Water for Food Security Under Climate Change: The Case of Iran

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Abstract
This paper examines how the post-1979 Government of the Islamic Republic of Iran developed its water resources management with the stated intent of attaining self-sufficiency in agricultural production. The paper investigates the bureaucratic and water resource management practices in Iran through the lens of the socio-political culture. We present how the policy, initially well-intentioned and perceived to address food security concerns, has hurt Iran due to inefficient distribution and management of water resources in the agricultural sector. Far from achieving IWRM (SDG 6.5), Iran failed to reach its goal of agricultural self-sufficiency. The paper argues that by ensuring efficiency in water use, i.e., SDG 6.4, Iran can manage its agricultural production to move toward food security within the perspective of SDG 2 – Zero Hunger.

Introduction
This paper examines how the Government of the Islamic Republic of Iran developed its water resources management to attain self-sufficiency in agricultural production post-1979. We present how the policy, initially well-intentioned and perceived to address food security concerns, has hurt Iran due to inefficient distribution and management of water resources in the agricultural sector. The paper will present the mismanagement of water resources in Iran by visualizing the uncertainty in the water supply to the agricultural sector. Furthermore, the essay will aim to understand the bureaucracy and the perception of water resource management in Iran through the lens of the socio-political culture.

This paper will primarily explore the success and failure of integrated water resource management from the lens of Sustainable Development Goal (SDG) 6 – Ensure availability and sustainable management of water and sanitation for all. Mainly, we will focus on implementing integrated water resource management systems in the Iranian agricultural sector. We will present how Iran failed to reach its goal of agricultural self-sufficiency and how the policy negatively impacted its agricultural production capability due to political and technological mismanagement of water resources. The paper will argue that by ensuring efficiency in water use, i.e., SDG 6.4, Iran can manage its agricultural production and ensure food security. We will present how developing the integrated water resource management system under the threat of climate change in Iran can ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production within the perspective of SDG 2 – Zero Hunger.

In the first part of this essay, we will present the concept of Integrated Water Resource Management (IWRM) and how efficient adoption of the principles of IWRM can help Iran reach the targets of SDG 6. The section will also briefly explore how adopting integrated policies will allow a state to boost food production in the age of climate crisis, resulting in improved food security and allowing the country to reach the targets of SDG 2 – Zero Hunger.
In the second part of the essay, the paper will present the history of water resource management in Iran, and the paper will present how current water management and agricultural production targets were adopted in Iran. The paper will focus on the policies that emerged after the Islamic Revolution of 1979. Iran adopted a policy of self-sufficiency in agricultural production post-1979 (Babagoli & Ikeda, 2019).

In the third part of the essay, the paper will explore the socio-political reasons behind the adoption of the current water resource management policy in Iran. Following that, the paper will present the technological aspect of Iran's current water management policy and how it was developed. The paper will explore the efficiency level of the system and will present the disadvantages presented by the current levels of technology. Finally, the paper will present what steps may be taken to ensure that principles of IWRM are adopted efficiently to ensure that targets of SDG 6 and SDG 2 are met.

What Is IWRM & How Can It Help Reach SDG 6 and 2?

Integrated Water Resource Management (IWRM) is a holistic approach to water management that aims to balance the competing demands of different water users while considering the ecological and social aspects of water resources (Pires et al., 2017). In other words, IWRM involves managing water resources in a way that considers the needs of all stakeholders, including the environment, and ensures water is used sustainably. The critical components of IWRM include governance, management, allocation, and assessment (Pires et al., 2017). Governance involves developing policies and regulations that guide water resource management, while management involves implementing these policies and regulations. Allocation refers to distributing water resources among different users, while assessment involves monitoring and evaluating the effectiveness of IWRM strategies. The adoption of IWRM has been widely recognized as a critical strategy for achieving sustainable water management, particularly in regions where water resources are scarce or under stress (Pires et al., 2017). IWRM has also been defined as "a process which promotes the coordinated development and management of water, land, and related resources to maximize the resultant economic and social welfare equitably without compromising the sustainability of vital ecosystems." (Giordano & Shah, 2014). The policy recognizes that water resources are finite, and their use must be managed sustainably to meet the needs of present and future generations. It emphasizes the importance of stakeholder participation and integrating various sectors in decision-making, including agriculture, industry, and urban development. The implementation of IWRM requires the identification of water-related problems, the development of solutions, and the establishment of institutional frameworks to ensure effective management. In conclusion, IWRM offers a comprehensive and practical approach to managing water resources, which ensures sustainable development and equitable distribution of benefits. It is essential for achieving water security and environmental sustainability.

