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The Isfahan Water Crisis, Zayandeh Rud River Basin: Sustainable Governance in Central Iranian Plateau

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A B S T R A C T

Water is a social element that is essential to the existence of human communities, not just a pure chemical or molecule. This issue is critical for Iran, a nation situated in a largely dry and semi-arid region. With only 5.2% of the globe's total freshwater resources, Iran encounters serious challenges concerning water scarcity. Scholars such as Witfogel and Marx have suitably articulated the "tyranny of water" concept. This study uses a secondary research methodology, applying qualitative content analysis to methodically examine 211 online works, news stories, and publications produced between 2001 and 2023. It delineates the principal themes that characterize the water issue as a social concern, referencing definitions by Earl R. Rabington and Martin Weinberg. Sustainable development necessitates a cohesive strategy for governance and administration, utilizing historical, natural, and regional infrastructures while safeguarding the environment. In this context, analyzing water as a social issue allows us to formulate a novel idea and definition of social concerns, informed by Ulrich Beck's viewpoints in risk society theory. This notion rekindles our optimism that cities in the Central Plateau, including Isfahan and Yazd, are water-sensitive urban areas necessitating water-sensitive strategies for effectively managing water supply and demand focused on efficiency.

Keywords: *societal challenges, water resources, governance, environmental and sustainable progress*

1. Introduction

Water scarcity has moved from a technical concern to a defining governance and social stability challenge across arid and semi-arid regions, where hydrological limits interact with economic development strategies, institutional capacity, and shifting social expectations. In such contexts, water becomes simultaneously a biophysical constraint, an economic input, a political resource, and a social "issue" whose meanings are publicly constructed and contested. Iran exemplifies this condition. Its central plateau cities and basins—among them the Zayandeh Rud River Basin—have experienced recurrent droughts, heightened demand pressures, intensified inter-sectoral competition (agriculture, industry, cities), and increasingly visible public dissatisfaction, turning water into a salient object of national debate and policy contention (Golzar, 2022; Talebi, 2021).

This transformation is not merely about reduced runoff or diminished reservoir storage; it is also about how institutions define priorities, allocate burdens, enforce rules, and maintain legitimacy when citizens experience water stress as an everyday disruption and as an emblem of broader governance performance (Bandehi & Kouli Vand, 2017; Moradi et al., 2024).

The Zayandeh Rud Basin is frequently treated as an emblematic case because it concentrates multiple drivers of crisis: climate variability and warming signals that shift precipitation regimes, persistent evaporation losses from surface storage in water-stressed regions, rapid urban and industrial growth, and the deep politicization of inter-basin transfer policies. Climate warming is increasingly associated with changes in ambient temperature and downstream health and livelihood exposure, especially where drought risk is compounded by urban heat and ecosystem degradation (Anadolu, 2020). In parallel, the physics of water loss in reservoirs—particularly evaporation—constitutes a major but sometimes underappreciated component of scarcity in arid environments, effectively reducing usable supply even when nominal storage volumes appear adequate (Shokri, 2025). At the same time, economic development strategies that privilege heavy industry and intensive agriculture can intensify basin-level demand far beyond sustainable yield, thereby converting periodic drought into chronic scarcity and conflict-prone allocation cycles (Golzar, 2022; Talebi, 2021). The result is a crisis that is simultaneously environmental, economic, political, and cultural—precisely the kind of multi-dimensional problem that requires an explicitly governance-oriented framing rather than a solely engineering or supply-expansion response.

Contemporary scholarship increasingly treats water crises as governance failures as much as hydrological shortages, emphasizing policy coherence, regulatory quality, accountability, and the institutional capacity to coordinate actors across sectors and scales. In Iran, the analysis of water governance highlights fragmented responsibilities, inconsistent enforcement, and path-dependent policy decisions that complicate integrated management and weaken the credibility of allocation regimes (Eslami et al., 2025; Moradi et al., 2024). "Good governance" approaches in the water sector typically stress transparency, rule of law, participation, responsiveness, and effectiveness—attributes that become crucial when scarcity forces explicit trade-offs among livelihoods, industrial output, and ecological needs (Eslami et al., 2025; Radzi et al., 2024). Implementation capacity matters as much as formal policy: even well-designed environmental management plans can fail if performance indicators, monitoring routines, and accountability mechanisms are weak, a finding repeatedly emphasized in sustainability and infrastructure project research (Radzi et al., 2024). For large basins and complex systems, the key question becomes whether water institutions can shift from reactive crisis administration toward anticipatory, evidence-based governance that manages scarcity risk and allocates water in ways that are perceived as procedurally fair.

A governance lens is particularly important in basins where allocation disputes intersect with political economy and center–periphery dynamics. Inter-basin transfers and large conveyance projects, while often presented as technical solutions to drinking-water security, can generate new distributional conflicts and social contestation when upstream communities perceive them as undermining local rights, ecological integrity, or intergenerational sustainability (Fars News, 2021; Talebi, 2021). These tensions are intensified by the macro-development narrative that associates industrial capacity with national resilience and economic security, thereby embedding water allocation in broader debates about strategic industries, regional equity, and state legitimacy (Golzar, 2022; Ministry of Foreign Affairs Economic Diplomacy, 2021). In Isfahan Province—often described as a critical industrial pole—industrial and economic "capacity" narratives coexist with scarcity realities, raising the question of how development pathways are chosen and justified under tightening hydrological constraints (Apurajungani & Nasrollahi, 2021; Ministry of Foreign Affairs Economic Diplomacy, 2021). In such situations, water becomes "political water": a resource whose distribution is interpreted through values and identities, and whose governance shapes trust in institutions.

The conceptualization of water as a social issue provides additional analytical leverage for understanding why scarcity produces not only material hardship but also symbolic and moral contestation. Social problem frameworks emphasize that issues become "social" when a condition is publicly defined as harmful, avoidable, and requiring collective response; the classification is not automatic but emerges through claims-making, media narratives, and institutional recognition (Moayyedfar, 2020; Rabinowton & Weinberg, 2019). Applying this lens to the water crisis helps explain why technical reforms can fail if they do not address perceived injustice, identity threats, or the erosion of social cohesion. Sociological approaches also encourage attention to social consequences beyond the

immediate water balance—such as livelihood insecurity, migration pressures, deteriorating public trust, and cultural disruption—consequences that are well documented in studies of drought impacts and urban sustainability in the Zayandeh Rud context (Faeghi & Navabahsh, 2017; Hohenthal et al., 2017). These impacts can create feedback loops: social discontent increases policy volatility, which further weakens governance consistency and intensifies scarcity outcomes.

