Iraqi governorate of Basra is known for its relatively high humidity. Nonetheless, drought poses a greater threat to Mosul Governorate (located in northern Iraq) than Basra Governorate.(13). Using rainfall data from the extensive stations, the drought in Iraq was examined from 1980-2010 and concluded that 2008 was the driest .

It has been found that the drought is not only affecting the entire country, yet also different sectors in it,(14). There is many kinds of vegetation cover in Iraq, and the soil affects water retention and soil angle of inclination. Also temperatures , humidity, and the amount of vegetation cover are all related . the lower temperatures was in Mosul in November and December, while the greatest value was in Basra reached 55 °C in July and August as a result of evaporation,(15).

2. Materials and Methods

One of the areas most impacted by climate change is the Middle East, and Iraq in particular is struggling with water resource instability (fig. 1). This is because the Tigris and Euphrates rivers, which are thought to be the country's primary water sources, originate in neighboring countries, and Iraq is located downstream from these rivers. Meanwhile, the rise in temperatures is getting worse, and no action is being done to address these Poor Adaptation strategies for water resources in the face of climate change, which puts Iraq at risk of severe drought. The data used for water resource from Iraqi ministry of water resources/ national center for water management, temperature and precipitation from NASA/POWER website and population data from Iraqi ministry of Planning.

priority of adaptation measures is the large number of cities situated on either side of the Tigris River and the farmed lands that rely on its irrigation. This is supported by the monthly data on the amount of water imported by the two rivers, which clearly show that the Tigris River is substantially larger than the Euphrates River. In addition, the fact that the most lucrative Figure No. 3 shows that in April 2019, the monthly quantity was greater than 1200 m³/s, within the time for which data was available.

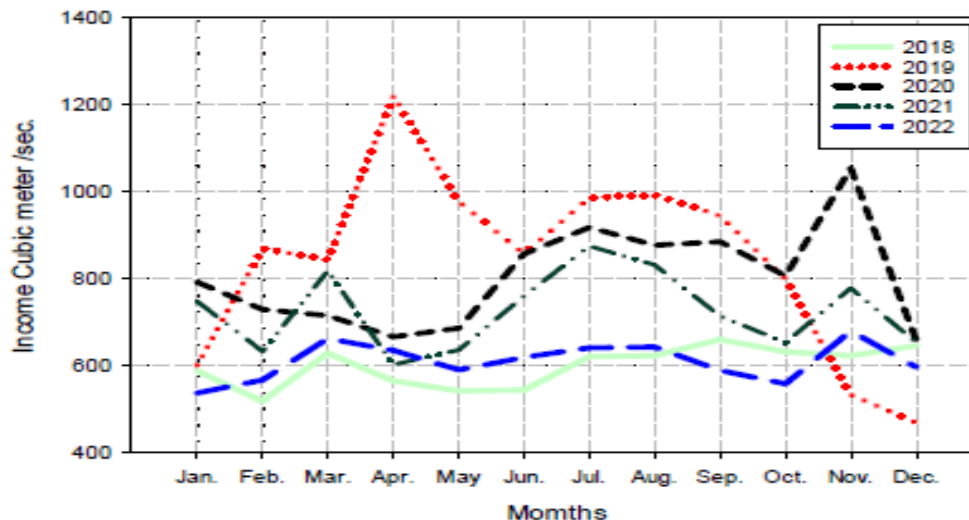


Figure 3. Time series for monthly income for Tigris.

In July 2019, the Euphrates River's monthly revenue peaked at 900 m³/s, even though the river's course is longer than the Tigris River's (as illustrated in Figure No. (4)).

