

# The Impact of Water Challenges on Social Security and Their Consequences for the Development of Khuzestan Province

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## ABSTRACT

This study aimed to investigate the impact of water-related challenges on social security and to identify their consequences for the development of Khuzestan Province. This qualitative study employed an applied, interpretive research design. The study population consisted of university faculty members, researchers, policy specialists, public-sector experts, and professionals in water resources management, environmental studies, sociology, social policy, security studies, regional planning, and sustainable development in Tehran. Participants were selected purposively based on relevant academic or professional expertise, and sampling continued until theoretical saturation was achieved. A total of 24 participants were included. Data were collected through semi-structured, in-depth interviews addressing water scarcity, drought, declining river flows, water quality, wetland degradation, governance, livelihood insecurity, migration, institutional trust, social cohesion, and developmental consequences. Interviews were transcribed verbatim and analyzed using thematic analysis through iterative coding, categorization, constant comparison, and abstraction. MAXQDA software was used to organize and manage the qualitative data, and trustworthiness was enhanced through credibility, dependability, confirmability, and transferability procedures. The analysis identified eight major themes: structural and environmental water pressures, livelihood and economic insecurity, social instability and weakening of social cohesion, migration and demographic disruption, institutional distrust and governance challenges, deterioration in public health and quality of life, constraints on regional development, and intensification of social-security risks. Water insecurity was found to operate through a cascading pathway in which hydrological and environmental pressures weakened livelihoods, increased migration and perceived inequality, reduced institutional trust, intensified social tensions, and ultimately constrained agricultural, industrial, demographic, environmental, infrastructural, and institutional development. Feedback mechanisms also indicated that underdevelopment, human-capital loss, weak governance, and environmental degradation could further intensify future water insecurity. Water challenges in Khuzestan should be understood as an integrated environmental, social, security, and developmental issue requiring coordinated policies that combine sustainable water governance, ecological restoration, livelihood resilience, distributive justice, institutional trust, and balanced regional planning.

**Keywords:** Water Insecurity; Social Security; Water Governance; Regional Development; Environmental Challenges; Social Cohesion; Khuzestan Province

## 1. Introduction

Water is one of the most fundamental resources shaping human security, social stability, economic productivity, environmental sustainability, and the long-term developmental capacity of societies. Although water scarcity was historically approached primarily as a technical issue concerning supply, storage, irrigation, and infrastructure, contemporary scholarship increasingly conceptualizes water security as a multidimensional condition involving sufficient quantity, acceptable quality, equitable access, ecological sustainability, institutional capacity, resilience to shocks, and the ability of communities to maintain livelihoods and well-being under conditions of environmental change. From this perspective, water insecurity is not limited to the physical absence of water; rather, it emerges when households, communities, economic sectors, or ecosystems cannot reliably access water of adequate quantity and quality without unacceptable levels of social, economic, environmental, or political risk. Global analyses have consequently emphasized that contemporary water crises are closely intertwined with population growth, climate variability, ecosystem degradation, unequal resource allocation, weak governance, increasing agricultural and industrial demand, and competition among different users (Salem et al., 2022; Swatuk, 2021). Such interactions transform water from a natural resource issue into a strategic development and security concern.

The concept of water security is particularly important because access to water underlies other dimensions of human welfare. Water availability directly influences food production, nutrition, public health, household stability, employment, agricultural livelihoods, ecosystem functioning, and economic productivity. Young et al. emphasize that water security is an essential prerequisite for food security, adequate nutrition, and human well-being because inadequate or unreliable access to water can affect food availability, food utilization, household expenditure, caregiving practices, and health simultaneously (Young et al., 2021). Similarly, the water–food nexus literature demonstrates that water-resource pressures can transmit across sectors, producing consequences that extend far beyond the boundaries of water management itself. Sustainable development therefore requires policy frameworks capable of addressing water availability alongside food production, environmental conservation, energy demand, and socioeconomic resilience (Salem et al., 2022). From this perspective, persistent water insecurity

may become a structural constraint on development because it weakens the material and institutional conditions required for sustained economic growth and social welfare.

Water-related ecosystem services also constitute an important dimension of the relationship between water security and development. Rivers, wetlands, aquifers, floodplains, and associated ecosystems perform ecological and socioeconomic functions that support agriculture, food production, energy systems, biodiversity, water purification, climate regulation, and human settlements. Research examining water-related ecosystem services has shown that integrated assessment of water, food, and energy systems is necessary for strengthening the security of interconnected resource systems, particularly in environmentally vulnerable and data-constrained regions (O. Saito & Yeshitela, 2019). Consequently, degradation of aquatic ecosystems can simultaneously reduce water availability, compromise agricultural productivity, increase environmental hazards, and weaken the resilience of communities dependent on ecosystem services. These cumulative effects are especially consequential in regions where local economies and social structures have historically developed around major river systems, irrigation networks, wetlands, and agricultural landscapes.

The growing strategic importance of water has also expanded the concept of security beyond conventional military and territorial interpretations. Water scarcity, inequitable allocation, declining water quality, drought, and competition among users may affect local and national security by increasing economic vulnerability, displacement, social dissatisfaction, intergroup tensions, and political contestation. Research in Iran has similarly identified the water crisis as a phenomenon with direct implications for national and local security, particularly where environmental pressures intersect with socioeconomic inequalities and governance limitations (Razaghi, 2020). At the international level, legal and political studies have increasingly treated water cooperation as a mechanism for preventing conflict and strengthening peace and security, demonstrating that water governance has implications for relations among political communities as well as for domestic stability (Jplsq, 2020). International legal scholarship also emphasizes that states have obligations associated with the protection and realization of water security, particularly where water access intersects with human welfare, environmental protection, and fundamental rights (Rashidi, 2019).

The geopolitical significance of water becomes particularly visible in regions characterized by shared basins,

transboundary rivers, border populations, and competing resource interests. Water may function simultaneously as an instrument of cooperation, a source of dependency, and a potential driver of geopolitical tension. Water diplomacy has therefore gained increasing importance as a strategy for coordinating resource interests, preventing disputes, advancing sustainable development, and contributing to broader security architectures (Krzymowski, 2021). The relationship among borders, energy, water, and security has also been demonstrated in geopolitical analyses of Iran and neighboring states, where mutual dependencies in these domains shape strategic relationships and security calculations (Omidi & Orhon Ozdag, 2023). These findings indicate that water insecurity cannot be separated from larger questions of political stability, territorial relationships, regional development, and institutional cooperation.

Within Iran, water-resource management has become increasingly complex because hydrological scarcity interacts with climatic variability, population concentration, agricultural demand, industrial expansion, uneven regional development, environmental deterioration, and institutional fragmentation. Research on water-resource policy in Iran and Iraq has highlighted substantial governance and policy challenges, including difficulties in coordination, allocation, strategic planning, and the management of competing demands (Nasri et al., 2022). Water governance is especially important because the effects of scarcity are determined not solely by natural supply but also by institutional arrangements governing allocation, regulation, participation, monitoring, and accountability. Effective governance can moderate the social consequences of scarcity through equitable distribution, transparent decision-making, conservation, adaptive planning, and conflict-resolution mechanisms, whereas ineffective governance may intensify insecurity even when some physical water resources remain available. Accordingly, studies of water governance have demonstrated its close relationship with both water security and food security (Abedi, 2020).