The intellectual roots of linking water management to political order are also longstanding. Classic arguments on "hydraulic societies" propose that the organization of large-scale irrigation and water control can foster centralized authority and bureaucratic domination, making water governance inseparable from political structure and power relations (Wittfogel, 2012). Contemporary reinterpretations do not require accepting strict determinism to acknowledge that water allocation systems can become mechanisms of control, bargaining, and institutional path dependence. In modern states under stress, scarcity can reinforce centralization through emergency management logics, or it can catalyze demands for participation, transparency, and decentralization when local communities see their survival at stake (Bandehi & Kouli Vand, 2017; Moradi et al., 2024). The Isfahan case therefore benefits from a conceptual framing that recognizes the co-production of water outcomes by hydrology, infrastructure, political economy, and social contestation.

Recent scholarship in sustainability and water management further underscores the need for decision-support and planning tools that can handle multi-criteria trade-offs. In agriculture, where water typically constitutes the dominant consumptive use, research increasingly emphasizes rational water use, crop pattern optimization, and decision-making systems that integrate ecological and economic indicators (Pádua, 2024; Tayirov et al., 2024). Iran-specific studies on virtual water and regional crop patterns show that adjusting production and trade strategies—effectively "importing water" through water-intensive commodities while exporting less water-intensive goods—can reduce basin pressure and align economic goals with hydrological reality (Mardani et al., 2017). Complementary consumption-based modeling, including input–output approaches, provides evidence that "who consumes" water in an economy may differ markedly from "who withdraws" it directly, a distinction that matters for fair burden-sharing and effective policy design (Apurajungani & Nasrollahi, 2021). These analytical approaches support a shift from simplistic supply expansion to integrated governance that aligns sectoral incentives, pricing signals, enforcement, and innovation.

At the operational level, technology and data-informed management are increasingly prominent in global water governance debates, particularly in forecasting demand and optimizing agricultural irrigation. Machine learning has been applied to predict crop water requirements more accurately, offering potential for efficiency gains where irrigation dominates withdrawals and where misestimation leads to significant losses (Nagappan et al., 2025). However, technological tools are not governance substitutes: they only translate into sustainability when institutions can embed them in planning routines, enforce allocation rules, and create incentives for adoption across heterogeneous users. This is why studies of organizational performance in water supply industries emphasize institutional factors such as organizational commitment, internal governance, and performance systems—variables that shape whether water utilities and agencies can reliably implement policies under stress (Thao et al., 2024). In large-scale construction and water infrastructure projects, performance indicator frameworks similarly point to monitoring, accountability, and institutional learning as decisive determinants of implementation quality (Radzi et al., 2024). Taken together, these strands highlight that effective water governance requires socio-technical integration: advanced analytics and infrastructure must be paired with credible institutions.

Water governance also intersects with risk management in late modern societies, where hazards are increasingly understood as human-produced and politically mediated rather than purely "natural." In this perspective, crises emerge from the interplay between modernization strategies and their unintended consequences, including ecological degradation, resource overuse, and distributive conflict. Within Iranian sociological scholarship, the application of Beck's ideas has emphasized how modernization can generate systemic risks that challenge conventional political control and produce legitimacy crises when the public experiences policy as "organized irresponsibility" (Ahmadi & Dehghani, 2015). Translating this insight to water implies that scarcity is not only about drought cycles but also about development decisions, institutional fragmentation, and policy choices that distribute risk unevenly across groups and regions (Bandehi & Kouli Vand, 2017; Moayyedfar, 2020). In the Zayandeh Rud Basin, the public meaning of the crisis is shaped by visible outcomes: intermittent river flow, agricultural disruption, urban stress, perceived inequities in

allocation, and contested transfer initiatives (Faeghi & Navabahsh, 2017; Fars News, 2021).

The Isfahan water crisis therefore sits at the intersection of three imperatives. First, the basin requires a realistic appraisal of supply limits under warming, variability, and evaporation losses, with explicit recognition that surface storage can lose substantial volumes in hot, water-stressed settings (Anadolu, 2020; Shokri, 2025). Second, demand governance must address agriculture, industry, and cities through integrated policy instruments—crop pattern adjustments, virtual water strategies, wastewater reuse, and economically rational allocation—supported by credible measurement and decision tools (Apurajungani & Nasrollahi, 2021; Mardani et al., 2017; Nagappan et al., 2025). Third, legitimacy-centered governance must incorporate social meanings, participation, and perceived fairness, because water crises become socially destabilizing when they erode trust, identity, and collective action capacity (Hohenthal et al., 2017; Moayyedfar, 2020; Rabinowton & Weinberg, 2019). Emerging international evidence on regulating self-supplied drinking water services and managing decentralized risk underscores the need for coherent regulatory priorities even when households and informal systems fill gaps left by centralized provision—an increasingly relevant consideration in water-stressed urban contexts (Priadi et al., 2024). Likewise, alternative economic paradigms such as the social economy emphasize that water governance should prioritize social and environmental objectives alongside economic performance, particularly in scarcity settings where purely market-driven allocation can exacerbate inequality (González, 2021).

Finally, historical and political readings of water in Iran's central plateau reinforce that the crisis cannot be treated as episodic. Narratives of Iran's water cycle, basin interconnections, and the long arc of water management challenges underline that scarcity is embedded in geography and in institutional evolution; ignoring these structural features leads to repetitive cycles of emergency response rather than sustained adaptation (Pourkashani, 2021; Talebi, 2021). The political interpretation of "oriental autocracy" as a frame for understanding state power and resource control remains influential in public discourse and scholarly debate, and it continues to inform how stakeholders interpret water allocation and the concentration of decision authority (Tavani, 2020; Wittfogel, 2012). Meanwhile, national planning debates, including discussions around Iran's development plans, highlight the policy tension between industrial expansion and ecological constraints, a tension that becomes acute in basins already near or beyond sustainable withdrawal thresholds (Golzar, 2022; Ministry of Foreign Affairs Economic Diplomacy, 2021). Recent Iranian public administration scholarship further reinforces that the effectiveness of water governance depends on aligning institutions, rules, and implementation capacity—particularly under "resistance economy" narratives that emphasize resilience but can inadvertently encourage resource-intensive strategies if not bounded by environmental realities (Eslami et al., 2025; Moradi et al., 2024).

Accordingly, the present study aims to analyze the Isfahan water crisis in the Zayandeh Rud River Basin as a multi-dimensional social and governance problem and to synthesize governance-relevant pathways for sustainable water management in the Central Iranian Plateau.

