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Forecasting the Area of Water Resources of the Tigris and Euphrates River Basin in 2040 and the effects of Water Reduction on Geopolitical Conflicts

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1-Introduction

Developing water resources in the Tigris-Euphrates basin remains a strategic goal for countries, but the political and economic implications vary between them. Periodic droughts and recent reductions in river flows indicate significant climate change. Projections for a future reduction of 29% in the Tigris flow and a 73% reduction in the Euphrates flow indicate the negative impact of reduced rainfall in the upstream basins, particularly in Turkey. River basin development plans such as irrigation expansion and inter-basin transfers could worsen drought conditions. These issues, often overlooked because of their impact on drought reduction and management, could lead to greater losses of water reserves. From this perspective, many researchers have used various methods and models. The reduction in water resources is expected to increase geopolitical conflicts in relations between countries in the Tigris-Euphrates basin. These elements are anticipated to contribute to a water crisis and exacerbate geopolitical conflict among Iran, Turkey, Syria, and Iraq. The hydropolitical disparities are likely to result in both conflict and convergence among the nations within the basin. To mitigate these tensions, this research recommends the establishment of a regional union for integrated water resources management, encompassing the four basin countries.

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2- Theoretical framework

Theories and doctrines concerning the utilization of international river waters are derived from the foundational sources of international water law. The principal theories include: 1. The theory of absolute territorial sovereignty, which posits that each state possesses the unrestricted right to exploit the waters of an international river within its territorial boundaries, without regard for the rights of other states. 2. The theory of absolute territorial integrity, which asserts that downstream states are entitled to receive water of natural quality, and that upstream states must obtain the consent of downstream states regarding water flow. 3. The theory of limited territorial sovereignty, which contends that while each state may utilize shared water resources, such use must be conducted with respect for the rights and interests of other states and must not result in harm to them. Furthermore, the principles of international water law are recognized as significant foundations in the governance of transboundary water resources. These principles include the principle of equitable and reasonable use, the obligation to prevent significant harm, as well as the principles of information exchange, consultation, negotiation, cooperation, and the peaceful settlement of disputes.

3- Methodology

This research used machine learning algorithms to predict the area of water resources in the Tigris-Euphrates Basin. Based on 2020 data, the area of water resources in the Tigris and Euphrates River basins in 2040 was predicted using 6 parameters: precipitation, humidity, evapotranspiration, land surface temperature, soil type, and NDVI. Gradient Boosting Regression model showed higher accuracy compared to other models. To evaluate the accuracy and efficiency of the models, the mean absolute scaled error (MASE) was used to predict the area of water resources in the Tigris-Euphrates basin. In addition, a descriptive-analytical method was used to analyze the relationship between the projected impacts of water resources and geopolitical conflicts.

4- Discussion

The results of model evaluation show that the accuracy of the GBR model (0.814 MASE) is better than that of the RF models (0.801 MASE), RF-SVM (0.796 MASE), and KNN (0.79.3 MASE). The primary concern of this research is to analyze the temporal changes in water resources within the Tigris and Euphrates river basins from 2000 to 2023, and to project the area of water resources in these basins for the year 2040, alongside the potential implications for geopolitical tensions. The predictive analysis indicates that the augmented gradient method yields higher accuracy, forecasting a decrease in the area of water resources from 8,356.16 square kilometers in 2020 to 5,956.04 square kilometers by 2040. Population growth, urbanization, economic pressures, and the expansion of agricultural land to meet society's water, energy, and food needs represent a global challenge and threaten the sustainability of natural resources.

5- Conclusion and Suggestions

The implementation of water control projects upstream of the Tigris and Euphrates rivers and the lack of wetland water rights have created a problem between Iran and Iraq. Turkey, Iraq, and Syria are struggling to distribute their water resources amid climate change and internal conflicts. Large dams in the Tigris and Euphrates basins, built by upriver countries such as Turkey, Syria, and Iraq, have led to significant reductions in water downstream. If these measures continue, the region could face the challenge of drought and even a complete drying up of rivers. The use of the upstream advantage for dam construction and water use, particularly by upstream Turkey, poses geopolitical challenges for downstream countries and could exacerbate regional tensions and conflicts. Although these conflicts may diminish in the future, bilateral relations among Iraq, Syria, Turkey, and Iran will likely remain intricate due to limited cooperation and varying degrees of tension. The current study predicts a decline in water resources by 2040, primarily attributable to dam construction and climate change, which is expected to adversely affect both the environment and the geopolitical relations of these countries. The geopolitical relations of these four nations entail complex dynamics that forecast future tensions. Consequently, hydropolitical crises can serve as both a source of discord and a catalyst for convergence among the countries within the

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river basin. Stakeholders may actively seek resolutions to disputes regarding water resources in the basin. One potential strategy for mitigating tensions is the establishment of integrated water resources management through the formation of the "Tigris-Euphrates Basin Regional Union," aimed at fostering cooperation among the four countries of the Tigris-Euphrates Basin (Iran, Iraq, Turkey, and Syria).

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