Water insecurity also creates significant challenges for urban systems. Rapid urbanization increases pressure on drinking-water supplies, distribution networks, sanitation infrastructure, emergency systems, and municipal governance. Studies of urban water insecurity demonstrate that the resilience of cities depends on the capacity of physical infrastructure, governance institutions, communities, and service systems to absorb and adapt to water-related disruptions (Mansouri Etminan et al., 2025). Inadequate or unreliable water supplies can intensify

socioeconomic inequality because affluent households and well-served districts typically possess greater adaptive capacity, whereas marginalized populations may face greater exposure to supply interruptions, quality problems, rising costs, and environmental hazards. International evidence likewise indicates that policy and regulatory frameworks for drinking-water services must explicitly address risk management, service quality, household vulnerability, and the regulatory gaps that emerge when formal infrastructure does not meet all community needs (Priadi et al., 2024). These concerns are highly relevant to the social-security implications of water challenges because unequal access can contribute to perceptions of deprivation, injustice, and institutional neglect.

The relationship between water security and social security is particularly evident through livelihood systems. In agricultural regions, water scarcity directly affects cultivation, livestock production, employment, household income, and rural economic stability. Agricultural adaptation is strongly conditioned by the suitability of land and water resources and by the efficiency of irrigation systems. Research conducted in Khuzestan Province has shown that differences in land suitability and irrigation methods are important considerations for the sustainable utilization of agricultural water resources (Papen et al., 2023). Where water availability declines or irrigation becomes less reliable, farmers may face reduced yields, rising production costs, abandonment of agricultural land, indebtedness, and loss of occupational stability. Such economic pressures can subsequently influence migration, family well-being, community continuity, and social cohesion. Thus, agricultural water insecurity represents not only a production problem but also a potential mechanism through which environmental stress is translated into wider social insecurity.

Energy security introduces an additional dimension to water-related development. Water and energy systems are deeply interconnected because water is required for many forms of energy production, while energy is necessary for water extraction, treatment, transfer, and distribution. Research on water-energy development demonstrates that limitations in water availability can constrain energy planning and create broader challenges for energy security and sustainable development (Thaib et al., 2025). This interdependence is particularly relevant to provinces with substantial agricultural and industrial activities, where competing water demands among domestic consumption, agriculture, industry, environmental needs, and energy

infrastructure can intensify pressures on resource allocation. Without integrated planning, expansion in one sector may increase vulnerability in another, creating a cycle in which resource insecurity becomes a barrier to balanced regional development.

Ecological water security provides another analytical framework for understanding these interconnected risks. Water ecological security refers to the capacity of water systems and associated ecosystems to maintain their ecological functions while supporting human and socioeconomic needs. Spatial assessments have demonstrated that water ecological security varies significantly between regions and is influenced by environmental conditions, resource pressures, socioeconomic structures, and management practices (Qiu et al., 2022). This spatial dimension is important because water insecurity is rarely distributed evenly. Certain communities, economic sectors, or ecological areas may experience severe impacts while others remain relatively protected. Consequently, province-level analysis must consider spatial inequalities in exposure, adaptive capacity, infrastructure, economic dependence, and environmental vulnerability. Such inequalities can become socially significant when affected populations perceive that the burdens and benefits of water allocation are distributed unfairly.

Khuzestan Province provides a particularly important context for examining the relationship among water challenges, social security, and development. The province possesses major rivers, agricultural lands, industrial activities, oil and energy infrastructure, wetlands, urban centers, border areas, and historically significant hydraulic systems. Water has shaped the region's settlement patterns, agricultural production, architecture, infrastructure, and cultural development for centuries. The historical importance of water management is illustrated by studies of the hydraulic structures of Shushtar, which demonstrate the profound relationship between water systems and the historical architecture and spatial organization of Khuzestan (Jalili & Bakhakh, 2015). This long-standing dependence on water means that contemporary disruption to hydrological systems carries consequences extending beyond resource availability into cultural landscapes, local identity, settlement continuity, economic activity, and regional development.

At the same time, Khuzestan exhibits complex hydrological characteristics that require careful management of surface water and groundwater resources. Research on karst aquifers in eastern Khuzestan, including the Garu karst

spring, demonstrates the complexity of groundwater recharge and water-resource mixing and highlights the importance of hydrogeological understanding for effective water-resource management (Chitsazian et al., 2021). Such findings underscore that the province's water challenges cannot be reduced to a single variable such as annual rainfall. Rather, they involve interconnected surface and groundwater systems, water quality, recharge patterns, extraction, ecological requirements, irrigation needs, and management decisions. These physical characteristics interact with socioeconomic pressures and institutional arrangements, making Khuzestan an appropriate case for investigating the broader social consequences of water insecurity.

Institutional capacity is particularly important in this context. Water governance depends not only on formal policies but also on the capacity of organizations and managers to respond to change, coordinate stakeholders, communicate decisions, and implement adaptive strategies. Research conducted within the Khuzestan Water and Power Organization has emphasized the role of managerial political intelligence in effective change management within governmental organizations (Jarfi & Hamidipour, 2023). This organizational dimension is highly relevant to water security because large-scale environmental and hydrological pressures frequently require institutional adaptation, interorganizational cooperation, negotiation among competing interests, and communication with affected communities. Weak institutional adaptability may increase the gap between technical water-management interventions and public expectations, thereby amplifying distrust and dissatisfaction.

The resilience of water-supply infrastructure is equally important in translating environmental hazards into social outcomes. Urban water systems can be affected by drought, contamination, infrastructure failure, emergencies, and deliberate or accidental disruptions. Studies emphasizing crisis management and passive-defense planning in urban water-supply facilities show that continuity of water services must be treated as an essential component of urban resilience and security planning (Riyahipur et al., 2020). In socially and economically strategic regions such as Khuzestan, disruption of water services can have cascading effects on households, hospitals, industries, agriculture, public services, and local governance. Consequently, water infrastructure must be understood as critical infrastructure whose reliability contributes directly to social stability and public confidence.

The growing digitization of infrastructure management also introduces an information-security dimension to contemporary resource governance. Accurate monitoring, remote sensing, digital mapping, data authentication, and secure information systems increasingly support environmental assessment and infrastructure management. In the broader information-security literature, techniques for protecting the integrity and ownership of digital information, including fine-grain watermarking and statistically optimized watermark detection, illustrate the increasing significance of reliable and secure digital information environments (Rizzo et al., 2019; Wang et al., 2022). Although these studies address digital information security rather than water security directly, their relevance to contemporary infrastructure governance lies in the broader requirement for trustworthy data, secure monitoring systems, and reliable information flows. As water governance increasingly depends on digital measurement, geographic information systems, environmental databases, and automated monitoring, the integrity of information becomes an enabling condition for credible planning and decision-making.

From a social perspective, the most consequential feature of prolonged water insecurity may be its capacity to generate cumulative rather than isolated effects. Loss of agricultural productivity can reduce household income; declining incomes can increase poverty and migration; migration can weaken local labor markets and social networks; environmental degradation can decrease quality of life; and perceptions of unfair allocation may undermine trust in institutions. These processes can interact, producing feedback loops in which social vulnerability reduces the ability of communities to adapt to subsequent environmental shocks. Water insecurity therefore has the potential to influence social security through economic, demographic, institutional, psychological, and spatial pathways. The concept of security in this context involves the capacity of communities to maintain stable livelihoods, predictable access to essential services, social cohesion, confidence in institutions, and protection from severe environmental and socioeconomic disruptions.

