

Water Crisis in Making in Iran

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Abstract

Iran is located in an arid and semi-arid region and is currently facing a serious water crisis. The climate change, droughts and political and economic problems are believed to have aggravated the water crisis. As a result, management solutions to resolve the water crisis are critically important. This paper discusses the current status of water resources in Iran and the root causes of water crisis, including population growth, inefficient agriculture, concurrent droughts and mismanagement of available water. If Iran wants to survive, it must prioritize water resources management in the country.

Keywords

Iran, Water Crisis, Drought, Water Management



Introduction

Conservation of natural resources is one of the main characteristics of sustainable development. Increasing population and increasing demand for natural resources lead to competition among people to provide food and call upon preservation and judicious use of these resources (Ashoori *et al.*, 2016). Water is the most important resource for agricultural production and food security. Considering acute shortages of water and high demands on this scarce resources, proper management and planning to sustain this resource are highly solicited (Gholamrezai and Sepahvand, 2017). In contemporary world, water crisis is one of the most important issues because about ¼ of the world's population is facing water shortages. The excessive use of water resources, poor management of water in agriculture sector, climate change and pollution have led to the drying up of rivers and groundwater (FAO, 2014). With increasing water scarcity and the numbers of the rural poor, especially in semi-arid region where drought and floods are expected to rise, access to freshwater for livestock and human's domestic consumption has become more vital than access to education and health services (UN-Water, 2006). The shortage of water resource is not specific to one region; more than 43 countries in the world are facing this crisis. The United Nations has warned that if the world continues to consume water at current rate, almost 1.8 billion people in the world will have faced water shortage by the year 2025 (FAO, 2007; WWAP, 2012).

Falling in Central Asian arid zone, Iran is not excluded from water crises. Iran comprises 0.36 of the world's fresh water supplies. The average rainfall is 251 mm/year, which is less than one-third of global average rainfall (Ardekanian, 2005). Iran receives 130 million cubic meters (MCM) of which 92% is utilized in agriculture sector, 6% for urban supply and 2% for industrial purposes (Iran Daily, 2015). Dry spells are common in Iran, for instance, between 1999 and 2002, Iran was critically affected by droughts that caused US\$305 billion loss with casualty of 800,000 livestock and dried reservoirs and lakes. At that time, most of the rivers dried-up or became remarkably shallow (Ansari-amoli, Naeini and Ravan, 2006).

In Iran, drought is concurrent phenomenon causing wide range effects on the environment. For instance, lake Hamoun located in the southeastern Iran, which was the largest freshwater in the country where fishermen took 12,000 tons of fish from, has disappeared now leading to rise of sandstorms and speedy winds in that area causing soil erosion in many southeastern villages (Foltz, 2002). Drought is seriously affecting country's development programs and creating widespread political, social and economic crises including a vulnerability of rural households who can no longer cope with acute water shortage. They are facing challenges of hunger, unemployment, illness, etc. (Sharafi and Zarafshani, 2011). Hence, if there is not any proper management, water crisis will lead to serious consequences in the form of social, economic and political issues (Rezaei *et al.*, 2017). Based on a review, this paper presents an overview of the current state of water in Iran and challenges furthermore. It also suggests management solutions to solve this crisis.

Review and Discussion

Environmental Evidence of Water Crisis in Iran

The water crisis is generally determined using the indices such as the Falcon Marc Index, the UN Index and the International Institute for Water Management Index. Based on Falcon Marc Index, status of Iranian water resources is supposed to be under acute stress and crisis (Ehsani and Khaledi,