2. Methods and Materials

The present study adopted a qualitative secondary-research design grounded in an interpretive and sociological approach to social problem analysis. The research was not based on direct human participation, experiments, or surveys; therefore, no human subjects were recruited, and no sampling of individuals was conducted. Instead, the unit of analysis consisted of documentary and textual materials related to the Isfahan water crisis and the Zayandeh Rud River Basin. The study population included a wide range of written sources produced between 2001 and 2023 that reflect institutional, scientific, media, and societal perspectives on water scarcity in Iran. These sources were selected because they collectively represent the discursive, policy-oriented, technical, and social dimensions of the water crisis. In total, 211 documents were analyzed, including peer-reviewed journal articles, academic books, governmental reports, policy documents, development plans, reports from national and international organizations, news agency articles, analytical commentaries, and materials published by non-governmental organizations active in the fields of water, environment, and sustainable development. The temporal range was chosen to capture both long-term structural trends and recent intensifications of the crisis, while the geographic focus on the Zayandeh Rud Basin allowed for an in-depth, context-sensitive examination of water scarcity as a socially constructed and governance-related phenomenon.

Data collection was conducted through systematic document retrieval and screening rather than through field instruments or questionnaires. Relevant materials were

identified using targeted keyword searches related to water scarcity, Zayandeh Rud, Isfahan Province, water governance, drought, inter-basin water transfer, virtual water, water footprint, sustainable development, and social consequences of water shortages. Sources were accessed through academic databases, university repositories, official governmental and ministerial websites, national and international organizational portals, and major Iranian news agencies. Inclusion criteria required that documents explicitly address water resources, water management, governance, social impacts, or environmental consequences within Iran or comparable arid contexts, with specific relevance to the central plateau or the Zayandeh Rud Basin. Documents that were purely technical with no social, governance, or policy relevance were excluded. All selected texts were archived, coded, and organized using a document management system to ensure traceability and consistency. Because the study relied exclusively on publicly available materials, no ethical approval or informed consent procedures were required.

Data analysis was carried out using qualitative content analysis guided by the theoretical framework of social problem analysis proposed by Rabinowton and Weinberg. The analysis followed an iterative and inductive–deductive process. In the first phase, open coding was applied to the full corpus of documents to identify recurring concepts, arguments, and problem definitions related to water scarcity. These initial codes were then grouped into higher-order categories reflecting causes and drivers, structural and institutional conditions, social, economic, environmental, cultural, and health consequences, and proposed solutions. In the second phase, axial coding was used to examine relationships among categories, with particular attention to how environmental stressors interacted with governance failures, development policies, and social responses. In the final phase, selective coding was employed to integrate the findings into a coherent analytical narrative that conceptualizes the Isfahan water crisis as a multi-dimensional social problem rather than a purely hydrological deficit. Throughout the analysis, constant comparison was used to refine categories and ensure internal consistency, while triangulation across different types of sources enhanced analytical credibility. The results were synthesized into thematic explanations that link empirical patterns to broader sociological and governance theories, enabling an integrated interpretation of water scarcity in the Zayandeh Rud River Basin.

3. Findings and Results

We constructed a conceptual framework for the study by qualitatively analyzing 211 published works from media outlets, information websites of institutions, organizations, executive agencies, non-governmental organizations in the water sector, and scientific databases of universities and research centers, based on the primary coding of causes, factors, consequences, and solutions. The corresponding tables documented the extracted components as significant and influential elements. An essential aspect of extracting these tables is recognizing the water problem as a multifaceted phenomenon with several origins and effects in different aspects of social existence, especially for urban dwellers.

Table 1

Extracted Themes for the Causes and Factors of Water Scarcity Conditions

	Influential Factors	Main Components	References and Resources Under Review
Low rainfall rate Evaporation Mismatch between rainfall and consumption time Rainfall fluctuations Inadequate and inefficient use of greywater and wastewater Two-degree increase in air temperature	Water Supply and Production Issues	7 cases	Journals and publications
Water supply and production problems 7 cases Journals and publications Low water productivity in the agricultural sector			

Traditional production structure in the agricultural sector Use of freshwater in industries (water footprint index) Unreasonable virtual water exports Physical transfer of freshwater between basins Unregulated extraction of groundwater resources Water loss during transmission "Unconventional Water Consumption Culture in the Household Sector The enormous volume of industries dependent on Zayandeh Rud Water Mobarakeh Steel Company and its subsidiaries, along with affiliated industries"	Water Demand and Consumption Problems	21 cases	News agencies

3.1. Water Crisis Emergence Factors and Susceptibilities

When allocating water to river basins, the Ministry of Energy measures water stress by dividing scheduled water withdrawal by renewable water resources. This index's appropriate range fluctuates based on several basin features, including climate, per capita renewable water, environmental conditions, income, and social tensions. We classify Iran as a country with a moderate level of income. The proportion of water withdrawal compared to renewable water resources is 11.3%. However, this percentage increases to 86% under present circumstances and 69% when considering planned water use, assuming effective consumption management. Therefore, (Heidari 2019) may classify Iran as a nation experiencing significant water stress. The World Resources Institute projects that Iran will face considerable water scarcity by 2040, ranking 13th worldwide. Over 50 instances of vandalism and damage have recently affected the Zayandeh Rud water transfer transmission line to Yazd.

"Identifying the factors and conditions that impact water scarcity in each region is an essential prerequisite for effective management of water supply and demand, as well as for adapting to water scarcity". This viewpoint provides a distinct framework for relevant authorities to develop management solutions and tackle water problems. Both the Isfahani farmers, who have relied on agriculture as their primary source of income for centuries, and the industries, including steel and other heavy industries in Isfahan and Yazd, which are the main drivers of the country's economy and have contributed to substantial economic growth, have given rise to a pressing social and environmental problem known as water scarcity. The present issue necessitates a sociological analysis of the origins and determinants of water scarcity using a situational approach. It is possible to categorize these causes and variables into many groups. Most important are water-related and non-water-related causes and conditions

We will elaborate further on the causes and situations associated with water later. We will sequentially analyze and critique alternative causes and variables unrelated to water, such as population expansion, unregulated use, inadequate legislation, the absence of executive assurances for effective legislation, and ineffective administration. Fundamental water-related causes and factors encompass: The water crisis is influenced by various water-related causes and elements.

A-Challenges in water provision

Inefficient rainfall, evaporation, discrepancy between precipitation and consumption schedules, variations in precipitation, and insufficient utilization of gray water can all contribute to water supply issues. With the country's present climate, it's clear that things are getting close to a breaking point. According to statistical data, there has been a consistent rise in the measured temperature within the Zayandeh Rud river basin over the last 35 years. Consequently, the mean temperature has risen by 1.2 degrees Celsius per two decades. This temperature increase has resulted in a significant change in the region's precipitation pattern, causing the solid phase to transition into a liquid phase. In previous times, precipitation mostly manifested as snow, which would then melt and contribute a consistent stream of water into the Zayandeh Rud River. Conversely, the precipitation pattern has shifted toward rainfall as a result of the increase in temperature, and a substantial portion of the precipitation falls within a brief period, resulting in inundation in the region.

In the 2019-2020 water year, the Zayandeh Rud dam discharged water throughout the summer without considering the drought situation, according to an informed

source. In contrast, prior years ensured the availability of potable water before releasing water.