Integrated Water Resources Management (IWRM) is crucial for achieving Sustainable Development Goal (SDG) 6 to ensure water and sanitation availability and sustainable management for all. SDG 6 requires a comprehensive and integrated approach to addressing water scarcity, pollution, and inadequate sanitation facilities. IWRM provides a framework to achieve this goal by promoting sustainable and equitable use of water resources, enhancing water security, and improving access to safe drinking water and sanitation. Furthermore, implementing IWRM can lead to economic, social, and environmental benefits, such as increased food security, reduced poverty, and improved health.

In addition to SDG 6, adopting IWRM can also lead to meeting the goals of SDG 2, which aims to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. IWRM can contribute to sustainable food production systems by promoting water-efficient technologies like drip irrigation and rainwater harvesting. These technologies can reduce water use and minimize the negative impact of irrigation on the environment, such as soil erosion, groundwater depletion, and pollution. IWRM can also support agroecological practices that promote sustainable use of natural resources and biodiversity conservation. In addition to improving water management in agriculture, IWRM can contribute to achieving SDG 2 by promoting rural development and infrastructure. Rural areas often need access to essential services such as safe drinking water, sanitation, and energy. IWRM can

help improve access to these services by promoting the sustainable management of water resources and supporting rural infrastructure development. For instance, IWRM can support the construction of water supply systems, sanitation facilities, and renewable energy sources in rural areas, leading to improved living standards and increased economic opportunities.

History of Self-Sufficiency & Water Resource Management in Iran Post-1979

The year 1979 marked the era of unprecedented changes in Iran. With the fall of the Shah, the new revolutionary government of Iran embarked on drastic policy changes that aligned with their ideology rooted in populism to appease primarily the rural subsistent farming population of the country who were being marginalized by Shah's policy of agricultural land reforms as part of The White Revolution (Wolfe, 2015). The country included the principle of attaining self-sufficiency in agricultural production in Article 3 of its new constitution (Constitution of the Islamic Republic of Iran. Art III § 13). The first post-revolution development plan prioritizes the "transformation of the oil-based economy to a non-oil" economy (Shakoori, 2006). It was supposed to be achieved by investing in rural development and agricultural self-sufficiency. Moreover, nationalist discourse to reduce dependence on imports pushed the revolutionary government to adopt policies to achieve self-sufficiency in agricultural production. The Iranian government's pursuit of agriculture was primarily driven by geopolitical concerns and the belief that the country's dependence on imports had made it vulnerable to foreign pressure and undermined its economic and political sovereignty (Matthee, 2020).

The quest for self-sufficiency has led to the depletion of water resources and inefficient water resource management systems. Since the 1980s, Iran has invested significant resources towards damming major rivers and expanding the cultivated land area. Due to this, many large-scale irrigated-farming schemes have been developed, and dams built over significant river systems. The policy to dam rivers to divert water had an irreversible impact on the sustainability of the nation's renewable water resources that continues to this day. The most significant consequence of this policy was the overexploitation of surface and groundwater resources to cultivate land. Water was diverted from rivers without regard for the minimum environmental requirement. This diverted water was offered to farmers at a minimal cost (Water Challenges in Iran - Fanack Water, 2022). While the Government of Iran has realized its mistake, dams were being built continuously to support its political ideology. Issa Kalantari, a former Minister of Agriculture, said in 2018. "We made these mistakes in the 1980s... we came to realize that in places that we'd built dams, we shouldn't have built any, and in places where we should have built dams, we didn't build any." (*Explainer: Iran's "Water Bankruptcy,"* 2021).