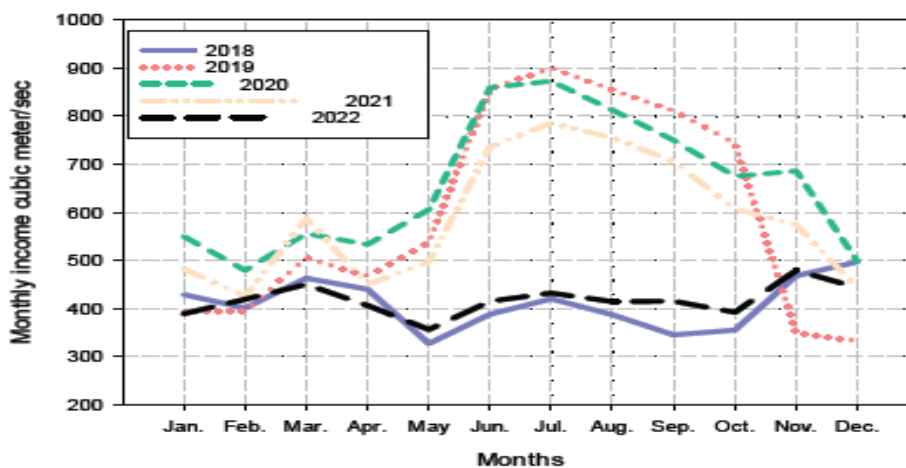
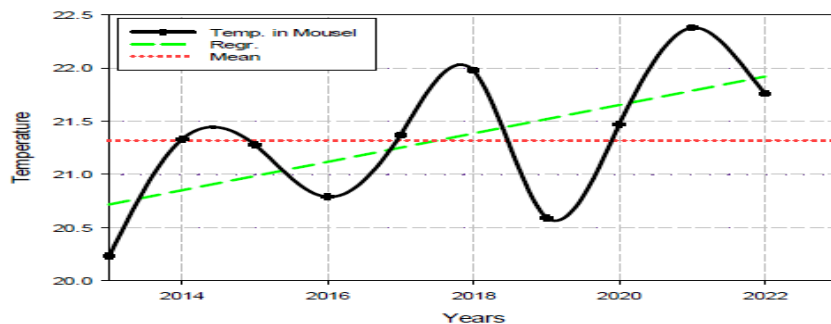


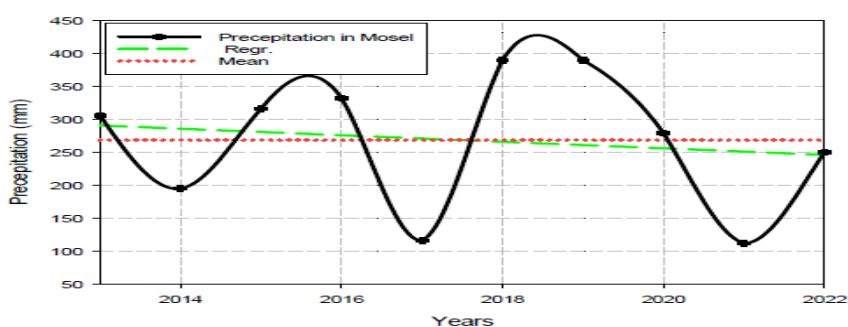
Figure 4. Time series monthly for Euphrates River.

The study confirmed that Iraq saw a noticeable rise in temperatures and a drop in rainfall over the study period, as observed by monitoring temperatures and rainfall values in four regions (Mosul, Baghdad, Rutba and Basra). As seen in figure 5 below The area is vulnerable to the consequences of climate change, and the harm will worsen unless adaptation strategies are put in place to mitigate these impacts. This tendency has impacted the water sector's resilience during seasons when water revenues are low due to a lack of rain and rising temperatures. Because of this the amount of water lost by evaporation in

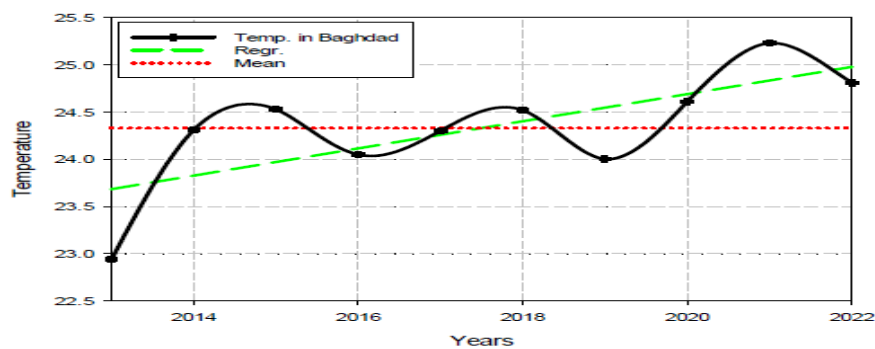
reservoirs and dams will increase. Iraq still vulnerable to the effects of this phenomenon in water sector as a case. This will lead to the effects on the plants and biological life. Hence to minimize losses and maximize water utilization, the aforementioned must be implemented.