The nation's statistical yearbook states that during the 2018–2019 water year, the province had 25,653 deep wells and extracted 1908 million cubic meters of water, a 3.4% increase over the year before. Furthermore, the province maintained a total of 12,537 springs, which is the same number as the previous year. The yearly water withdrawal from these springs amounted to 1036 million cubic meters.

Approximately 55% of the Zayandeh Rud water basin has poor subsurface water quality. Of the remaining 45%, nearly 30% of the affected areas fall into either restricted or critical classifications. The annual excessive groundwater removal amounts to roughly 400 million cubic meters. An estimated 40% of the rainfall in the basin takes place during the non-agricultural season. The utilization of fossil water will result in irreversible outcomes including land subsidence, climate change, and the proliferation of diseases.

"Fossil waters" refers to water reserves located at depths greater than 300 meters below the earth's surface. Researchers project their storage time to span from thousands to millions of years. The reserves of these waters are finite and their utilization has the potential to disrupt the equilibrium of soil, water, and air. Consuming them via deep wells is tantamount to annihilating the local ecology (Pourkashani, 2021).

B- water demand and consumption Problems

1.The agricultural industry suffers from suboptimal water efficiency.

2. Traditional agricultural production structure

3. Industrial Utilization of Freshwater (Water Footprint Index) 4. Virtual Water Export

5. Interregional physical interconnection of freshwater

6. Unregulated depletion of subterranean water reserves

7. Transportation-related water loss 8. Unconventional hydrological consumption patterns

The Zayandeh Rud River is home to numerous industries that rely on water.

10. The Mobarakeh Steel Company and its associated entities

Iran endured its third consecutive drought in 2022. Under these circumstances, the industrial sector consumes 4 billion cubic meters of the nation's water resources annually (Fars News, 2021). The industrial sector currently utilizes 2.1 billion cubic meters of wastewater, offering opportunities for treatment and reuse in both industrial and urban green spaces (Fars News, 2021). Given the acute water shortage in central provinces like Isfahan, Yazd, Kerman, and Markazi, characterized by arid and desert conditions with minimal precipitation, it is not only imprudent but also results in environmental degradation and contamination of soil, water, and air, ultimately giving rise to a range of diseases. According to the Isfahan University of Medical Sciences, the cancer prevalence among Isfahan inhabitants is 20%, making this province have the highest incidence of multiple sclerosis (MS) patients in the country.

The nation consistently generates buoyant virtual water exports. "Virtual water" refers to the total amount required to create a unit of restricted products or services. In particular, between 2007 and 2014, the average virtual water consumption for the strategic wheat product in Isfahan Province was 2.41 cubic meters per kilogram. This data suggests that each kilogram of wheat requires approximately 2410 liters of water. From 2008 to 2014, Isfahan Province transitioned from a virtual water exporter to a virtual water importer, particularly for wheat cultivation. In Iran, the average virtual water content of wheat is approximately three cubic meters per kilogram, which is nearly twice the global average.

With 563,000 hectares of cultivable land and just 3.4% of the nation's agricultural area, Isfahan Province is a significant producer of citrus fruits, greenhouse goods, and medicinal plants. With 2400 hectares, including 2200 hectares dedicated to vegetable cultivation and 200 hectares intended for ornamental plants, it holds the country's top position in greenhouse production. The facility has a refrigerated product production capacity of 573,000 tons, placing it third in honey production with 31,000 tons, first in milk production with 2.1 million tons, second in egg production with 93,400 tons, second in meat production with 192,000 tons, and third in apple harvesting. Nevertheless, these significant elements are no more essential than the quantity of freshwater used in heavy enterprises, resulting in water's physical movement between diverse regions.

3.2. Water consumption in industries. (Water footprint index)

The water footprint concept is closely related to "virtual water export." In other words, a region's residents consume the total volume of fresh water that the water footprint represents. This index prioritizes product-producing locations with low water consumption. It can prepare the land. This index also shows natural resource use.

Blue, green, and grey water footprints exist. According to the national water footprint index (nwf), the province used 6950.3 million cubic meters of water to produce economic

products in 2013, with a water footprint of 13502 million cubic meters (Apurajungani & Nasrollahi, 2021). This research found a considerable disparity between economic sectors' water use based on water footprint and adverse outcomes based on traditional measures.

A water resources management and sustainable development report based on UNESCO data states, "Iran has the third place in the water footprint index among the countries of the world after the United States and China with an index of 1640." Due to water shortages, the World Resources Institute predicted in 2005 that Iran would have acute water stress by 2040.

Isfahan province has 9000 active industries and industrial units, making it the 2nd industrial region of the country, and 834 mines rank second in the country. It ranks third in investment with 6.7% of the country's mines, and its steel industry ranks first with 60% of the country's steel, including Mobarakeh Steel Industrial Complex, the Middle East and North Africa's largest sponge iron and steel producer. In Iran, the cement industry accounts for over 12% of production, the gold and jewelry industry for over 50% of workshops, the Hesa Aircraft Company for advanced aircraft manufacturing, the Isfahan Oil Refinery Company for 23% of petroleum products, and the Isfahan textile companies for 35% of textile production. The third country contributes 5.89 percent to Iran's GDP and 46.1 percent to its economic participation, as the Deputy for Economic Diplomacy of the Ministry of Foreign Affairs reported in January 1400. It exports 2.07 billion dollars and imports 563 million dollars. The water footprint index and virtual water export estimate the extent to which per capita water consumption for producing goods and services surpasses the import deduction.

3.3. The nation river's highest-consumer

Mobarakeh Steel Company is the primary consumer of water from the Zayandeh Rood River in the Republic of Iran. Addressing the impact of Mobarakeh steel on the water social problem is a challenging and intricate endeavor. Although this major corporation has made a substantial contribution to the growth and development of our province and country, it has also caused numerous conflicts and disputes in recent years due to environmental pollution and excessive consumption of fresh water from the Zayandeh Rood River and the transfer of water between watersheds, particularly Zayandeh Rood water. However, the investigation of the social aspects of Isfahan Mobarakeh Steel's role in the water issue is far more complex and profound than what is described in the current literature. has been

In order to achieve the objective of achieving equilibrium in the value chain of Mobarakeh Steel Group, the company intends to invest 7000 billion Rials. This investment will be made through the purchase and sale of shares in mining and metals development companies, as well as through participation in capital increase and management activities in strategic companies. The company requires an annual supply of foreign exchange resources amounting to 1000 billion tomans to support its value chain, finance, and the collection of resources from exports and payment of foreign exchange expenses. This has positioned the company as the primary contributor to economic, cultural, and political growth and development.