After the revolution, in 1982, Iran's passed its first water management law. The law states that the Ministry of Energy will allocate industrial, agricultural, and residential water permits. Along with the energy supply, the Ministry also oversees the construction of large hydraulic works, including dams, irrigation networks, and drainage canals for water distribution. On the other hand, The Ministry of Agriculture is responsible for maintaining rain-fed and irrigated crop development, whereas the Department of Environment is responsible for assessing the environmental impact of irrigation and hydropower projects (*Water Management in Iran - Fanack Water*, 2022). Furthermore, constructing dams and other mega-projects symbolized development legitimizing the regime's rule. The Government of Iran prioritized symbolic gestures, including subsidies which allowed them to gain sympathy among the rural population. However, it also resulted in an inefficient water resource management system.

State of Water Resources in Iran

Water Resources and Consumption in Iran (2017)	Amount (billion cubic meters)	Citation
Total Renewable Water Resources	120	FAO

Total Internal Renewable Water Resources	88.5	FAO
Total External Renewable Water Resources	31.5	FAO
Total Surface Water Resources	130	FAO
Total Groundwater Resources	75	FAO
Total Desalinated Water Production	0.67	World Bank
Total Treated Wastewater Reused	0.06	World Bank
Total Water Withdrawal	94.5	FAO
Agricultural Water Withdrawal	89.5	FAO
Industrial Water Withdrawal	4.4	FAO
Municipal Water Withdrawal	0.6	FAO

Iran is in arid and semi-arid areas. Agriculture uses 90% of water while contributing to only 10% of the GDP (Mirzaei et al., 2019). Also, 20% of the population are farmers and are reluctant to change their careers since there is no better alternative for them (Madani et al., 2016). Heavy subsidies for energy and water also reinforce easy and cheap food production, which provokes the locals to compensate for the mismatch between water availability and demand through underground exploitations. However, agricultural practices are not industrialized, and farming technologies need to be updated, leading to low efficiency in irrigation and production (Madani, 2021). In addition, agriculture in Iran significantly depends on underground water (due to surface water scarcity). This equals 60% of all water supply (Mirzaei et al., 2019). The number of wells increased by almost 84%, while the underground water level decreased by 18% (Noori et al., 2021). The depletion of underground water caused a 10 to 100 cm/y decrease in different areas, leading to irrigation water salinity (Noori et al., 2021). Based on UNICEF and World Bank Data, 97% of Iranians have access to basic drinking water, while 81% face water stress. Although Iran is facing severe water security and, consequently, food security for the depletion of water supplies, severe food insecurity is almost 8% in 2020, and the prevalence of undernourishment is 4% in the population (87 million). Deep wells, overexploitation of underground water, and building dams and diversion projects on surface water negatively affect the progress of SDGs (Sustainable Development Goals) regarding water security.

What is wrong?

Although there are thousands of well-designed plans and projects (with the help of many national and international environmental organizations, NGOs, and professionals), implementing such plans is necessary for the IWRM in Iran. The failure of these projects (at least in the long term) is associated with the instability and complexity of the economy, the governance structure, and social boundaries.