This perspective is particularly relevant to development policy. Sustainable development cannot be achieved solely through increased investment or infrastructure expansion when the natural-resource base required to sustain those investments is deteriorating. Conversely, environmental interventions that do not address household livelihoods, employment, inequality, local participation, and institutional

legitimacy may fail to generate lasting social resilience. The strategic significance of water therefore lies in its cross-sectoral character: it simultaneously supports agriculture, industry, energy, household consumption, ecosystems, public health, urban development, and social stability. Water-related challenges can consequently influence virtually every major dimension of regional development. Global and regional scholarship increasingly demonstrates that effective responses require integrated governance, environmental sustainability, institutional coordination, risk management, and attention to the distributional consequences of resource decisions (Krzymowski, 2021; Mansouri Etmnan et al., 2025; Priadi et al., 2024).

Despite the growing literature on water scarcity, water governance, ecological security, water diplomacy, infrastructure resilience, and resource-development interactions, an important analytical gap remains regarding the way these dimensions converge at the provincial level to affect social security and long-term development. Much of the existing literature focuses separately on hydrological conditions, agricultural efficiency, transboundary politics, governance, infrastructure, or specific dimensions of water security. In Khuzestan, however, these factors operate simultaneously within a region characterized by substantial agricultural dependence, strategic industries, major water systems, ecological sensitivity, urbanization, environmental pressures, and important socioeconomic and geopolitical characteristics. An integrated analysis is therefore necessary to identify how water challenges are transformed into livelihood insecurity, migration, dissatisfaction, institutional distrust, social tensions, and ultimately developmental constraints. Understanding these relationships is essential for moving from narrowly sectoral water management toward a comprehensive policy framework in which water security is treated as a foundation of social resilience and sustainable regional development.

Accordingly, the aim of the present study was to investigate the impact of water-related challenges on social security and to identify their consequences for the development of Khuzestan Province.

## 2. Methods and Materials

This study employed a qualitative research design with an applied purpose and an interpretive approach to investigate how water-related challenges influence social security and, subsequently, the development of Khuzestan Province. A qualitative design was considered appropriate because the

relationships among water scarcity, environmental pressures, social stability, population displacement, livelihood insecurity, public trust, and regional development are multidimensional and cannot be adequately understood solely through quantitative indicators. The study therefore sought to obtain detailed accounts from individuals possessing specialized knowledge and professional experience concerning water governance, social security, environmental management, regional development, and the socioeconomic conditions of Khuzestan Province. The study population consisted of university faculty members, researchers, policy specialists, public-sector experts, and professionals working in fields related to water resources management, environmental studies, sociology, social policy, security studies, regional planning, and sustainable development in Tehran. Participants were required to have sufficient academic or professional familiarity with water-related challenges in Iran, particularly the environmental, social, economic, and developmental conditions of Khuzestan Province. Purposive sampling was initially employed to identify information-rich participants whose expertise was directly relevant to the objectives of the study. Subsequently, theoretical considerations emerging during data collection were used to guide the inclusion of additional participants capable of elaborating on insufficiently developed concepts and relationships. A total of 24 participants from Tehran were included in the final sample. Inclusion criteria comprised possession of at least a master's degree or equivalent professional expertise in a relevant field, a minimum of five years of academic, research, managerial, policymaking, or executive experience, familiarity with water-resource or development issues in Iran, and willingness to participate in an in-depth interview. Particular attention was given to achieving disciplinary diversity so that the phenomenon could be examined from environmental, social, economic, political, security, and developmental perspectives. Recruitment and interviewing continued until theoretical and conceptual saturation was achieved, meaning that the final interviews no longer produced substantively new concepts or analytical dimensions related to the central research problem. Participation was voluntary, and before each interview the objectives of the research, the voluntary nature of participation, confidentiality of the information, and the participant's right to withdraw from the study were explained. Participants were assured that their identities and institutional affiliations would not be disclosed in the reporting of the findings.

Data were collected through semi-structured, in-depth interviews developed in accordance with the objectives and conceptual focus of the study. The interview guide was designed to provide sufficient consistency across interviews while allowing participants to elaborate on their experiences, interpretations, and professional assessments of water-related challenges and their consequences. The initial interview questions addressed participants' perceptions of the major water challenges affecting Khuzestan Province, including water scarcity, drought, declining surface and groundwater resources, inter-basin water transfers, inefficient water allocation, deterioration of water quality, wetland degradation, agricultural water shortages, climate-related pressures, and weaknesses in water governance and resource management. Subsequent questions explored the perceived social consequences of these conditions, with emphasis on livelihood insecurity, unemployment, poverty, rural vulnerability, migration and displacement, social dissatisfaction, public protests, intergroup and interregional tensions, perceived inequality in resource distribution, declining institutional trust, weakening of social cohesion, and changes in residents' sense of security. Participants were also asked to explain how these social consequences could influence the broader development trajectory of Khuzestan Province, particularly in relation to agricultural sustainability, industrial development, human capital retention, investment, public welfare, demographic stability, environmental sustainability, infrastructure planning, and balanced regional development. Follow-up and probing questions such as "Could you explain this further?", "What factors contribute to this situation?", "How does this issue affect social security?", and "What developmental consequences result from this process?" were used whenever necessary to clarify participants' statements and identify causal relationships among the emerging concepts. The interview guide was reviewed by experts in social sciences, environmental management, and regional development to ensure that the questions were relevant, comprehensible, and sufficiently comprehensive. Minor modifications were subsequently made to the sequence and wording of the questions to improve the flow of the interviews. Interviews were conducted individually and continued until participants had fully expressed their perspectives regarding the research questions. With participants' permission, interviews were audio-recorded to ensure accurate documentation of the data, and supplementary notes were taken during and immediately after each interview to record contextual information, significant emphases, and preliminary analytical

observations. Audio recordings were transcribed verbatim as soon as possible following each interview. The transcripts were repeatedly reviewed and compared with the recordings to ensure accuracy and completeness before entering the formal analysis process. To enhance the credibility of the collected data, the researcher used prolonged engagement with the interview material, iterative questioning, comparison of perspectives across participants with different professional backgrounds, and clarification of ambiguous statements during the interviews. Selected interpretations were also reviewed against participants' original statements to reduce the possibility of misrepresentation and to ensure that the analytical categories remained closely grounded in the interview data.