An analysis of the holding businesses of this large corporation, as well as other steel companies that heavily rely on the material and spiritual resources of Foulad Mobarakeh and can only sustain themselves through the policies and strategic initiatives of this group, reveals the magnitude of Foulad Mobarakeh. Extending beyond the 35 square kilometers of the factory located in the southwest of Isfahan city, it encompasses the entire area of Iran.

The steel sector relies on fresh water and liquefied gas for its survival, and the absence of these two vital resources puts its survival in jeopardy. The extensive production carried out in the plant located in Mobarakeh, Isfahan, as well as in its associated industries spanning from Chahar Mahal and Bakhtiari to Ardakan, Yazd, Hormozgan, and Khorasan, necessitates a substantial provision of fresh water.

3.3 Freshwater systems inter-basin physical transfer

Records related to Yazd province's water delivery. To fulfil his obligation to his fellow citizens, the former president, Mr. Khatami, appointed his fellow citizen, Mr. Bibar, to the Ministry of Energy. In spite of negative effects on the environment, politics, and the area, and protests from the public and some officials, he made this change. Yazd Regional Water Company provided statistical information to the Mehr news agency on January 31, 2017. The initial phase of this water transfer project entails moving 78 million cubic meters of drinkable water from the Zayandeh River sources into this area. The inclusion of water transfer statistics for industrial and agricultural activities has a catastrophic effect on Isfahan and Zayandeh Rud's ecological integrity.

Table 2

Extracted Themes for the Causes and Factors of Water Crisis Conditions

Main Components		References and Sources Reviewed
Newspaper and publications	3 cases	Population growth and heightened consumption
News agencies	5 cases	Excessive and irrational consumption
Governmental Websites and NGO	9 cases	Inadequately formulated legislation, insufficient enforcement, and a lack of commitment to implementing effective laws.
Scientific information banks	7 cases	Management is characterized by inefficiency, isolation, and a focus on self-interest.

3.4. Water dissipation in transportation

An accurate estimation of the quantity of water lost during physical water transfer is only possible due to reliable data. Conversely, the Yazd Regional Water Company's Vice President of Planning and Development refers to an "innovative plan to conserve water transfer to Yazd" in a news article published in 1400. The transmission route undergoes substantial water loss, as indicated by the Yazd Central Radio and Television report. The Yazd Regional Water Company's Research and Development Unit has determined that the majority of water transfer occurs in the country's catchment areas, specifically in Isfahan. These regions have put clever and inventive waste management techniques into practice. Efficient waste management is the top priority for Yazd province's water managers.

3.5. Non-aquatic causes, elements, and circumstances

A- Population growth and excessive consumption

"In recent decades, the imbalance in economic planning, the concentration of planning and industrial investments in a small area of the province, polar development, and the lack of attention to spatial development have impacted Isfahan province, leading to severe population transfers." More than 591,000 individuals (15% of the province's population) entered or relocated within the province between 1965 and 1975. Of this number, 40% were from other provinces, 3% were emigrants from abroad, and 57% were associated with urban and rural relocation within the province. According to research on inter-provincial migrations in Isfahan, the province's net migration of 190 thousand individuals in 1335 increased to +67 thousand individuals in 1375. This province, on the other hand, has transitioned from a migrant-sending to a migrant-receiving state.

As a result, the city of Isfahan has a greater capacity for industrial, commercial, cultural, and service development, as well as immigration, than other regions. It has elevated the metropolis to the third position in Iran. According to the province's displacement statistics, there is an uneven distribution of foreign and domestic immigrants across various cities, with some experiencing annual population growth exceeding 19.5% (Shahin Shahr). Born in 1378, Bik Mohammed

B-Lack of assurance, and enactment of desirable laws

The number of approved water-related laws are extensive and contradictory, requiring a thorough review of hundreds of books. It only mentions a selected few laws: "In 1383, the government of the time submitted a bill to the parliament under the title of the provinces' water independence law." This law became effective upon its approval by the parliament. According to this law, each province can manage and own the water resources within its political boundaries, without regard for critical factors such as ownership and natural boundaries." This legislation has drawn numerous criticisms. In recent years, it has had a significant impact on the country, resulting in multiple water tensions. The managers of Chaharmahal and Bakhtiari provinces have overlooked the fact that Ben city lies within the Zayandeh Rood watershed, drawing its water resources from the Zayandeh River and the Gavkhoni wetland (Tavani, 2020).

According to Rule 127, the Ministry of Energy is required to take action "with the objective of reducing the water consumption of the industry and mining sector in relation to the reallocation of the water consumption of industries, mines, refineries, and power plants." Even under the most optimistic circumstances, this legislative provision appears to significantly impact the decrease in water usage nationwide.

Article 141 strictly prohibits the movement of water between internal watersheds for non-drinking purposes. Despite this provision's apparent efficiency and effectiveness, the problem is that nearly all water transfer plans developed and implemented in the country are based on the slogan "supply of drinking water." The contractors who work with the Ministry of Energy have developed a

level of expertise in creating jobs for themselves as a result of the drinking water shortage slogan. We recommend amending this legal article to permit the transfer of water between basins for the purpose of providing drinking water, provided that the deteriorated urban and rural water transfer network, the coordinates of the transfer destination, and all processes related to optimizing drinking water consumption have been put into place.

C-Ineffective and isolated administrations

Conducting research and investigation on the ineffectiveness of ministers and managers in the water sector reveals vast amounts of evidence regarding the failures of system managers in various administrations, both prior to and following the revolution. The only point of reference is the separation of the Chaharmahal Bakhtiari regional water company from Isfahan, as well as the appointment of ministers and managers from Yazdi and Kermani to the Ministry of Energy in various governments, including Khatami (Habibullah Bitraf, born in Yazd), Ahmadinejad (Majid Namjoo, born in Kerman), and Rouhani (Reza Ardakani, born in Yazd). Additionally, the process of dam construction and interbasin water transfer, particularly towards Yazd and Kerman, from Isfahan province, Chahar Mahal and Bakhtiari, Kohkiloyeh and Boyer Of course, the tempo persists; it is important to remember that this issue is not limited to these regions; the protest

3.6. Implications

An analysis of the patterns of causes and elements contributing to water scarcity as a societal problem in Iran uncovers six distinct categories of outcomes. Environmental repercussions encompass climate change, land subsidence, heightened dust levels, and desertification, which in turn give rise to further consequences, including health implications.

The health implications arise from the increase in temperatures, the occurrence of floods, and the decrease in snowfall. These lead to adverse occurrences and impact human biology and body composition, fostering the development of several diseases, including cholera and other illnesses. Therefore, they increase healthcare expenses and significantly strain the government's financial resources for patient treatment. The third category of economic repercussions includes reduced gross domestic output, heightened unemployment in the agriculture industry, and food security risks.