Economic dependency on national resources (oil and gas) has led to a state-run economy, inequity, fraud, and corruption. Rentier state theory was first proposed by Iranian economist Hossein Mahdavy in 1970 to clarify how selling oil can affect the national income (GDP) without significant economic growth leading to many social, environmental, and economic inequities and problems (oil curse). Poor administration in the extended public sector has also weakened social capital. Many strategies, including food-related policies, depend on

the governmental budget for subsidizing food, water, and energy. Although 90% of lands have private owners, privatization in the food industry has failed since the government control the cost of production in the market and allocate subsidized exchange rate for importing goods in this sector. Small stakeholders (usually in rural areas) cannot compete with the public sector (the most significant food market). As a result, the public agricultural sector is significantly extended, which prolongs any incentive programs or hinders IWRM implementation in many ways, particularly - 1) Increasing Bureaucratic Routines. 2) Impeding Integrated Projects and Cohesion 3) Politicizing the Agriculture Projects 4) Affecting the Investors and Privatization. When the government makes most decisions in this sector, the plans are usually restricted to urgent problems for only four years (the duration of the government). Therefore, the IWRM become the last priority (Madani, 2019).

Another barrier to achieving the IWRM in Iran is the need for more monitoring of the projects. Managers in the Department of Environment (DOE), with the help of international, national, and regional organizations and activists, usually need the force of law for actions (a huge gap between theory and practice). The DOE cannot monitor and inflict a penalty on a farmer for having an unpermitted well. At a higher level, it influences the government's decisions on building dams or transferring basins. An example of this issue was the Chamshir Dam (come to stream by March 2023). The domination of powerful engineers and a political will for rapid development restrict environmentalists and IWRM. Due to the lack of power and financial resources, IWRM usually does not apply to local stakeholders (Qader et al., 2018).

From the societal perspective, a national desire for exporting crops and food self-sufficiency caused the depletion of water resources for water-intensive crops (for domestic use and exporting). For many people, food self-sufficiency equals food security, and the amount of exporting is a sign of development. In addition, women must be more involved in most projects as they play a crucial role in farming. On average, 70% of farming activities are done by women (65% of rice, 60% of cotton, and 70% of fruits and vegetables), but they only contribute to 11% of home income (Statistical Center of Iran, 1998).

However, the government is not the only contributor to blame. Since the revolution in 1979, all growth in GDP has been shut down by sanctions. From 2007 to 2008, GDP growth decreased from 8.2% to 0.3% because of the toughest sanctions. This scenario also happened in 2012 with -3.7% growth in GDP. During the UN nuclear agreement in 2015, the GDP grew to 8.8%, while in 2018, President Trump withdrew from that international agreement causing a 2.3% growth in GDP (World Bank Data). Before the Ukraine-Russia war, Iran had imposed the largest sanctions in history, with 3,616 active sanctions by multiple countries (Castelum.ai). International economic sanctions against Iran have significantly exacerbated food security by restricting technology and services and increasing pressure on natural recourse (Madani, 2021). In addition, sanctions extend the government since the government's intervention increase to make balance in the system, causing a reinforcing loop of problems.

State-regulated water management and irrigated agriculture increase the competition between provinces to produce food and water consumption, leading to many conflicts for surface water in the center of Iran (such as in Isfahan province). Some local projects exacerbate the situation. As the demands increased in Isfahan, the government relocated the basins, which needed to be more sustainable and caused many conflicts between beneficiaries in nearby provinces. Karun and Dez basins transfer to the Zayandeh-Rud basin. As a result of desertification and providing water by relocating other water sources to Zayandeh-Rud, the migration to this province increased. This population also increased the demand for water, food, and land. Isfahan is the country's second most important industrialized region, and many move to this province (especially youths) in search of better jobs (Due to sanctions, many industries and companies in the country have been closed, affecting the employment rate). Therefore, there is a conflict between households, industries, and agriculture regarding water.

Water Systems – Development and Diversion

Water systems development and diversion have been a significant aspect of Iran's agricultural sector since 1979. This development has been instrumental in the country's food production and water security. The existing water system has allowed for increased irrigation and crop production, providing sustenance for many Iranian farmers. However, this development has not been without its challenges and criticisms. In this section, we will explore the development of water systems in Iran since 1979, and the impact of water diversion on food and agriculture.