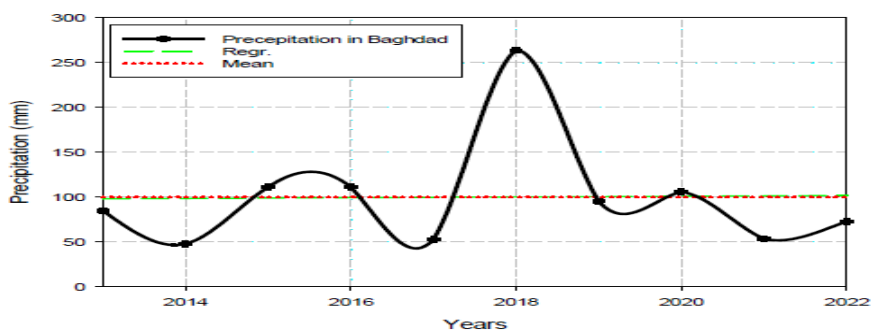
a) The temperature in Mosul from 2013-2022.



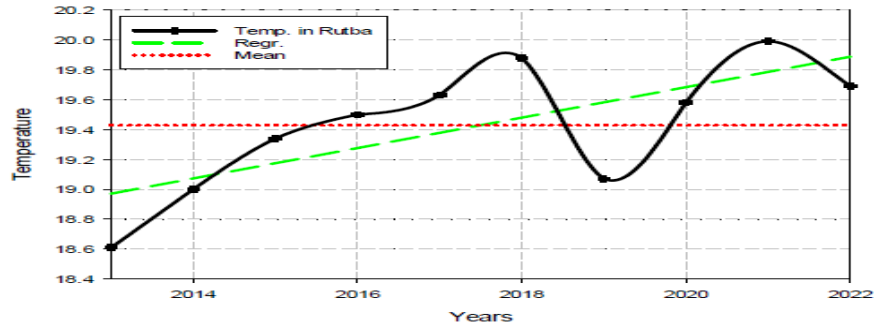
b) Precipitation in Mosul from 2013-2022.



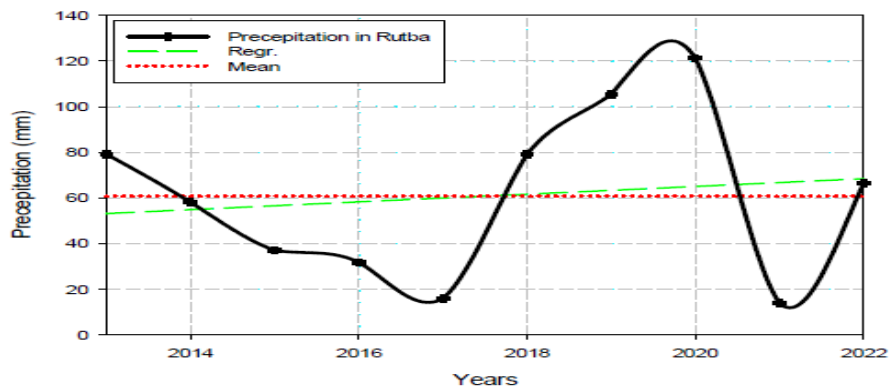
c) Temperatures in Baghdad from 2013-2022.



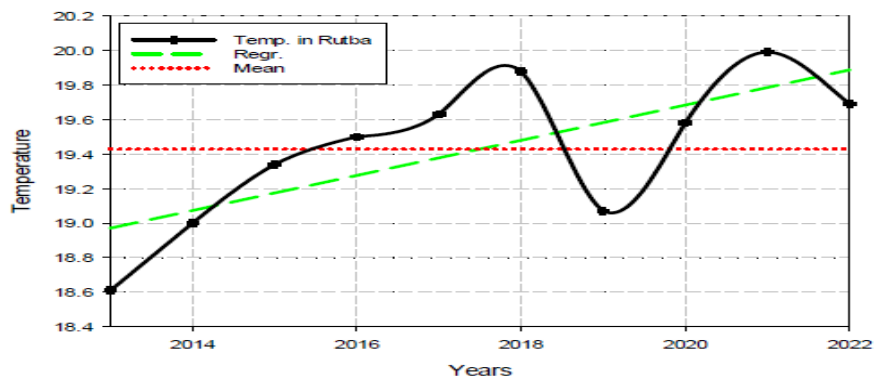
d) Precipitation in Baghdad from 2013-2022.