2003). The comprehensive water studies indicate that 72% of precipitation evaporates and transpires and only 22% of precipitation flows in as surface water source (Alemohammad and Gharari, 2015). In Iran, very low quantity of water is available in the surface water bodies such as Lake Urmia, Bakhtegan Lake, Gavkhoni Lake, etc. The low water availability in such lakes is attributed to decreasing rainfall, increased evaporation and negative anthropogenic activities, such as dam construction, diversion of water from the rivers, unlimited withdrawal of surface water, and loss of vegetation. The situation of underground water is further grim. The statistics of 2010 shows that about 10 trillion cubic meters of water was withdrawn over the past 50 years, while the current withdrawal from underground sources has tripled (Kalirad, Malekian and Motamedvaziri, 2013). The effects of groundwater depletion may be seen in the form of saltwater penetration into groundwater, deepening of underground wells, declining water quality and downfall of groundwater aquifer (Assadollahi, 2009). As a result, 277 of the 609 plains in the country have been hit by critical conditions and characterized by reduced groundwater levels (Frootan *et al.*, 2014; Joodaki, Wahr and Swenson, 2014).

The Causes of the Water Shortage

The existing evidences suggest that human being is main contributor to the water crises. Below are described some factors responsible for water shortage in Iran.

Population Increase and Dispersion:

Iran has witnessed a significant increase in the population over the last century having the population of about 80 million. Its population growth rate is about 1.3%, which is, of course, declining over the past 30 years (Ardekanian, 2005). However, it is expected to reach 92 million by 2050 leading to increase the water demand dramatically (Abbasi-Shavazi, 2000; Karimi, 2009). Population growth is the main cause of the global water crisis. It can be called as the Mother of Water Crisis. Statistics shows that the national water availability per capita has decreased from 7,000 m³/person/year to 2,000 m³/person/year over the last 40 years. So, it is clear that overpopulation is the main cause of water crisis (Vojdani, 2004). As a result, access to freshwater is decreasing with the growing population that poses challenge to drinking water sources. On an average, each Iranian citizen should consume 150 to 175 liters of water per day, while actually a citizen consumes 1.5 to 2 times higher that quantity (Panahi, 2000). Population growth has two direct and indirect impacts on using more water resources via: 1. increasing need for potable water in population centers; 2. increasing agricultural production (Ardekanian, 2005).

Most of Iranian people prefer living in areas where access to drinking water is better. Nearly 50% of the population living in the north and west parts of this country receive more rainfall. On the other hand, 70 percent of the population live in the urban areas lacking proper distribution of water. Unabated urbanization in Iran is adding to the problem of water shortage. Studies show that Iran's urbanization ratio has jumped from 31% in 1956 to 74% in 2011 ((Ali and Mahesh, 2011). As a result, over the past 50 years, the urban population in Iran has grown by 9 times, whereas the rural population has increased marginally by 1.7 times during the same period (Ali and Mahesh, 2011). It seems that imbalanced population distribution and population density in some regions of Iran, regardless of the main cause of water scarcity, lead to the implementation of water diversion projects, which ultimately lead to increasing water scarcity in these regions.

Inefficient Agriculture:

Iran has always suffered from agricultural inefficiencies. Nearly 92% of Iran's water is used for agriculture with average productivity of 0.75 kg/m³ (Keramatzadeh, Chizari and Moore, 2011). For example, the yield of wheat per cubic meter of water is 0.7 kg, as against the average 1 to 1.7 kg per cubic meter (Zwart and Bastiaanssen, 2004). It seems that farmers use the water for growing crops without proper planning and because of not using modern technologies. Moreover, low water efficiency in irrigation systems has led to more use of groundwater in agriculture (Assadollahi, 2009). Principally, irrigated agriculture is the main cause of water scarcity in this sector. Most of the studies show that irrigation efficiency in Iran is between 33% and 37%, which is less than world average (Keshavarz *et al.*, 2005). On the other hand, inappropriate and mismatched crop patterns throughout the country are the main factors that farmers choose based on market prices regardless of the water scarcity (Madani, Agha Kouchak and Mirchi, 2016).