The dry climate of Iran makes water resources management and development a crucial aspect of its economy and livelihoods. Over the past few decades, Iran has invested significantly in water systems development and diversion projects to meet the increasing water demand for various purposes, such as agriculture, industry, and urbanization. According to a study by B. Libanda and H. Paeth (2023), Iran's water system development projects have intensified since the 1979 revolution, symbolizing the government's commitment to sustainable water resource management. The study reveals that Iran has constructed numerous dams, reservoirs, and irrigation systems, including the Karaj and Dez dams, among the country's largest water projects. These projects have increased water supply and storage and enhanced energy production, flood control, and irrigation. However, the study also highlights that these water systems development and diversion projects have led to ecological and social consequences, such as displacement of local communities, loss of biodiversity, and water pollution. Nonetheless, Iran's water systems development has significantly contributed to its economic development and social well-being, making it a critical area for continued research and management.

Impact on the Agricultural Sector

The impact of water diversion on food and agriculture in Iran is a crucial issue that needs to be addressed, as it affects the country’s food security and its economic stability. According to Moridi (2017), water diversion projects have resulted in significant reductions in the flow of rivers, which has affected water availability for agricultural purposes. This has led to a decline in crop yields and increased food prices, making it difficult for farmers to earn a livelihood. Moreover, water diversion projects have also caused soil degradation due to the increased salinity of the soil, further reducing agricultural productivity. The construction of dams and canals has also resulted in the displacement of rural populations, significantly impacting their livelihoods. The loss of land and access to water has forced many farmers to migrate to urban areas in search of alternative employment opportunities, leading to urbanization and a decline in rural economies. Therefore, policymakers in Iran must address the issue of water diversion and its impact on food and agriculture to ensure the country's food security and economic stability.

Failure in the Existing Water Management Systems

Water management failures have had a significant impact on Iran’s agricultural sector. According to H Salami, N Shahnooshi, and KJ Thomson’s article published in the Journal of Ecological Economics in 2009, the lack of efficient water management and appropriate technology has contributed to the sector’s failure. In particular, they note that water resources in Iran are increasingly affected by climate change, resulting in a decrease in available water supplies. This has caused an increase in the cost of irrigated farming, leading to a decrease in production and an increase in the cost of food for consumers. Also, the lack of proper water management has increased water salinity levels, negatively impacting soil fertility and decreasing the quality and quantity of crop yields (Madani, 2021). These failures have had detrimental effects on the health of the agricultural sector and the economy.

Poor planning has been a significant factor in the water management issues in Iran. According to AR Ommani in the African Journal of Business Management (2011), the country possesses

abundant water resources yet is facing a water crisis due to the need for proper management and planning. Ommani argues that this is due to an inadequate national water resources management plan, which needs to account for population growth and the effects of climate change and regional water demand. Furthermore, unsustainable water extraction practices have led to over-exploitation of groundwater resources and the drying up of rivers, resulting in water shortages and degraded environments. Moreover, the lack of a comprehensive water resources management system has made it difficult to monitor, regulate, and protect water resources effectively. Poor governance and bureaucratic inefficiency have also contributed to the inefficient use of water resources, leading to water scarcity and environmental degradation. Ultimately, these issues demonstrate the need for a comprehensive and holistic approach to water management in Iran, considering the various political, economic, and environmental factors affecting water resources.

Existing Strategies for Improvement

Water management and technology are essential factors for the agricultural sector of Iran to sustain its existing infrastructure and build on it for future growth. Iran faces several water-related challenges, such as water scarcity, priority water rights for urban areas, and water pollution (Madani, 2014). The Iranian government has identified several strategies to improve water management and technology in the country's agricultural sector to overcome these challenges. These strategies include implementing efficient irrigation systems and introducing modern technologies to reduce water wastage and improve water distribution (Madani, 2014). Additionally, the Iranian government has implemented several policies to encourage water conservation and discourage over-extraction of water resources (Madani, 2014). These policies include the development of new water resources, the rehabilitation of existing water resources, and the improvement of water infrastructure (Madani, 2014). The Iranian government has also set ambitious goals to increase water use efficiency and reduce water pollution (Madani, 2014). It is expected that by implementing these strategies, Iran will be able to manage its water resources better and ensure the sustainability of its agricultural sector.