From a sociological perspective, the nation's migration and demographic displacement are the primary dangers posed by water scarcity. The "drought migration" phenomenon to metropolitan areas intensifies urban challenges, including poverty, unemployment, marginalization, and social damage. According to Sabzevari and Kulivand (2017), The most challenging consequence of water scarcity is political repercussions arising from inadequate planning and the absence of preventive measures. Significant water conflicts marked 2021-2022 among the provinces of Khuzestan, Chaharmahal, Bakhtiari, Isfahan, and Yazd. These tensions can result in social isolation, disappointment, rage, and acute confrontations if not adequately comprehended and controlled. Cultural factors are the final category of effects. Failure to uphold the concept of water and soil identity and national cultural integrity and straying from this shared identity fosters the expansion of ethnic, racial, and religious extremisms. Consequently, in turn, it reinforces separatist ideologies that target Arabs, Turks, Sunnis, and other groups.

Examining the consequences of water shortage reveals a significant interconnection. The occurrence of one consequence will initiate another, therefore establishing a chain reaction that presents possible hazards to the lives of individuals not only in a specific area but also throughout the entire nation. These hazards jeopardize the ecology, environment, climate, identity, and national cohesion and affect a nation's autonomy, exposing it to economic collapse and fragmentation. This is particularly concerning in a country where the dominant strategy is based on identifying enemies and deliberately instilling fear.

Table 3

Extracted Components for Social Consequences

News agencies	26 cases	
References and Reviewed Sources	Main Components	Influential Components

Newspaper & publication	21 cases	-Substantial everyday migration -Degradation of social cohesion -Reduced social engagement -Reduced civic participation Reduced social trust Diminished sense of social security -Propagation of social abnormalities -Reduced perception of personal social influence	-The increasing migration of elites -Higher inter-provincial employment migration Increased rural-to-urban migration as a result of the drought -Mounting public discontent with authorities because to ongoing drought conditions -Insufficient reaction from institutions and organizations to voluntary initiatives -Officials' neglect of the populace's demands and concerns -Inadequate governmental backing for people-centric groups Prioritization of personal interests over communal advantages at all levels -Upsurge in drug-related criminal activity Increase in violent offenses against individuals -notable rise in group disputes -Increase in deliberate homicides -Growing unemployment rates Increased marginalization, particularly in peripheral urban villages with migrant populations -Growth in property theft
Governmental sites & NGO's	5 cases		
Scientific information data bank	9 cases		

Table 4

Extracted Components for Economic Consequences

References and Reviewed Sources		Main components	Influential Factors
Newspaper& publication	20 cases	Destructive components with devastating effects	-The reduction in agricultural income and insolvency of downstream farmers in eastern Isfahan are attributed to the Zayandeh Rud River. -Rising trend of agricultural land sales because to recurrent droughts -The utilization of wastewater and greywater by farmers in agricultural production -Escalating prices of agricultural commodities attributed to heightened water expenses resulting from resource constraints. -The escalating indebtedness of farmers to financial institutions and ... -Escalated healthcare costs for individuals -Increasing per capita expenses of insurance entities and medical institutions -Infrastructure devastation resulting from flooding -Recession and market stagnation resulting from diminished tourism appeal due to the desiccation of the Zayandeh Rud River. -Substantial escalation in urban land costs, especially in cities housing major industries.
News agencies	17 cases		
Governmental sites & NGO's	92 cases	Positive Consequences	-Growth in Gross Domestic Product (GDP) -Increase in the economic participation rate. -Advancement of primary and transformation industries -Expansion of industrial agriculture -Notable expansion in the service sector -Establishment of dry orchards and groves aligned with optimal land use practices, utilizing drip irrigation and cultivating low-water plants and trees.
Scientific information data bank	13 cases		

Table 5

Extracted Themes for Cultural Consequences

References and Sources Reviewed		Main Components
Newspapers & Publication	7 cases	Modifications in lifestyle and behaviors
News agencies	9 cases	Alterations in dietary inclinations
Government websites & NGO's	4 cases	Alterations in cultural identity
Scientific Information databases	5 cases in	Decline in the production and development of literary and artistic masterpieces
		Alterations in the scope of cultural capital
		Disinterest in historic structures associated with the Zayande Rud River
		Decline in tourists' inclination to see ancient monuments
		Modifications in symbolic capitals
		Reduction in the sense of pride over the city's distinctiveness (Faeqi et al., 2017)
		Advocating for Water Rights through Efficient Petitioning Water embodies identity and philosophy.i

Table 6

Extracted Health Impact Topics

References and Sources Reviewed		Components Main	Influential Components
Newspapers & publications	14 cases	Elevation in air temperature and a 2-degree increase in the central plateau	Higher cardiovascular mortality rates among adults and individuals with preexisting conditions.
News agencies	21 cases	Effects of temperature elevation on cellular biological processes	Elevated respiratory mortality rates among adults and individuals with pre-existing health conditions.
Government websites & NGO's	7 cases	Adverse impacts on physical and emotional well-being	Alterations in the prevalence of malaria, typhus, and cholera in the central plateau region since ancient times.
Scientific data bank	4 cases	Reduced social liveliness	Effects on molecular response and enzymatic activity in animals serving as primary food sources
		Reduced life expectancy	Rising social desperation and elevated suicide rates
		Provision of processed products comprising industry wastewater, greywater with heavy metals, and other wastewater byproducts	Increase in conflicts and violence
			Notable rise in respiratory and allergic diseases, as well as a significant increase in specific conditions such as multiple sclerosis and cancer, among others.Increase in gastrointestinal and internal infectious diseases linked to the consumption of low-quality food products.

Table 7

Extracted Components for Natural Consequences

References and Resources Reviewed		Main Components
Newspapers & publications	6 cases	Desiccation of the Zayandeh Rud River and persistent water flow within its channel
News agencies	9 cases	Desiccation of Gavkuni Wetland
Government websites & NGO's	24 cases	Elevated levels of particulate matter
Scientific data bank	9 cases	Increasing air temperature, particularly in the upper sections of the Zayandeh Rud River and the origins of the Bakhtiari Mountains
		Inadequate storage of abrupt and unforeseen precipitation as snowpack in the sources of the Zayandeh Rud River.
		Excessive and hazardous use of subterranean water, particularly fossil water
		Land subsidence refers to the gradual sinking or settling of the Earth's surface, often resulting from various factors such as groundwater extraction, mining activities, or natural geological processes.