Drought and Temperature Variations:

Aridity creates erratic pattern of temperature and rainfalls in Iran. In more than half of the country, rainfall is only less than 100 mm. The average temperature of Iran is 16°C and the average annual evaporation is 2,556 mm. Iran's trend of erratic and deficit rainfalls makes it a dry and semi-arid country (Assadollahi, 2009). The uncertainties of rainfalls also create barrier to planning for handling water shortages. Erratic rainfall pattern, occurrence of floods and declining snowfall are indicators of changing weathers, which also cause severe flood in humid regions in north of Iran and less precipitation in arid regions in the west of Iran with extension of drought (Abbaspour *et al.*, 2009). Moreover, Iran's mean temperature has jumped up by 2 degrees in a hundred years' period, and it is 4 times higher than the global average (Masoodian, 2004). It has exacerbated the consequences of water shortage: high evaporation and transpiration, increasing water requirement of plants, reducing aquifers and vegetation, declining quantity and quality of agricultural production, decreasing farm incomes and growing costs of living, declining livestock production and number, declining fertility and quality of pastures, increasing deforestation and desertification, increasing salinization, and the loss of wildlife habitats.

Mismanagement of Water:

The mismanagement of water resources plays a major role in creating a water crisis. In Iran, the government has no program to conserve rainwater and compensate water shortage during dry spells. Evidently, drought is resulted by mismanagement of rain waters, and most of the lands are converted without taking into account the ecological and environmental capabilities of different categories of lands in the country. For instance, turning 90,000 hectares of Orumiyeh grape fields into apple orchards by using 5 times more water is one of the most important reasons of Orumiyeh Lake dried out. Similarly, converting Isfahan province to an agricultural and industrial land has caused the Zayande river to dry. In addition to the lack and/or weakness of water management, limited government investment, lack of support, influence of powerful groups, inappropriate plans for the region, extended population in metropolises, water diversions and lack of its proper distribution, and lack of attention to and investment in the modern irrigation methods should be considered important issues causing water shortage in Iran (Maghsoudi *et al.*, 2013).

Water Management Strategies

By increasing awareness about freshwater resources, quality and quantity of water may be conserved. Water crisis is not about too little water that we have; however, it is about bad

management of water (Cosgrove and Rijsberman, 2000). Water management in arid and semi-arid area needs special policies and measures in order to reduce water wastage, decline water demand and increase water use efficiency because drought is unpredictable and water shortage and drought issues have multidimensional aspects for community (Pereira, Oweis and Zairi, 2002). At the moment, most of the offered solutions are solutions from short-sightedness and focus mainly on curing symptoms of problems rather than addressing root causes. Iran's water problems are gigantic; hence, an urgent action is essential. Therefore, described below are some solutions to cope with the problem.

Control of Population and Dispersion:

As mentioned above, unplanned and irregular expansion of the main cities in the past 100 years contributed to overpopulation. Overpopulation causes different problems such as urbanization, migration and increasing water demand, especially leading to competition between human consumption, agriculture and industries for using water, while there is no match between demand and water availability in Iran. Therefore, the government's priority should be to keep and maintain the population of Iran, and to provide support programs and allocate budget for small villages and towns by creating employment, welfare services and reducing poverty in order to begin the reverse process of population migration from the large cities of the country to small towns and villages (Taherkhani, 2002). For instance, 20% of population live in Tehran (capital of Iran) where government should consider different short-term and long-term policies in order to decrease economic attractiveness for migration. Moreover, increasing the quality of living and working the other parts of the country especially tribal and rural areas to avoid migration to Tehran and other mega cities (NRC, 2005) might be useful for controlling of dispersion.