The interview data were analyzed using thematic analysis with a systematic process of coding, categorization, comparison, and abstraction. Analysis began concurrently with data collection so that concepts emerging from earlier interviews could inform subsequent interviews and allow the researcher to examine developing themes in greater depth. Each transcript was initially read several times to obtain an overall understanding of the participant's perspective and the contextual relationships among water challenges, social security, and development. Meaningful units of text relevant to the research objectives were then identified and assigned preliminary codes. Coding remained close to participants' statements during the initial stage in order to minimize premature abstraction and preserve the substantive meaning of the data. Similar codes were subsequently compared, merged where appropriate, and organized into more comprehensive subcategories. Through continuous comparison within and across interviews, subcategories were examined for conceptual similarities, differences, causal relationships, contextual conditions, and consequences. These subcategories were then integrated into broader categories representing major dimensions of the phenomenon, such as structural and environmental water challenges, livelihood and economic insecurity, migration and demographic pressures, social dissatisfaction and conflict, institutional trust and governance, social cohesion, environmental vulnerability, and constraints on sustainable regional development. At the higher level of analysis, relationships among these categories were examined to determine how water challenges could operate as environmental and socioeconomic stressors, how such stressors could affect different dimensions of social security, and how the resulting insecurity could constrain the developmental capacity of Khuzestan Province. The

analytical process was iterative rather than linear; transcripts and codes were repeatedly revisited as new concepts emerged, and categories were refined until they demonstrated sufficient internal coherence and clear conceptual distinction from one another. MAXQDA software was used to organize the interview transcripts, manage codes, retrieve coded segments, compare categories, and maintain an auditable record of the analytical process. Trustworthiness was addressed according to the criteria of credibility, dependability, confirmability, and transferability. Credibility was strengthened through purposive selection of knowledgeable participants, prolonged engagement with the data, repeated comparison of interviews, and examination of divergent perspectives. Dependability was supported by maintaining systematic documentation of the stages of data collection, coding decisions, category development, and revisions made during analysis. Confirmability was enhanced by grounding interpretations in participants' statements and repeatedly reviewing whether the developed themes were adequately supported by the original interview material. Transferability was facilitated by providing a clear description of participant characteristics, selection criteria, research procedures, and the contextual focus of the study. Analysis continued until the coding framework became conceptually stable and examination of the final interviews did not lead to the identification of additional major categories, indicating that sufficient analytical saturation had been achieved.

### 3. Findings and Results

A total of 24 experts participated in the study, all of whom completed the interview process and were included in the final qualitative analysis. The participants represented a heterogeneous group of academic and professional specialists whose backgrounds enabled the phenomenon of water-related challenges in Khuzestan Province to be examined from environmental, social, economic, governance, security, and regional development perspectives. Of the 24 participants, 15 were men and 9 were women. Participants ranged in age from 34 to 61 years, with a mean age of 46.83 years. In terms of educational attainment, 17 participants held doctoral degrees, five held master's degrees, and two possessed specialized professional qualifications equivalent to postgraduate academic training. Regarding professional background, eight participants were university faculty members or academic researchers, five were experts in water resources and environmental

management, four were specialists in sociology and social policy, three worked in regional planning and development, two had professional experience in governance and public administration, and two had backgrounds related to social security and strategic studies. Participants had between 6 and 29 years of relevant professional experience, with a mean of 15.71 years. Fourteen participants had more than 10 years of direct research, administrative, consultancy, or policymaking experience concerning Khuzestan Province,

while the remaining participants had substantial professional familiarity with national water governance, environmental policy, or regional socioeconomic development. The diversity of the participants' professional positions and disciplinary backgrounds contributed to the identification of convergent as well as contrasting interpretations of the relationships among water challenges, social security, and provincial development.

**Table 1**

*Main Themes and Subthemes Identified Regarding the Effects of Water Challenges on Social Security and Development in Khuzestan Province*

| Main theme                                          | Subthemes                                                                                                                                                               | Number of coded references | Participants referring to theme |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------------|
| Structural and environmental water pressures        | Persistent water scarcity; declining river flows; drought intensification; wetland degradation; water-quality deterioration; salinity and environmental decline         | 168                        | 24                              |
| Livelihood and economic insecurity                  | Agricultural losses; unemployment; household income instability; livestock losses; declining rural livelihoods; increasing economic vulnerability                       | 143                        | 22                              |
| Social instability and weakening of social cohesion | Social dissatisfaction; perceived injustice; local tensions; conflict over water allocation; weakening collective trust; reduced sense of belonging                     | 126                        | 21                              |
| Migration and demographic disruption                | Rural-to-urban migration; interprovincial migration; depopulation of vulnerable areas; youth out-migration; growth of informal settlements                              | 105                        | 19                              |
| Institutional distrust and governance challenges    | Perceived inequitable water allocation; weak policy coordination; insufficient public participation; inconsistent decision-making; declining confidence in institutions | 118                        | 21                              |
| Public health and quality-of-life deterioration     | Unsafe or inadequate water access; dust and environmental exposure; psychological pressure; reduced living standards; sanitation concerns                               | 92                         | 18                              |
| Constraints on regional development                 | Reduced agricultural productivity; weakened investment attractiveness; industrial limitations; infrastructure pressures; loss of human capital; spatial inequality      | 151                        | 23                              |
| Intensification of social-security risks            | Protest potential; local disputes; resource competition; feelings of marginalization; vulnerability of border and rural communities                                     | 97                         | 19                              |

The qualitative analysis produced eight interrelated main themes representing the mechanisms through which water-related challenges affected social security and the development trajectory of Khuzestan Province. As presented in Table 1, structural and environmental water pressures constituted the most universally identified theme, appearing in the interviews of all 24 participants and encompassing 168 coded references. Participants repeatedly described the province's water difficulties not as a single problem of insufficient water supply, but as a multidimensional environmental condition characterized by declining river flows, persistent drought, degradation of wetlands, deterioration in water quality, salinity, and the cumulative weakening of aquatic and terrestrial ecosystems. Constraints on regional development constituted the second most extensively coded theme, with 151 references across 23 participants. Interviewees commonly argued that water

stress influences development through several simultaneous channels, including reduced agricultural production, uncertainty for industrial activities, weakened incentives for investment, increasing infrastructure costs, and gradual loss of skilled and economically active populations. Livelihood and economic insecurity was similarly prominent, with 143 coded references reported by 22 participants. This theme reflected the centrality of agriculture, livestock production, fisheries, and water-dependent occupations in parts of Khuzestan and demonstrated how environmental shocks could rapidly become household-level economic pressures. Social instability and weakening of social cohesion, institutional distrust, migration, public-health pressures, and the intensification of broader social-security risks were also consistently identified. The thematic structure therefore indicated that water challenges were perceived by participants as a cascading process rather than an isolated

environmental phenomenon. Water scarcity and ecological degradation first affected livelihoods and access to essential resources; these effects subsequently influenced perceptions

of fairness, institutional legitimacy, population mobility, social cohesion, and ultimately the province's capacity to achieve stable and sustainable development.

**Table 2**

*Structural and Environmental Dimensions of Water Challenges Identified by Participants*

| Category                                         | Key manifestations identified in interviews                                                                                       | Frequency of coded references | Number of participants |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------|
| Quantitative water scarcity                      | Reduced availability of surface water, insufficient agricultural water, seasonal shortages, declining reliability of water supply | 52                            | 22                     |
| River-flow reduction and hydrological alteration | Reduced downstream flows, altered seasonal water regimes, pressure on river-dependent communities and ecosystems                  | 39                            | 20                     |
| Wetland and ecosystem degradation                | Drying or contraction of wetlands, ecological decline, loss of ecosystem services, increased dust vulnerability                   | 31                            | 18                     |
| Water-quality deterioration                      | Salinity, pollution, unsuitable drinking or agricultural water, increased treatment and household costs                           | 27                            | 17                     |
| Climate and drought pressures                    | Higher temperatures, prolonged drought periods, increased evaporation, reduced environmental resilience                           | 34                            | 19                     |
| Water-management and allocation problems         | Inefficient allocation, competing sectoral demands, insufficient coordination, perceived imbalance in distribution                | 46                            | 21                     |

