Water Crisis in Iran: Its Intensity, Causes and Confronting Strategies

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Abstract

Objectives: This investigation was done in order to study Iran’s water crisis intensity as well as its causes and also to propose some solution to confront and mitigate this crisis. Methods/Statistical Analysis: This research was carried out as a documentary and library research using Grounded Theory Method. Also 3 famous and common water crisis indexes were used in order to assess Iran’s water crisis. Findings: Results of all investigated indexes showed and confirmed that Iran is in intense water stress condition. Among the factors causing and intensifying this crisis the most important factors are: Irregular water consumption and increasing demand for water along with limited water resources and consequently water supply-demand imbalance; Rapid urbanization along with population growth and its unsuitable geographical distribution across the country; Iran’s geographical and climatic condition as a country in arid and semi-arid region of the world; Mismanagement of water resources; Improper development of agriculture section along with unsuitable cropping pattern in agriculture. Application/Improvement: some exit strategies in two categories of short-term and long-term solutions are presented at the end in order to confront water crisis condition of Iran.

Keywords: Drought, Water Crisis, Water Crisis Index, Water Resources, Water Efficiency

1. Introduction

Water is a vital and irreplaceable factor to human life. Nowadays this importance is more highlighted regarding the fact that around two billion people are facing water shortage1. Water scarcity is considered as “the major crisis of the 21st century”2.

Water crisis can be defined as a condition in which the water supply in a region is less than that region’s demand. The World Economic Forum considered the “water supply crisis” as the fourth crisis in likelihood and second in impact3.

Iran is located in the Middle East a region which is the largest part of the world with water scarcity4, also Iran’s mean annual precipitation is only about 250 mm which is about one third of the global average4. Nearly 70% of this slight precipitation is being lost due to evaporation5. About 65% of the country is considered as arid and the 20% is semi-arid5.

Also water resources distribution in the country and temporal distribution of precipitation during the year is heterogeneous and uneven5,6. Water scarcity in Iran is combined by inefficient water use where domestic use of water is 70% higher than the global average6.

Water shortage in Iran has been considered as one of the limiting factors for sustainable development5 and it is predicted that Iran is among the countries which will face an absolute water scarcity by 20252.

Regarding the water shortage in the Middle East and principal role of water in agriculture, industry and people’s life, the countries in which there is not a balance between water supply and its demand will face political as well as social problems. This problem is more serious
in the Middle East which has a history of water-based political conflicts\textsuperscript{12} and scientists warned about intense water scarcity and desertification in future\textsuperscript{11}. Even per-capita water availability will fall by 50 percent by 2050\textsuperscript{12}. Therefore this study aimed to investigate the water crisis, its intensity and causes in Iran and to propose some exit strategies in order to confront it or to mitigate its effects.

2. Materials and Methods

This research was carried out as a documentary and library research using Grounded Theory Method. Great quantity of scientific reports and researches in both English and Persian (country’s national language) has been reviewed to collect the most important causes and inducers of water crisis in Iran. In order to assess the water shortage of countries several indicators have been proposed. This investigation assessed Iran’s water shortage status using the following indicators which are the most popular and important water scarcity indicators:

2.1 Falkenmark Index

This index was first introduced by a Swedish water researcher\textsuperscript{13} and is based on renewable water per capita in a given area. This index is among the most commonly used water stress indicators\textsuperscript{14}. Based on this index countries with per capita renewable water of less than 1700 (m\textsuperscript{3}/inhab/yr) are in water stress condition (Table 1).

| Water stress condition | Index (m\textsuperscript{3}/inhab/yr) |
|------------------------|-------------------------------------|
| No water stress         | > 1700                              |
| Water stress            | 1000 – 1700                         |
| Water scarcity          | 500 – 1000                          |
| Absolute water scarcity | < 500                               |

2.2 Water Resources Vulnerability Index

This index is based on the proportion of total annual withdrawals to available water resources in a country\textsuperscript{15}. It is also sometimes referred as Criticality Ratio\textsuperscript{14} or technical water stress\textsuperscript{16}. According to this indicator a country with annual water withdrawals of more than 40% of its available water resources is severely water scarce (Table 2).

| Water stress condition | Water withdrawals from renewable resources |
|------------------------|---------------------------------------------|
| Low or no stress       | <10 %                                       |
| Medium low water stress| 10 – 20 %                                  |
| Medium high water stress| 20 – 40 %                                |
| High water stress      | > 40 %                                      |