Changing Cropping Pattern with Environmental Protection:

One of the most important issues at the macro level is food security. Keeping and improving quality and quantity of agricultural products through efficient use of natural resources should be achieved through a suitable cropping pattern. The cropping pattern in a given soil and water resource is determined by various factors such as climate, water resources, soil properties, culture, mechanization, crop disease and marketing (NRC, 2005). One solution is changing agricultural production and using different crops, which are more tolerant to water scarcity. Farmers can change their crop calendars to harvest earlier and avoid using much water, especially, in the hottest months of the year from June to August. In arid regions, specialized technique like deficit irrigation can be applied in order to get maximum productivity per unit area (Diaz *et al.*, 2007). Another solution is planting annual crops instead of perennial crops. The farmers can select annual crops based on seasonal water demand especially crops with the least demand to reduce water consumption (NRC, 2005).

Monitoring Surface and Underground Water and its Withdrawal:

Water resource laws emphasize the initialization of primary data on surface and underground water, because lack of enough information is a barrier to suitable management of these resources. It is essential to audit all resources and identify new resources. It is also important to provide practical solutions in order to develop the operation of pump stations and deep water wells. Moreover, measuring and telemetering of water in different parts of transmit and production of water to determine exact percentage of unaccounted water will improve efficiency (Vojdani, 2004). Assigning funds to monitor data through piezometers and improving data collection and monitoring of water quality will help manage water resources in better way. Furthermore, the

investment by the government to install pipelines to transmit water for cities and villages will improve quality and quantity of available water. Evaporation loss can be checked in such a manner. Government must support farmers to convert the earthen canals into cement-lined canals to stop water leakages. The polyethylene pipes can also be used to transport water. This will help manage water resources effectively and increase irrigation efficiency (Assadollahi, 2009). One of the major areas needs to be repaired is the leaking water distribution systems, as in some cities from 40% to 90% of water is lost during transfer from one point to the other (Moe and Rheingans, 2006).

Increasing Water Prices:

The price of water is cheap, so people do not have an incentive to protect this precious resource in urban areas and in rural areas. The physical unavailability of water is just a limiting factor rather than a price. On the other hand, not only government's support (by subsidization of water and energy) has not led to an improvement in the livelihood of farmers and agricultural productivity, but also surface and groundwater has become rare or declined significantly. In fact, farmers extract cheap water from groundwater by electricity or diesel devices without any restriction (Madani, Agha Kouchak and Mirchi, 2016). The government should increase the price of water and energy in the crops, industries, companies and the villages with high income. This will utilize the earnings to improve and adjust the methods of cultivation in addition to irrigation. On the other hand, by providing low-interest loans to agricultural modernization the government can decrease the consumption of water (Mohammad and Yazdanian, 2014).

Establishing Local Cooperatives by Participation of Farmers:

Maghsoudi *et al.* (2013) believe that lack of government support, failed government promises, inappropriate regional plans and unfavorable policies tended not to support the farmers in Iran. Moreover, no participation of farmers, complex bureaucracy, uncertainty of projects, and lack of utilizing local capacities are the main reasons for unsustainability of water cooperatives (Maghsoudi *et al.*, 2013). The government should adopt the right policies along with encouragement and strengthening of the cooperatives' membership, activities, board of directors, management, staff training, expertise, and so on. The cooperatives should be strengthened to become democratic institutions with farmers' candid participation. The farmers' participation is crucial for understanding farmers' priorities and new ways of managing land and water, and for ensuring that farmers have enough information about existing technologies (Ziadat *et al.*, 2012) to better manage water resources. Technical innovations are necessary along with four main decisive factors: 1. creating community-based partnerships; 2. encouraging participation of local people; 3. training of management personnel; and 4. facilitating the organizations to play important role in the development of innovation (Bhuyan, 2007).

