

ORIGINAL ARTICLE**An Analysis of the Impact of the Water Crisis on the Hydropolitics of Khuzestan Province with Emphasis on Environmental Challenges and Consequences**Alireza Mehrabi¹ , Soroush Farshchin^{2*} , Reza Hashemi³

1. Associate Professor,
Department of Human Geography,
Shahid Beheshti University,
Tehran, Iran.

2. Ph.D Candidate, Department of
Human Geography, Shahid
Beheshti University, Tehran, Iran.

3. MSc. Department of Human
Geography, Shahid Beheshti
University, Tehran, Iran.

***Correspondence**

Soroush Farshchin

E-mail: s_farshchin@sbu.ac.ir

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EXTENDED ABSTRACT**Introduction**

Water resources constitute one of the most strategic components of sustainable development, environmental security, and regional stability, particularly in arid and semi-arid regions. In recent decades, the growing impacts of climate change, population growth, agricultural expansion, industrial development, and unsustainable water management practices have intensified water-related challenges across many regions of the world. In Iran, these challenges have become increasingly evident, especially in Khuzestan Province, which is traditionally recognized as one of the country's most water-rich regions. Khuzestan Province occupies a unique position in Iran's hydrological and geopolitical structure. The province hosts several major river systems, including the Karun, Karkheh, Dez, Maroon, and Zohreh river basins, which have historically supported agricultural production, industrial development, ecosystem sustainability, and human settlements. However, despite its significant water resources, Khuzestan has experienced growing water stress over the past decades. The increasing imbalance between water availability and water demand has generated a series of environmental, economic, social, and political challenges.

The concept of hydropolitics provides a useful analytical framework for understanding the interactions between water resources, governance systems, environmental processes, and political decision-making. Hydropolitical challenges emerge when water scarcity, resource competition, environmental degradation, and governance failures influence regional stability and socio-political relations. In Khuzestan, declining water availability has been accompanied by wetland degradation, dust storms, declining agricultural productivity, ecosystem deterioration, and increasing social concerns. These developments highlight the need for a comprehensive assessment of the relationship between water crisis indicators and hydropolitical dynamics. The present study aims to analyze the impact of the water crisis on the hydropolitical conditions of Khuzestan Province by examining major water resource indicators and their environmental consequences during two statistical periods, 2006 and 2016. By integrating hydropolitical and environmental perspectives, the study seeks to provide a comprehensive understanding of the drivers and consequences of water insecurity in one of Iran's most strategically important provinces.

Methodology

This research adopts a descriptive-analytical approach and utilizes a combination of quantitative and qualitative data. The study focuses on Khuzestan Province and evaluates changes in water resources, environmental indicators, and hydropolitical conditions between the years 2006 and 2016. To assess the status of water resources, several widely recognized indicators were employed, including the Falkenmark Water Stress Index, the Renewable Water Sustainability Threshold (RWST), the Consumption-to-Renewable-Water Ratio (C/RW), the River Basin Water Sustainability Index (RWSI), and the Maximum Irrigable Land Index (MILI). These indicators were selected because they provide a comprehensive evaluation of water availability, water consumption, agricultural carrying capacity, and basin-level sustainability. Data were collected from official statistical sources, hydrological reports, environmental databases, and relevant governmental publications. Environmental indicators such as wetland area, wetland depth, air quality, desertification extent, soil salinity, biodiversity status, and dust storm conditions were also examined to identify the environmental consequences of water scarcity. In addition, multiple regression analysis was used to investigate the relationship between hydropolitical variables and environmental indicators. Before conducting the regression analysis, all variables were normalized through linear standardization procedures to ensure comparability across datasets. The analysis further examined the relative influence of different factors, including water governance and management policies, water utilization patterns, climate change, inter-basin water transfers, and external geopolitical factors on the hydropolitical conditions of the province.