Table 2 demonstrates that the water crisis described by the participants was composed of mutually reinforcing quantitative, qualitative, ecological, climatic, and governance-related dimensions. Quantitative water scarcity was the most frequently discussed direct manifestation, generating 52 coded references and being identified by 22 participants. Participants emphasized that scarcity was experienced not only through absolute reductions in water availability but also through declining reliability and predictability of access, particularly for agricultural and rural populations. Water-management and allocation problems were identified by 21 participants and accounted for 46 coded references, indicating that participants did not interpret the crisis exclusively as a consequence of climatic or natural conditions. Instead, many experts emphasized the interaction between environmental pressures and governance arrangements, including allocation priorities, coordination among responsible organizations, competing agricultural, industrial, municipal, and environmental demands, and insufficient incorporation of local conditions into decision-making. Declining river flows were also considered particularly important because of the province's

dependence on major river systems for agriculture, urban water supply, industry, wetlands, and ecological stability. Participants described wetland degradation as one of the mechanisms through which hydrological pressures became broader environmental and social problems, particularly through the loss of ecosystem services and increased vulnerability to dust-related environmental conditions. Water-quality deterioration, including salinity and contamination, was interpreted as a qualitatively distinct form of water insecurity because the nominal presence of water did not necessarily guarantee its suitability for household, agricultural, or productive use. Climate-related pressures, particularly prolonged drought, elevated temperatures, and high evaporation rates, were frequently described as amplifying pre-existing structural vulnerabilities. Collectively, these findings indicate that participants understood Khuzestan's water challenges as a compound water-security problem in which physical scarcity, ecological degradation, climatic stress, and institutional governance interact to intensify the province's social and developmental vulnerabilities.

**Table 3**

*Social-Security Consequences of Water-Related Challenges in Khuzestan Province*

| Social-security dimension                            | Specific consequences identified by participants                                                                        | Frequency of coded references | Number of participants |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------|
| Livelihood insecurity                                | Loss of agricultural income, occupational instability, reduced productivity, household financial pressure               | 64                            | 22                     |
| Migration and displacement                           | Village depopulation, migration to urban centers, movement to other provinces, expansion of peripheral settlements      | 48                            | 19                     |
| Social dissatisfaction and protest                   | Perceived deprivation, frustration with water conditions, collective grievances, increased potential for public protest | 42                            | 18                     |
| Institutional distrust                               | Reduced confidence in water governance, perceived policy inconsistency, concerns regarding distributive justice         | 45                            | 20                     |
| Intergroup and local tensions                        | Competition over water resources, disputes between users or regions, conflict between livelihood groups                 | 31                            | 16                     |
| Weakening of social cohesion                         | Reduced attachment to place, weakened community solidarity, feelings of abandonment or marginalization                  | 29                            | 17                     |
| Health and psychosocial insecurity                   | Stress, reduced quality of life, concern over water quality, environmental health pressures                             | 38                            | 18                     |
| Increased vulnerability of disadvantaged communities | Greater exposure among rural households, farmers, low-income groups, and environmentally vulnerable settlements         | 36                            | 19                     |

As shown in Table 3, the social-security consequences of water challenges extended considerably beyond immediate shortages of water and were most strongly manifested through livelihood insecurity, migration, declining institutional trust, and increasing social dissatisfaction. Livelihood insecurity generated 64 coded references and was identified by 22 participants, making it the most prominent social-security consequence. Participants consistently explained that when agricultural production declines, livestock activities become less sustainable, or local water-dependent occupations lose economic viability, water scarcity is transformed into a direct threat to household economic security. This process was considered especially significant in rural communities and areas where employment alternatives are limited. Migration and displacement were discussed by 19 participants, who described population movement as both an adaptive response and a source of new social vulnerability. According to the interviewees, households may initially use temporary migration to compensate for declining livelihood opportunities, but prolonged water stress can contribute to permanent relocation, village depopulation, expansion of urban peripheral settlements, and the weakening of local social networks. Institutional distrust was another substantial finding. Twenty participants referred to declining

confidence in decision-making institutions when communities perceived water allocation as unequal, insufficiently transparent, or inconsistent with local needs. Such perceptions were closely associated with social dissatisfaction and protest potential. Participants stressed that perceived injustice could be as socially consequential as physical scarcity itself because unequal or poorly communicated allocation policies may transform an environmental problem into a legitimacy and governance problem. Intergroup tensions were reported particularly in relation to competition among agricultural, urban, industrial, and environmental uses of water. The findings further indicated that prolonged exposure to water-related hardship could weaken community cohesion, intensify feelings of marginalization, and reduce attachment to place. Public-health and psychosocial concerns were also repeatedly reported, especially where poor water quality, environmental degradation, dust exposure, declining living standards, and uncertainty about future livelihoods occurred simultaneously. Overall, the participants portrayed social security as a multidimensional condition dependent on livelihood continuity, institutional confidence, distributive fairness, social cohesion, population stability, and acceptable environmental living conditions.

**Table 4**
*Developmental Consequences of Water Challenges and Associated Social Insecurity*

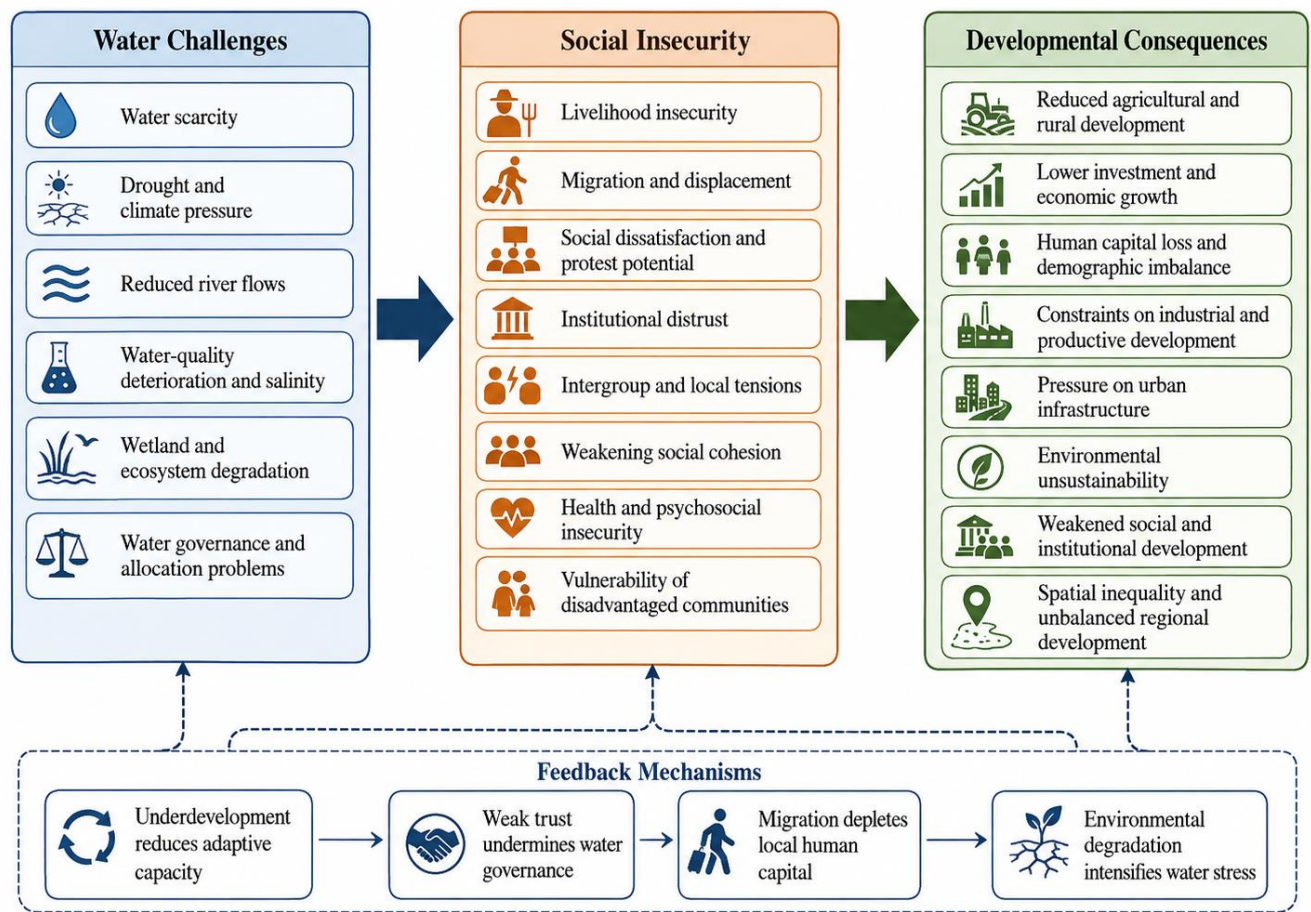
| Development dimension                     | Reported consequences                                                                                                                   | Frequency of coded references | Number of participants |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------|
| Agricultural and rural development        | Reduced crop production, declining agricultural viability, abandonment of farmland, weakened rural economy                              | 58                            | 22                     |
| Investment and economic development       | Increased uncertainty, higher operating costs, reduced attractiveness for long-term investment, economic stagnation in vulnerable areas | 37                            | 18                     |
| Human capital and demographic development | Migration of young and skilled populations, declining local labor capacity, demographic imbalance                                       | 34                            | 17                     |
| Industrial and productive development     | Competition for water, production constraints, tension between industrial and environmental needs                                       | 31                            | 16                     |
| Infrastructure and urban development      | Pressure on urban services, expansion of marginal settlements, increased water-supply and environmental management costs                | 33                            | 18                     |
| Environmental sustainability              | Ecosystem degradation, wetland decline, land deterioration, dust vulnerability, reduced ecological resilience                           | 47                            | 21                     |
| Social and institutional development      | Reduced trust, weakened participation, dissatisfaction with development policies, lower institutional legitimacy                        | 41                            | 20                     |
| Spatial and balanced regional development | Increasing inequality between localities, concentration of population and services, decline of water-dependent settlements              | 36                            | 19                     |