	Depletion of subterranean water tables, particularly fossil water aquifers.
	Desertification refers to the process by which fertile land becomes increasingly arid and unproductive, often due to various factors, including climate change, deforestation, and unsustainable agricultural practices.
	Climate change and environmental degradation
	Distribution of particulate matter in the arid bed of the Zayandeh Rud River and Gavkuni Wetland
	Interruption of the water supply cycle and chain
	Disruption of the water supply cycle and chain due to land subsidence.
	Heat island formation and increasing temperatures
	Increase in waste and contamination of soil and water resources

Table 8

Extracted Themes for Solutions

References and Resources Reviewed		Main Components
Newspapers & publications	6 cases	Importing goods necessitating high water consumption in their production while exporting goods and services is characterized by low per capita water usage.
News agencies	9 cases	Virtual water exports have garnered significant interest from global communities as an innovative method for accessing water resources. The agricultural sector's 90% share in this trade warrants focused examination.
Scientific data bank	24 cases	
Government websites & NGO's	9 cases	Managing floodwaters and directing rainwater to usable reservoirs.
		Recycling wastewater and implementing greywater recovery systems in industrial and residential settings.
		Revising ineffective legislation and instituting legal obligations to enforce sound laws, accompanied by executive assurances, while implementing structural changes in governance strategies prioritizing sustainable development capabilities, including eco-tourism.
		Establishing a Vice Presidency for crisis prevention within the Presidential framework promoting unity of procedure in preventing the growth of water-intensive industries in the central plateau, as well as the growth of further water tensions.
		Investing and encouraging the growth and development of water technologies in proper supply and demand management."

Figure 1

Water scarcity implications, roots, theoretical Model

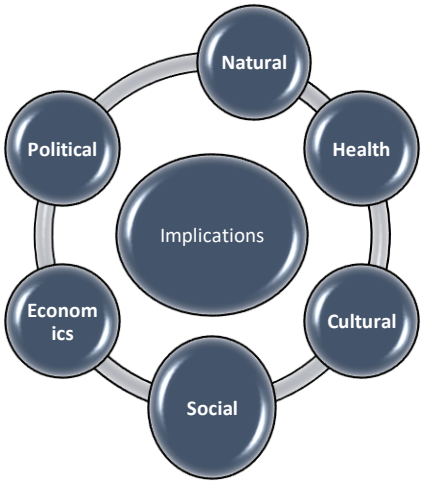
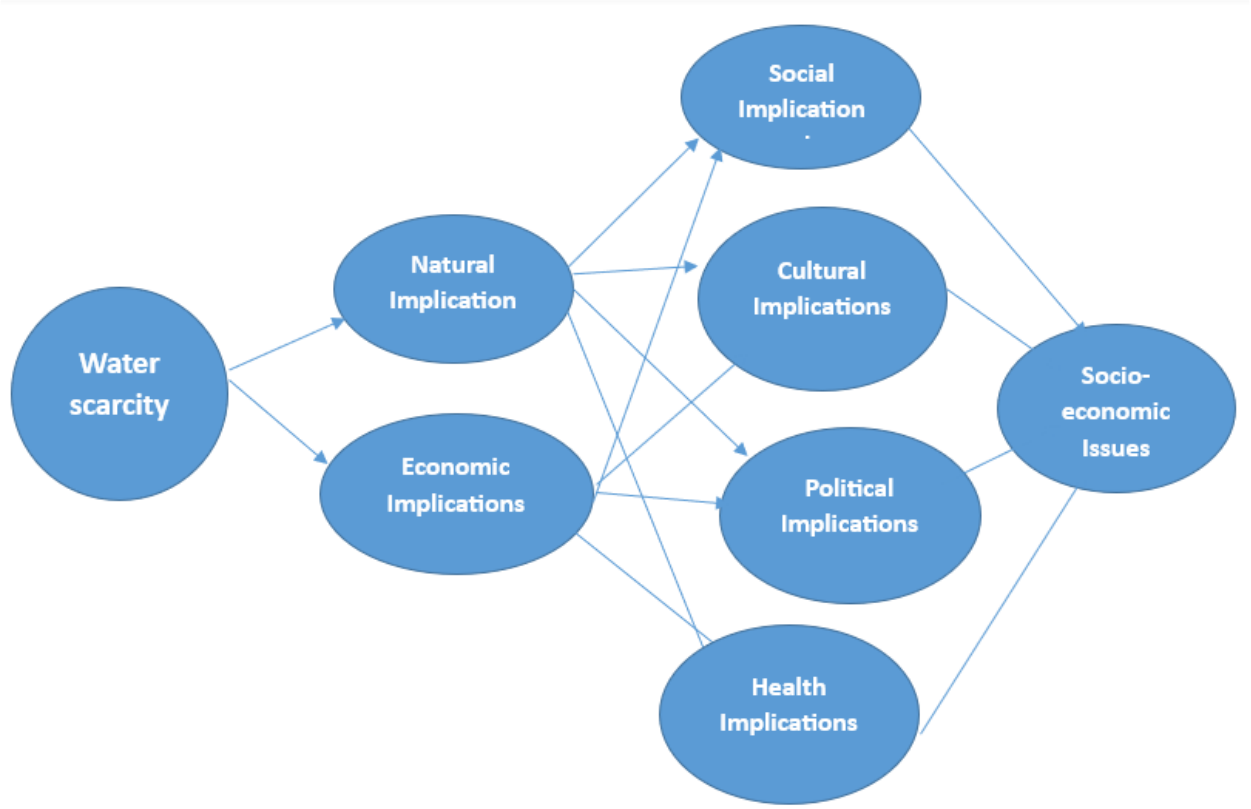


Figure 2

Water scarcity implications, roots, theoretical Model



4. Discussion and Conclusion

The findings of this study confirm that the Isfahan water crisis in the Zayandeh Rud River Basin is not reducible to hydrological scarcity alone but should be understood as a complex social, institutional, and governance problem produced through the interaction of climatic stressors, development trajectories, and policy choices. The qualitative synthesis of documents, reports, and media sources shows that water scarcity has become socially visible, politically contested, and culturally meaningful, which is consistent with sociological approaches that conceptualize social problems as conditions defined and experienced collectively rather than merely measured technically (Moayyedfar, 2020; Rabinowton & Weinberg, 2019). In this sense, the drying of the Zayandeh Rud has transformed water from a background infrastructure into a focal symbol of governance performance, distributive justice, and state–society relations.

At the environmental level, the results highlight climate-related drivers—temperature rise, altered precipitation regimes, reduced snowpack, and intensified evaporation—as structural pressures that constrain supply and amplify vulnerability. These findings align with broader evidence on the impacts of global warming and ambient temperature increases on water availability, ecosystems, and human well-being in arid regions (Anadolu, 2020; Yang, 2024). The prominence of evaporation losses from reservoirs and open water bodies in the basin corroborates recent analyses emphasizing that, in water-stressed regions, evaporation can significantly erode effective storage and must be treated as a core governance concern rather than a marginal technical detail (Shokri, 2025). Thus, even when infrastructure exists, climatic conditions can undermine supply reliability unless adaptive strategies are implemented.