Findings

The findings reveal a significant deterioration in the status of water resources in Khuzestan Province between 2006 and 2016. The Falkenmark Index decreased from 1,743 cubic meters per capita to 1,230 cubic meters per capita, indicating a transition from relatively favorable conditions toward a critical water stress threshold. This decline reflects both reduced water availability and increasing water demand across agricultural, industrial, and domestic sectors. The analysis of agricultural water capacity demonstrated a substantial reduction in the Maximum Irrigable Land Index. The maximum cultivable area supported by available renewable water resources declined from 1,704,510 hectares in 2006 to 1,233,600 hectares in 2016. Simultaneously, the actual cultivated area exceeded the estimated sustainable capacity, indicating growing pressure on water resources and increasing environmental vulnerability. The Consumption-to-Renewable-Water Ratio increased from 0.64 to 0.75 during the study period, moving the province from a threshold condition to a critical water crisis status. This trend reflects the increasing imbalance between water consumption and renewable water availability. At the basin scale, the results indicate worsening sustainability conditions across all major river basins. While the Dez and Karkheh basins were already approaching critical thresholds in 2006, they experienced severe water stress by 2016. The Maroon-Jarrahi and Zohreh-Hendijan basins displayed the most critical conditions, with sustainability indicators reflecting severe water crisis levels.

The environmental consequences of these developments were substantial. Wetland ecosystems experienced significant degradation, including reductions in both surface area and average depth. The loss of wetland ecosystems contributed to declining biodiversity and increased vulnerability to dust storm formation. The number of healthy air-quality days declined considerably during the study period, while desertified areas expanded significantly. Soil conditions also deteriorated. Soil salinity increased from previous levels, and the proportion of saline agricultural lands expanded substantially, reducing agricultural productivity and increasing the risk of soil degradation and erosion. Biodiversity indicators similarly declined, reflecting the cumulative impacts of ecosystem degradation and habitat loss. Regression analysis revealed that all examined hydropolitical factors significantly influenced water conditions in Khuzestan. However, their relative impacts varied. Water governance and management policies, water utilization patterns, and climate change emerged as the most influential factors affecting hydropolitical dynamics. In contrast, transboundary factors and inter-basin water transfer policies demonstrated comparatively weaker effects. The results further indicate that water scarcity significantly affects environmental indicators. The strongest relationships were observed between declining water resources and changes in wetland conditions, dust storm intensity, and surface water levels. As water availability decreased, wetland areas and water depths declined, while dust storm frequency and environmental degradation increased.

Discussion and Conclusion

The findings confirm that the water crisis in Khuzestan Province is not merely a hydrological problem but a multidimensional hydropolitical challenge involving environmental, social, economic, and governance dimensions. Although climate change and declining precipitation have contributed to reduced water availability, the results suggest that governance-related factors and patterns of resource utilization play a more decisive role in shaping current hydropolitical conditions. These findings are generally consistent with recent national and international studies that emphasize the interaction between climate pressures and governance failures in generating water insecurity. Similar studies have demonstrated that environmental degradation, unsustainable water consumption, and ineffective allocation policies often amplify the impacts of climatic stress. The present study extends these findings by providing an integrated assessment of hydropolitical indicators and environmental consequences at the provincial scale. One of the principal contributions of this research lies in its integration of multiple hydropolitical indices with environmental indicators to evaluate the broader consequences of water scarcity. Unlike many previous studies that focus exclusively on hydrological or environmental dimensions, this research provides a comprehensive framework for understanding how water crises influence hydropolitical stability and environmental sustainability simultaneously. The study also demonstrates that environmental degradation should be considered both a consequence and a driver of hydropolitical instability. Wetland degradation, increasing dust storms, declining biodiversity, and expanding desertification not only result from water scarcity but also create additional pressures on governance systems and local communities. Despite its contributions, the study faces certain limitations. Data availability and temporal consistency across environmental indicators constrained the level of detail that could be achieved for some variables. In addition, the analysis focused on two major statistical periods and therefore may not capture all short-term fluctuations in hydrological conditions. Future research may expand the temporal scope of analysis, incorporate climate projection scenarios, and examine the socio-economic dimensions of hydropolitical vulnerability at local scales. Comparative studies among different Iranian river basins may also provide valuable insights into regional variations in water governance and environmental resilience. Based on the findings, several policy recommendations can be proposed. Improving water governance mechanisms, increasing irrigation efficiency, promoting sustainable agricultural practices, protecting environmental water rights, preventing excessive withdrawals from river headwaters, and strengthening integrated water resource management systems should be prioritized. Furthermore, environmental restoration programs targeting wetlands and degraded ecosystems can contribute to reducing dust storms and improving ecological resilience. In conclusion, the future hydropolitical stability of Khuzestan Province depends on the adoption of integrated and sustainable water management strategies. Without significant reforms in governance structures, water utilization patterns, and environmental protection policies, the ongoing deterioration of water resources may further intensify environmental degradation and hydropolitical challenges in the province.

Keywords

Hydropolitics, Khuzestan Province, Environmental challenges and consequences, Water crisis.