Table 4 illustrates the broader developmental implications of water insecurity and shows that the participants perceived provincial development as highly dependent on the interaction between ecological sustainability and social stability. Agricultural and rural development was the most frequently discussed domain, with 58 coded references across 22 participants. Interviewees emphasized that persistent water scarcity reduces cultivated areas, lowers agricultural productivity, increases production uncertainty, and can eventually make farming economically unsustainable in highly affected communities. This consequence was regarded as particularly important because the deterioration of agriculture was closely linked to employment, household income, migration, food production, and the viability of rural settlements. Environmental sustainability was the second most prominent developmental domain, with 47 coded references from 21 participants. Participants argued that degradation of wetlands, soils, water bodies, and natural ecosystems reduces the long-term ecological carrying capacity of the province and increases the cost of maintaining both urban and rural development. Social and institutional development was likewise identified as a critical domain. The experts emphasized that development projects cannot be sustainable when communities perceive decision-making processes as inequitable or when trust in responsible institutions declines. Investment and economic development were also negatively

affected because environmental uncertainty and recurrent social tensions could increase the perceived risk of long-term economic activities. Several participants specifically stated that businesses and investors require predictable access to infrastructure, energy, water, labor, and stable institutional conditions; therefore, chronic water insecurity can weaken the province's comparative economic advantages even in sectors not directly dependent on agriculture. Human capital loss constituted another major pathway connecting water insecurity to long-term underdevelopment. Out-migration of younger and more skilled residents was viewed as a mechanism through which affected communities lose entrepreneurial capacity, professional expertise, and demographic vitality. Urban development was also influenced through the receiving side of migration, as displaced or economically vulnerable households may relocate toward larger cities and peripheral settlements, increasing pressure on housing, public services, employment markets, sanitation systems, and urban infrastructure. Participants further argued that water insecurity can intensify spatial inequality by accelerating decline in already vulnerable rural and peripheral areas while concentrating population and resources in more resilient urban centers. The combined evidence therefore indicates that water challenges affect development through environmental, economic, demographic, institutional, and spatial mechanisms simultaneously.

**Figure 1**

*Conceptual Pathway Linking Water Challenges, Social Insecurity, and Developmental Consequences in Khuzestan Province*



The conceptual pattern represented in Figure 1 summarizes the central relationship emerging from the qualitative analysis. Participants generally described the phenomenon as a sequential but mutually reinforcing process beginning with structural water challenges, including scarcity, drought, reduced river flows, declining water quality, ecological degradation, and weaknesses in water governance. These pressures directly affect agricultural production, employment opportunities, household income, environmental living conditions, and access to reliable water resources. The resulting livelihood and environmental pressures then contribute to a second layer of social consequences characterized by migration, dissatisfaction, perceived inequality, competition over resources, reduced institutional trust, weakening social cohesion, and increased vulnerability among rural and low-income communities. These social-security effects subsequently influence the developmental environment of the province by reducing human capital, destabilizing rural economies, discouraging investment, increasing pressure on

urban infrastructure, constraining industrial and agricultural planning, and weakening institutional capacity for long-term development. Importantly, the participants did not perceive these relationships as strictly unidirectional. Rather, several feedback mechanisms were identified. For example, underdevelopment and inadequate infrastructure can reduce communities' capacity to adapt to water scarcity, while unemployment and poverty can intensify the social consequences of environmental shocks. Likewise, weak institutional trust may reduce public cooperation with water-management policies, thereby making effective resource governance more difficult. Migration may temporarily reduce pressure on local resources but simultaneously diminish the human and social capital required for local economic recovery. Environmental degradation may decrease agricultural productivity and subsequently increase demand for alternative employment, infrastructure, and social support. The resulting conceptual framework therefore positions water challenges as a foundational structural pressure whose effects are mediated by livelihood

conditions, governance quality, distributive justice, and community resilience, ultimately shaping the prospects for sustainable development in Khuzestan Province.

#### 4. Discussion and Conclusion

The present study examined the impact of water-related challenges on social security and the consequences of these challenges for the development of Khuzestan Province. The findings revealed that water insecurity in Khuzestan is a multidimensional phenomenon extending well beyond the physical shortage of water. Eight major themes emerged from the qualitative analysis: structural and environmental water pressures, livelihood and economic insecurity, social instability and weakening of social cohesion, migration and demographic disruption, institutional distrust and governance challenges, deterioration in public health and quality of life, constraints on regional development, and intensification of social-security risks. The findings further showed that these dimensions were interconnected through a cascading process in which environmental and hydrological pressures affected livelihoods, household security, migration patterns, perceptions of distributive justice, trust in institutions, and community cohesion, ultimately restricting the economic, demographic, environmental, and institutional development of the province. In this sense, water insecurity functioned not merely as an environmental problem but as a structural condition capable of influencing the broader social and developmental system of Khuzestan.