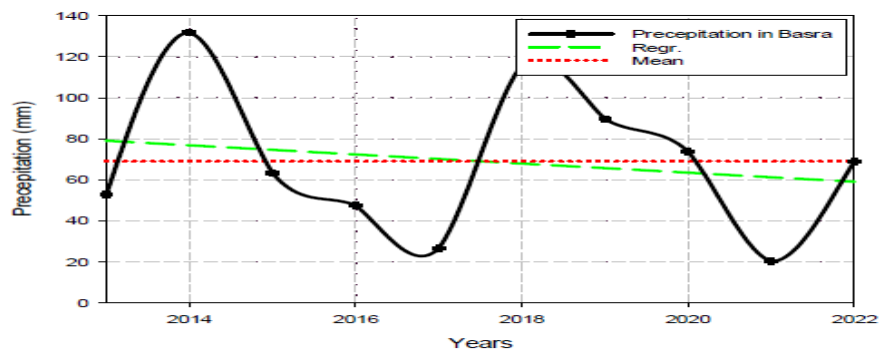
e) Temperatures in Rutba from 2013-2022.



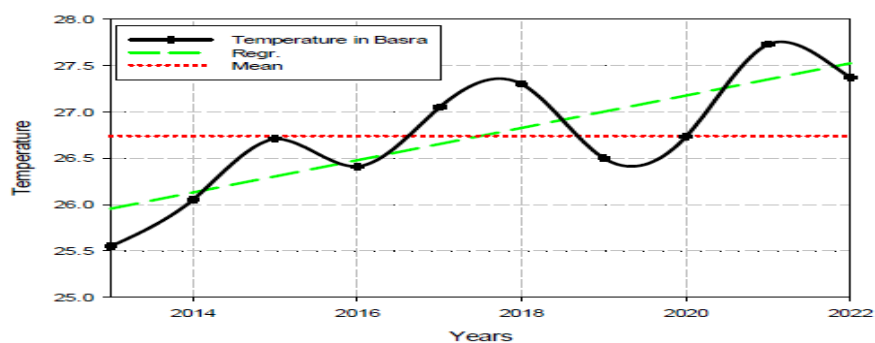
f) Precipitation in Rutba from 2013-2022.



g) Temperatures in Rutba from 2013-2022



h) Precipitation in Basra from 2013 to 2022.



i) Temperatures in Basra from 2013-2022.

Figure 5. From (a to i), the area is vulnerable to the consequences of climate change, and the harm will worsen unless adaptation strategies are put in place to mitigate these impacts.

With a predicted 1% relative increase per year, the Iraqi Ministry of Planning's population forecasts for the years 2018–2030 highlight the need to prepare for this growth by securing essential resources sustainably in line with the impacts of change. Shields from heat waves in Iraq. With a growing population comes the need to take swift action to adapt to future climate change. This is because more people means more strain on already-scarce natural resources, such as water, and Iraq isn't exactly a climate change superpower—not to mention there are fixed water quotas for agriculture that need to be considered. Keeping the food basket full requires an increase in population.

Table 1. The Iraqi Ministry of Planning's population forecasts for the years 2018–2030.

Population	Year
38124182	2018
39127900	2019
40150174	2020
41190658	2021
42248900	2022
43324000	2023
44414800	2024
45520500	2025
46639900	2026
47771600	2027
48914100	2028
50061500	2029
51211700	2030

4. Conclusion

In conclusion, this study underscores the significant fluctuations in Iraq's water resources sector, particularly evident in the annual and monthly variations of water supply from the Tigris and Euphrates Rivers. The observed disparity, with 2019 recording over 93 billion cubic meters and 2018 plummeting to approximately 30 billion cubic meters, accentuates the sector's susceptibility to climatic shifts. Monthly variations further illustrate this vulnerability, with peaks in river flow observed in April and July 2019. Moreover, the growing strain imposed by urbanization and population growth exacerbates these challenges, emphasizing the urgent need for adaptive strategies. The inclusion of Bedouin communities in resilience research highlights the broader socio-economic dimensions and disparate impacts of water resource management. Moving forward, addressing these vulnerabilities requires a multifaceted approach that integrates climate adaptation measures, sustainable urban planning, and inclusive governance frameworks. Moreover, fulfilling international commitments necessitates a concerted effort proportional to the magnitude of these challenges, underscoring the imperative for enhanced cooperation and resource allocation. Further research should delve into the nuanced interactions between climate variability, population dynamics, and socio-economic factors to inform targeted policy interventions and enhance the resilience of Iraq's water resources sector.

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