Beyond supply-side pressures, the study's results underscore demand-side misalignments as central contributors to the crisis. Agriculture remains the dominant consumer, characterized by low water productivity, traditional cropping patterns, and continued reliance on freshwater despite scarcity signals. This finding is consistent with Iranian studies showing that optimizing virtual water exchanges and crop patterns could substantially reduce basin-level stress if consumption-based perspectives are adopted (Apurajungani & Nasrollahi, 2021; Mardani et al.,

2017). The persistence of water-intensive agriculture in arid zones reflects not only technical inefficiency but also institutional inertia and policy incentives that prioritize short-term output and employment over long-term sustainability. Comparable evidence from other arid and semi-arid contexts demonstrates that rationalizing agricultural water use requires coordinated policy reform, farmer engagement, and decision-support systems rather than isolated technical interventions (Pádua, 2024; Tayirov et al., 2024).

Industrial water consumption, particularly by large-scale steel and associated industries in Isfahan, emerged in the findings as a socially salient and politically sensitive issue. While industrial activity contributes significantly to regional and national economic indicators, its dependence on freshwater in a severely stressed basin has intensified public perceptions of inequity and ecological sacrifice. This tension reflects a broader governance dilemma identified in national development debates, where industrial expansion is framed as a pillar of economic resilience even as it exacerbates resource depletion (Golzar, 2022; Ministry of Foreign Affairs Economic Diplomacy, 2021). Similar conflicts between industrial growth and water sustainability have been observed internationally, underscoring the need for strict environmental management plans, performance indicators, and accountability mechanisms in water-intensive projects (Radzi et al., 2024). The Isfahan case illustrates how the absence of such robust enforcement mechanisms can convert economic assets into social liabilities.

Inter-basin water transfers constitute another critical dimension of the findings. Although officially justified as measures to secure drinking water, these projects have generated new ecological risks and social tensions, particularly when downstream communities experience reduced flows and wetland degradation. The results echo media and policy analyses indicating that transfer tunnels and conveyance schemes can aggravate crises when governance frameworks fail to account for basin integrity and stakeholder consent (Fars News, 2021; Talebi, 2021). From a sociological perspective, these conflicts are not merely technical disagreements but manifestations of competing value systems and claims to legitimacy, reinforcing the interpretation of water as a politicized social issue (Rabinowton & Weinberg, 2019).

The social consequences identified in the study—migration, declining social cohesion, reduced trust, and increased public discontent—are consistent with prior research on drought-affected regions in Iran and elsewhere. Studies focusing on Zayandeh Rud have similarly documented how water scarcity reshapes cultural identity, urban sustainability, and collective memory tied to the river as a symbol of life and continuity (Faeghi & Navabahsh, 2017; Hohenthal et al., 2017). These findings reinforce the argument that water crises generate cascading effects: environmental degradation leads to livelihood disruption, which in turn fuels migration, marginalization, and social stress. Such dynamics align with risk-society interpretations, where human-made risks undermine institutional credibility and intensify public anxiety when preventive governance fails (Ahmadi & Dehghani, 2015; Bandehi & Kouli Vand, 2017).

Health impacts identified in the results further demonstrate the multi-dimensionality of the crisis. Rising temperatures, dust exposure from dried riverbeds and wetlands, and the use of low-quality water in agriculture and urban systems are linked to increased respiratory, cardiovascular, and chronic diseases. These patterns are consistent with international evidence connecting water scarcity and climate stress to adverse health outcomes and increased public health costs (Anadolu, 2020; Hohenthal et al., 2017). The socialization of these health risks contributes to the politicization of water, as citizens increasingly interpret scarcity as a direct threat to bodily security and quality of life rather than as an abstract environmental issue.

Governance failures emerged as a unifying explanatory thread across environmental, economic, and social outcomes. Fragmented institutional responsibilities, contradictory legislation, weak enforcement, and limited participation were repeatedly identified as underlying drivers that transform hydrological stress into crisis. This finding aligns closely with recent analyses of Iranian water governance that emphasize the need for policy coherence, institutional coordination, and accountability to achieve sustainable outcomes (Eslami et al., 2025; Moradi et al., 2024). The study's results suggest that without reforming governance structures, technological advances and infrastructure investments alone will remain insufficient. International research on water supply organizations similarly highlights that organizational commitment, performance systems, and institutional culture significantly influence policy implementation under scarcity conditions (Thao et al., 2024).

The theoretical framing of water as a social problem is reinforced by the study's evidence that public attention, media coverage, and civic mobilization have increased

markedly around the Zayandeh Rud crisis. This supports constructivist perspectives that define social problems through claims-making and collective recognition rather than objective thresholds alone (Rabinowton & Weinberg, 2019). At the same time, historical and political interpretations—such as those derived from discussions of oriental autocracy and centralized resource control—remain influential in shaping public narratives about responsibility and power in water governance (Tavani, 2020; Wittfogel, 2012). The persistence of these narratives suggests that contemporary water conflicts are embedded in long-standing institutional memories and political imaginaries.

Finally, the findings indicate that alternative paradigms—such as consumption-based accounting, virtual water trade, wastewater reuse, and social economy approaches—offer promising pathways for reframing water governance. Evidence from Iranian and international studies suggests that aligning production, trade, and consumption with water availability can reduce pressure on stressed basins while maintaining economic viability (González, 2021; Mardani et al., 2017). However, the adoption of such strategies depends on political will, social acceptance, and institutional capacity, reinforcing the central conclusion that sustainable water management in Isfahan is fundamentally a governance challenge rather than a purely technical one.

The present study relies on secondary qualitative data drawn from documents, reports, and media sources, which limits the ability to capture real-time behavioral responses and informal decision-making processes among water users. The absence of primary fieldwork, such as interviews or surveys with farmers, industrial managers, and households, constrains the depth of insight into lived experiences and micro-level adaptations. Additionally, the qualitative content analysis approach emphasizes thematic breadth rather than quantitative causality, which may limit the generalizability of specific findings beyond the Zayandeh Rud Basin.

Future studies should integrate mixed-methods designs that combine qualitative insights with quantitative modeling to assess the relative weight of climatic, economic, and governance drivers in shaping water outcomes. Longitudinal research examining how public perceptions, trust in institutions, and patterns of protest evolve over time would provide valuable understanding of the social dynamics of water crises. Comparative basin-level studies within Iran and across other arid regions could further illuminate how different governance arrangements mediate similar hydrological pressures.

Policy practice should prioritize integrated water governance frameworks that align environmental limits with economic planning and social equity considerations. Strengthening institutional coordination, enforcing existing regulations, and enhancing transparency and participation are essential to restoring public trust. Practical measures such as promoting wastewater reuse, adjusting crop patterns, limiting water-intensive industries in stressed basins, and investing in demand-management technologies should be embedded within a broader governance reform agenda that treats water as a shared social good rather than a sectoral commodity.

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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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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