One of the most prominent findings concerned the structural and environmental dimensions of water insecurity. Participants consistently referred to reduced water availability, declining river flows, drought, water-quality deterioration, salinity, wetland degradation, and weaknesses in allocation and governance. This finding is consistent with the broader literature conceptualizing contemporary water crises as complex interactions among physical scarcity, environmental degradation, climatic pressures, population demands, and governance limitations (Salem et al., 2022; Swatuk, 2021). The importance attributed to water governance also aligns with the argument that the availability of water alone does not determine water security; rather, institutional structures responsible for allocation, regulation, conservation, and coordination substantially shape the outcomes experienced by communities (Abedi, 2020). In the context of Iran, previous research has similarly identified deficiencies in water-resource policy and

coordination as major challenges affecting effective resource management (Nasri et al., 2022). Thus, the present findings suggest that the water problems of Khuzestan should not be interpreted solely as consequences of drought or reduced hydrological supply. Instead, their severity appears to be shaped by the interaction between environmental constraints and institutional decision-making.

The prominence of ecological degradation in the findings is also noteworthy. Participants described wetland decline, deterioration in water quality, salinity, and weakening ecosystem resilience as central dimensions of water insecurity. These findings are consistent with research emphasizing the importance of water-related ecosystem services in maintaining the food-water-energy nexus and supporting regional resilience (O. Saito & Yeshitela, 2019). Water systems provide far more than direct consumption; they sustain agriculture, biodiversity, local climate regulation, economic activities, and settlement systems. Consequently, degradation of rivers, wetlands, and aquifers may generate cascading effects throughout the socioeconomic system. The findings concerning the hydro-environmental complexity of Khuzestan are also consistent with research on groundwater and karst systems in eastern Khuzestan, which demonstrates the importance of understanding interactions among different water sources when managing regional water resources (Chitsazian et al., 2021). The ecological-security perspective further supports these findings because spatial assessments of water ecological security demonstrate that environmental pressures are not uniformly distributed and may create geographically concentrated areas of vulnerability (Qiu et al., 2022).

A second major finding was the strong relationship between water insecurity and livelihood instability. Participants repeatedly emphasized that agricultural losses, declining income, livestock-related difficulties, unemployment, and reduced economic viability of rural communities were among the earliest social consequences of persistent water challenges. This result is consistent with the close relationship between water security, food security, nutrition, and human well-being identified in previous research (Young et al., 2021). In regions where agriculture remains an important source of household income and employment, shortages or unreliability of agricultural water can directly threaten household economic security. The findings are also compatible with research on irrigation suitability in Khuzestan, which highlights the importance of matching irrigation methods and land conditions to

sustainable water-resource management (Papen et al., 2023). Where water availability becomes insufficient or irrigation systems are poorly adapted to environmental conditions, agricultural productivity may decline, thereby increasing household vulnerability. The current findings therefore reinforce the view that agricultural water management should be regarded not only as a technical production issue but also as an important component of social-security policy.

The findings further indicated that livelihood insecurity can become a precursor to migration and demographic disruption. Participants described rural-to-urban migration, interprovincial migration, youth out-migration, village depopulation, and expansion of peripheral urban settlements as significant consequences of prolonged water stress. This pattern can be explained by the decline of place-based livelihood opportunities. When agriculture, livestock production, and other water-dependent activities become increasingly uncertain, households may adopt migration as an adaptation strategy. However, while migration can reduce immediate economic pressure at the household level, it may simultaneously create new developmental vulnerabilities. The departure of younger and economically active populations can weaken the human-capital base of rural communities, reduce entrepreneurship, accelerate demographic aging, and undermine the viability of local services. At the receiving end, migration may place additional pressure on urban housing, employment markets, public services, and water infrastructure. The importance of urban resilience under conditions of water insecurity has similarly been demonstrated in research showing that urban areas require adaptive institutional and infrastructural capacity to withstand water-related disruptions (Mansouri Etminan et al., 2025). The present study extends this perspective by showing that rural water insecurity and urban resilience are interdependent through migration processes.

Another important result concerned the relationship between water insecurity, perceived injustice, and institutional distrust. Participants emphasized that dissatisfaction was intensified when water allocation was perceived as unequal, insufficiently transparent, or inconsistent with local needs. This suggests that the social consequences of water scarcity are mediated by the perceived legitimacy of governance processes. The physical reduction of water resources may be interpreted as an environmental hardship, but perceptions of inequitable distribution can transform that hardship into a governance and legitimacy problem. This interpretation is consistent with studies emphasizing that water governance has direct

implications for food security, resource access, and broader public welfare (Abedi, 2020). It is also consistent with research on water policy challenges in Iran and Iraq, which highlights the role of coordination and policy deficiencies in intensifying resource-management problems (Nasri et al., 2022). At the organizational level, research in the Khuzestan Water and Power Organization has shown that effective change management is influenced by managerial capacities, including political intelligence, suggesting that institutional adaptability and communication are important dimensions of water governance (Jarfi & Hamidipour, 2023).

The emergence of institutional distrust and social dissatisfaction also supports a broader security interpretation of water crises. Participants connected persistent water problems with grievances, protest potential, local tensions, perceptions of marginalization, and competition among different user groups. These findings align with previous Iranian research identifying a relationship between the water crisis and both national and local security (Razaghi, 2020). They also correspond with legal and political perspectives that view water cooperation as an important mechanism for sustaining peace and security (Jplsq, 2020). Water security therefore possesses a political dimension because resource allocation affects relationships among communities, regions, economic sectors, and governmental institutions. Where water is perceived as scarce and distributional decisions are contested, competition can intensify between agricultural, industrial, domestic, and environmental users. The present findings suggest that such competition becomes particularly consequential when governance mechanisms are not perceived as transparent, participatory, or equitable.

The connection between water and broader geopolitical security identified in previous studies also helps explain why provincial water insecurity may have consequences beyond local environmental management. Water diplomacy research emphasizes that water resources are strategically significant for sustainable development and security architectures because shared or contested water systems require cooperation, negotiation, and institutional coordination (Krzymowski, 2021). Similarly, geopolitical analyses involving Iran have demonstrated that water, borders, and energy can operate as interconnected dimensions of regional security (Omidi & Orhon Ozdag, 2023). Although the present study focused on internal social security and provincial development, these perspectives reinforce the interpretation that water cannot be treated as an isolated sector. In a strategically important and border-adjacent province such as Khuzestan, environmental

instability, population displacement, economic disruption, and declining institutional trust may acquire broader security significance.

The findings also demonstrated that water insecurity affects public health and quality of life. Participants referred to problems associated with water quality, environmental degradation, psychological pressure, sanitation concerns, and declining living standards. This finding is consistent with the broader understanding that water security is closely related to health, nutrition, and overall well-being (Young et al., 2021). Poor water quality can impose direct health risks, while unreliable access to water increases household costs and creates psychological uncertainty. Environmental degradation may further compound these problems through dust exposure, loss of green and wetland environments, and deteriorating local living conditions. The policy significance of drinking-water quality and risk management is reinforced by international evidence showing that regulatory frameworks must account for risks associated with self-supply, unequal service provision, and household vulnerability (Priadi et al., 2024). Thus, the social-security implications of water insecurity include not only income and employment but also physical well-being, environmental comfort, and confidence in the reliability of essential services.