Inclusive implementation

Although changing the entire system of economy and international policies in Iran is farfetched, improving some areas can improve progress or at least decrease the problems. Since 90% of water is used for agriculture, and women participate in 70% of farming production, the target of IWRM should be women. They are cheap workers (11% of farming income) and more vulnerable to water scarcity in many ways. However, in a paternal society like Iran, most top-down strategies focus on activities led by men.

Increasing participation of all stakeholders plays a vital role in implementing IWRM in Iran (Qader et al., 2018). the multiplicity of organizations that change policies and priorities every four years causes challenges for integrated management networks and participatory practices (Moghaddam and Fatemi, 2023), and the male-dominated pattern of participation in projects has impeded the progress of plans. To address this issue, the social interactions of the stakeholders and organizations should be improved (Moghaddam and Fatemi, 2023). Women traditionally play this role in Iran. The grassroots practices for empowering women in this sector affect agriculture and the interactions between organizations.

Aligning Water Management Policies with SDGs

Like many other countries worldwide, Iran faces a significant challenge in meeting the United Nations' Sustainable Development Goal (SDG) 6: to ensure the availability and sustainable management of water and sanitation for all. Despite having a long history of water and irrigation management, Iran's current water management system faces numerous challenges, as explained in the above sections (climate change, population growth). To meet SDG goal number 6, Iran must change its water management system significantly. According to Aysan et

al. (2021), technology, finance, and governance innovations are critical for achieving this target. One such technological innovation is using mobile applications for water quality monitoring, which can provide real-time data and alerts to both water managers and users. Innovative financing mechanisms such as social impact bonds can also attract private sector investment in water and sanitation projects while ensuring accountability and impact evaluation. In terms of governance, adopting integrated water resources management approaches can help address the fragmentation and lack of coordination that often hinder effective water management.

To ensure the food security of the nation and meet the goals of SDG 2, more concrete measures will be required. Subsidy programs in the agricultural and energy sector should better align with actual water and fuel prices to encourage efficient consumption. By changing the guaranteed prices for certain goods in certain areas to represent the availability of resources, new agricultural patterns better suited to the land and water conditions in the area may be encouraged. The savings generated by subsidy reform could be used to fund agricultural investment and innovation. Shifting cultivation away from water-scarce regions and improving irrigation efficiency could increase national yields while decreasing water demand. Furthermore, the involvement of local communities and stakeholders in decision-making processes can ensure that the solutions implemented are tailored to each region's specific needs and challenges. A decrease in red tape through the integration of the ministries and departments involved in managing water resources will encourage efficiency through a single coordinated policy regulating water use. Overall, adopting these innovative solutions can help accelerate progress toward achieving SDG 6 and SDG 2 and ensure that no one is left behind in accessing safe and sustainable water and sanitation services.

Conclusion

In this paper, we examined the water resources management policy of the Islamic Republic of Iran and its impact on the country's agricultural sector. Our findings show that the mismanagement of water resources has negatively impacted agricultural production, failing to achieve self-sufficiency in food production. We proposed the idea of implementing - Integrated Water Resource Management (IWRM). By adopting IWRM principles, Iran can improve the management and distribution of water resources, ensuring sustainable water management and meeting the targets of SDG 6. Additionally, IWRM has the potential to improve food security and reach the SDG 2 - Zero Hunger targets by allowing a state to boost food production in the age of climate crisis. The Iranian government must adopt efficient IWRM policies to ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production. Collaboration is key - the government must work hand in hand with local communities, NGOs, and international organizations to develop comprehensive policies prioritizing sustainable water management practices. By adopting an integrated approach and investing in long-term solutions, Iran can ensure access to clean water and sanitation for its citizens, protect its natural resources, and contribute to achieving a sustainable future.

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