Education and Familiarization of Farmers:

The awareness leads to concerns about environmental problems. Inevitably, sufferings from problems push to find solutions (Sudarmadi *et al.*, 2001). However, the farmers generally have insufficient knowledge to manage and preserve water; so appropriate training at all levels can help manage agricultural water. Gholamrezai and Sepahvand (2017) found in Lorestan province of Iran that most of the population of farmers is middle-aged and majority of them (about 67.6%) were educated less than high school. These results are similar to the results of the other researchers in different regions of Iran (Gholamrezai and Sepahvand, 2017). Rezaei *et al.* (2017) also reported that in rural Sabzevar the majority of the farmers have education under diploma or no education (i.e., 73.7%). Therefore, farmers' empowerment with education related to the preservation of water

and soil resources will increase the knowledge of farmers in the face of existing problems, which will also lead to farmers' participation in optimal irrigation (Akwabi-Ameyaw, 1997; Salam, Noguchi and Koike, 2005). Positive attitude is the most important thing that can help farmers' participation in irrigation management for the purpose and solving problems (Rezaei *et al.*, 2017). Because awareness of farmers about water scarcity and knowledge about technologies, it can be a positive effect on their behavior to deal with this crisis. For instance, using subsurface water retention technology (SWRT) (polyethylene membranes with surface mulch) by farmers can overcome the water scarcity, especially, in sandy soil areas (Amirpour *et al.*, 2016).

Water Consumers' Training:

Although urban areas use less than 10% of water, the urban population grows so rapidly that water demand increases dramatically. In addition to drinking water, sanitation services also have become costly and hard to access (Richards, 2001). Therefore, it is necessary to change public attitude toward water and consider water an economic commodity in the domain of economic, social and cultural development (Mohammad and Yazdanian, 2014). Many researchers believe that increasing community and consumer awareness will impact water management meaningfully (Pereira, Oweis and Zairi, 2002; Jahani, 2005). For example, in Amman, in condition of a water crisis, members of the family play an important role to cope with water problem and they use water judiciously to conserve it better. The children specially are educated how to protect water supplies on daily basis (Potter and Darmame, 2010). Education and awareness of the people can change their attitude at individual level and community level. As a result, training and education are the best ways to improve and reform society's behavior as well as action (Abadi, 2017). The engagement of people and society in preserving and developing the environment and water resources will push managers and planners to respond to the needs of the community and to pay attention to the environment. The responsible government officers cannot be allowed to disengage from the burden of responsibilities, as they may change the attitude of the public towards water (Babran and Honarbakhsh, 2007).

Development of Services and Industry:

It should be admitted that agriculture with a high consumption of water and low productivity cannot have a significant impact on economic growth and food supply throughout the country. The government should allocate budget for imports of agricultural products with high water consumption and the development of services and industries to economic growth and save more water in these circumstances. The studies show that, for instance, most of the countries in Middle East and North Africa (MENA) region are dependent on cereal production using a lot water with less efficiency. It is better to shift to less water dependent crops and exporting them to other countries in return of importing cereals. On the other hand, using development services and new technologies can improve efficiency. Roudi-Fahimi, Creel and De Souza (2002) indicated that drip irrigation compared to conventional irrigation uses 30% to 70% less water and increases crop yield from 20% to 90%. Efficient plumbing fixture can also reduce water use in cities. It can be setting up low flush, dual flush and vacuum flush toilets in place of ordinary flush, thereby, saving water significantly and using rainwater collection systems for toilet flushing and gardening, greywater recycling for gardening, and landscaping. In industrial areas, recycling water and improving water productivity can be applied to reduce overall water use (Moe and Rheingans, 2006).

Conclusion

Iran is located in arid and semi-arid zone with limited rainfall and increasing water scarcity, while suffering from overpopulation as well as mismanagement in different areas such as social, economic and agricultural sectors. Neither the government nor the society take the water crisis seriously. The shortsightedness and one-dimensional view of the managers do not help solve water crisis; rather the situation is deteriorating in different areas of the country. Many cities, especially, in southern parts of Iran have been suffering from acute water shortage. Assessing the water crisis scientifically and using the experience of other countries in managing water problems would help solve to a great extent. Arresting the urbanization, distribution of population in the whole country, increasing agricultural productivity, realizing the value of water, creating local cooperatives and encouraging farmers' participation, developing the services and industries and mass education about the judicious use of water may some crucial measures to help improve the conditions.

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