The results further showed that water challenges have substantial consequences for regional development. Participants identified reduced agricultural productivity, weakened investment attractiveness, constraints on industrial development, human-capital loss, increasing infrastructure pressure, environmental unsustainability, and spatial inequality. These findings support the water-food-energy nexus perspective, according to which water-resource limitations can create cross-sectoral constraints that impede sustainable development (Salem et al., 2022). Water shortages affecting agriculture can reduce food production and employment, while industrial competition for water may intensify pressure on households and ecosystems. Water is also critical to energy systems, and limitations in water availability can restrict energy development and increase vulnerability across interconnected resource systems (Thaib et al., 2025). The present findings therefore suggest that development planning in Khuzestan should incorporate water availability as a structural constraint rather than assuming that water can be supplied independently of ecological capacity.

The finding regarding agricultural and rural-development decline was particularly prominent. Participants described

reduced cultivation, abandonment of agricultural activities, and weakening rural economies as central developmental consequences. This is consistent with studies demonstrating the importance of irrigation efficiency and land suitability for agricultural sustainability in Khuzestan (Papen et al., 2023). It also resonates with the historical importance of water systems in shaping the province's settlement and economic structures. The Shushtar hydraulic structures illustrate how deeply water management has historically been integrated into the architecture, settlement, and social organization of Khuzestan (Jalili & Bakhakh, 2015). The contemporary deterioration of water systems therefore represents not simply a technical disruption but a challenge to patterns of livelihood and settlement that have been historically structured around water availability.

The findings concerning industrial development and infrastructure also warrant attention. Participants emphasized that competition for limited water supplies may constrain productive activity and create tension among industrial, agricultural, domestic, and environmental demands. Water and energy infrastructures are particularly interdependent, and studies of water-energy development show that inadequate water availability can create substantial challenges for energy security (Thaib et al., 2025). Similarly, reliable urban water infrastructure is an essential component of crisis resilience. Research on urban water-supply facilities demonstrates the importance of crisis management and passive-defense planning for maintaining continuity of essential water services (Riyahpur et al., 2020). In Khuzestan, where major urban, industrial, agricultural, and energy systems coexist, infrastructure resilience becomes especially significant because disruption in one sector may rapidly affect others.

The role of information integrity should also be considered in increasingly digitized water-management systems. Modern water governance relies on monitoring, geographic information systems, remote sensing, digital databases, and automated infrastructure control. Although research on digital watermarking primarily addresses intellectual-property and information-security problems, it underscores the broader importance of ensuring the reliability and integrity of digital information (Rizzo et al., 2019; Wang et al., 2022). This is relevant to contemporary water governance because planning decisions increasingly depend on accurate hydrological and environmental data. Where digital monitoring systems are unreliable, insecure, or poorly integrated, institutional capacity for evidence-based decision-making may be weakened. Thus, the

informational dimension of water governance, although less visible than physical infrastructure, can also influence adaptive capacity and public confidence.

A particularly important contribution of the present study is the identification of feedback mechanisms linking water challenges, social insecurity, and underdevelopment. Participants described a cyclical process in which water insecurity reduces livelihoods and social stability, while declining development subsequently weakens adaptive capacity and increases vulnerability to future water stress. Migration can remove human capital from affected communities; institutional distrust can undermine cooperation with resource-management policies; economic stagnation can reduce investment in resilient infrastructure; and environmental deterioration can further diminish water availability. This interpretation is compatible with resilience-based approaches showing that water insecurity can affect the capacity of urban and regional systems to absorb and adapt to environmental pressures (Mansouri Etminan et al., 2025). It is also consistent with ecological-security approaches emphasizing interconnected relationships among environmental conditions, spatial vulnerability, and socioeconomic systems (Qiu et al., 2022). Therefore, water insecurity in Khuzestan should be understood as a dynamic system characterized by reciprocal relationships rather than a simple linear cause-and-effect process.

Overall, the findings support an integrated conceptualization of water security, social security, and sustainable development. Water scarcity and ecological degradation become socially destabilizing when they threaten livelihoods, undermine perceptions of fairness, stimulate migration, weaken institutional trust, and reduce quality of life. Conversely, resilient governance, equitable allocation, reliable infrastructure, and adaptive development policies can mitigate these effects. This interpretation is consistent with the broader literature emphasizing water diplomacy, institutional cooperation, legal responsibility, and sustainable resource governance (Jplsq, 2020; Krzymowski, 2021; Rashidi, 2019). The findings therefore suggest that solutions to Khuzestan's water challenges should not be confined to increasing physical supply. Effective responses require coordinated attention to ecological restoration, governance reform, livelihood resilience, social participation, distributive justice, infrastructure adaptation, and long-term regional planning.

One limitation of the present study concerns its qualitative design and the composition of the participant

group. Although the inclusion of 24 experts from diverse academic and professional backgrounds enabled a multidimensional analysis of the phenomenon, the findings represent expert interpretations rather than statistically generalizable estimates of the experiences of the entire population of Khuzestan Province. Participants were recruited from Tehran, which facilitated access to policy, academic, and administrative expertise but may have limited direct representation of the everyday experiences of residents living in rural, agricultural, border, and environmentally vulnerable communities within Khuzestan. In addition, qualitative analysis necessarily involves interpretation by the researchers, and despite systematic coding and procedures for enhancing credibility, alternative categorizations of some interview material may have been possible. The cross-sectional nature of the interviews also limited the ability to observe how perceptions of water insecurity and social-security risks change over time in response to climatic variability, policy interventions, or changing economic conditions.

Future research should extend the present findings through mixed-method, longitudinal, and comparative designs. Quantitative studies could develop and validate measures of perceived water insecurity, institutional trust, livelihood vulnerability, social cohesion, migration intention, and regional-development expectations and test the structural relationships among these variables in large samples of residents from different areas of Khuzestan. Future qualitative research should include farmers, rural households, industrial workers, women, young adults, local community leaders, environmental activists, municipal officials, and residents of communities directly affected by water shortages and ecological degradation. Longitudinal studies would be particularly valuable for examining whether changes in water availability, infrastructure investments, or governance reforms lead to measurable changes in social trust, migration, livelihood stability, and perceived security. Comparative research across Iranian provinces could also determine which consequences are specific to Khuzestan and which represent broader patterns of water-related social vulnerability. Spatial analysis combining hydrological, socioeconomic, migration, and environmental indicators could further identify high-risk areas and clarify how exposure and adaptive capacity vary geographically.

From a practical perspective, the findings indicate that water policy in Khuzestan should be designed as an integrated social-development policy rather than as a

narrowly technical resource-management program. Provincial and national authorities should prioritize transparent and evidence-based allocation mechanisms, meaningful participation of affected communities, restoration and protection of wetlands and river ecosystems, modernization of irrigation systems, reduction of water losses, improvement of drinking-water quality, and strengthening of crisis-resilient infrastructure. Livelihood diversification programs are also necessary in highly water-dependent rural areas so that households are not forced to rely exclusively on vulnerable agricultural activities. Social-impact assessments should accompany major water-transfer, industrial, agricultural, and infrastructure decisions, with explicit attention to distributive effects across communities and socioeconomic groups. Programs addressing youth employment, rural investment, local entrepreneurship, and community-based environmental restoration may reduce migration pressures and strengthen local adaptive capacity. Finally, coordination among water authorities, environmental institutions, municipalities, agricultural agencies, industrial organizations, and social-policy bodies should be institutionalized so that environmental sustainability, social security, and regional development are addressed through a coherent and mutually reinforcing policy framework.

### Authors' Contributions

Authors contributed equally to this article.

### Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

### Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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### Declaration of Interest

The authors report no conflict of interest.

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### Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

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