2.3 International Water Management Institute Index

This index was proposed by International Water Management Institute (IWMI) and is based on two primary indicators which are “(i) the projected percentage increase in total withdrawals from 1990 to 2025 and (ii) the total withdrawals in 2025 as a percentage of the annual water resources”\textsuperscript{17}. Based on these criteria they have grouped countries into 5 groups as shown in Table 3:

| Water scarcity condition | International Water Management Institute Index | Grouping |
|--------------------------|-----------------------------------------------|----------|
| *Physically water scarce | Countries with withdrawals as percentage of annual water resources > 50% | Group 1  |
| **Economically water scarce (high scarcity) | Countries with an increase in projected 2025 water withdrawals of 100% or more | Group 2  |
| Economically water scarce (medium scarcity) | Countries with an increase in projected 2025 water withdrawals of 25% to 99% | Group 3  |
| Economically water scarce (low scarcity) | Countries with an increase in projected 2025 water withdrawals of below 25% | Group 4  |
| No water scarcity        | Countries with no or negative increase in projected 2025 water withdrawals | Group 5  |

\*Physically water scarce: Countries that will not be able to satisfy the estimated water demands in 2025  
\**Economically water scarce: Countries that have sufficient water resources, but have to make significant investment in water infrastructure to make these resources available
3. Results and Discussion

3.1 Water Scarcity Indicators

Falkenmark Water Stress Index: This indicator emphasizes on per capita renewable water resources (m³/inhab/year) of each country. Based on the report of FAO AQUASTAT, Iran’s renewable water resources in 2005 was about 2000 (m³/inhab/year) which was higher than water stress thresholds and Iran was ranked among “no water stress” countries. But due to population increase particularly in urban areas this amount reduced to 1850 in 2010 and reached to 1644 in 2016 which put Iran among countries with “water stress” mode (Figure 1 and 2).

Water Resources Vulnerability Index: Iran’s total annual water withdrawals is about 70% which is remarkably higher than stress threshold based on WRVI which means Iran is in “high water stress” condition.

International Water Management Institute Index: Since Iran’s total annual water withdrawals is about 70% and is significantly above the water stress thresholds of IWMI therefore according to this indicator Iran is a country of “physically water-scarce” condition.

Totally the all studied water scarcity indicators showed that Iran is in water stress condition.

3.2 Causes of Iran’s Water Crisis

Among a great amount of scientific reports and researches in both English and Persian it has been found that the main factors of Iran’s water crisis based on their importance and their repeat in different citations are as follow:

- Irregular water consumption and increasing demand for water along with limited water resources and consequently water supply-demand imbalance
- Rapid urbanization along with population growth and its unsuitable geographical distribution across the country
- Iran’s geographical and climatic condition as a country in arid and semi-arid region of the world
- Mismanagement of water resources
- Improper development of agriculture section along with unsuitable cropping pattern in agriculture
- Water pollution
- Over-withdrawal of groundwater
- Climate change and consecutive droughts
- Inefficient agriculture and traditional irrigation systems
- Dam construction without paying enough attention to technical, economical and environmental issues
- Industrialization
- Lack of attention to virtual water
- Lack of efficient laws
- Low price of water
- Inattention to transboundary waters
3.3 Exit Strategies for Water Crisis

Totally regarding the main causes and inducers of Iran's water crisis, the following strategies are suggested as solution of the crisis in two categories of short- and long-term solutions:

3.3.1 Short-Term Solutions

- Increasing water price and realistic pricing of water to end the wrong idea of considering the water as a free and endless resource, particularly in agriculture section which consumes the majority of country's water
- Stopping over-withdrawal of groundwater specially in the main plains of the country
- Satisfying the water demand of industry by water recycling technology
- Protecting surface and groundwater through more efficient implementation of the water related laws and policies
- Avoiding construction of hydraulic structures, such as dams, without environmental and social considerations
- Applying cloud seeding technology
- Freshwater production using desalination technology at southern coasts and transmitting the produced freshwater into the inner arid areas

3.3.2 Long-Term Solutions

- Reforming consumption pattern in agriculture, industry and domestic section
- Paying attention to groundwater protection
- Revival of lakes and lagoons
- Using transboundary water resources
- Reforming of irrigation methods and water conveyance structures and using new irrigation methods such as underground irrigation, regarding the high evaporation of the country
- Increasing agricultural production through increase in efficiency of land instead of increase in water consumption
- Preventing contamination of existing water resources
- Paying attention to virtual water
- Revision of cropping pattern in agriculture with regard to food security
- Creating cooperative organizations for agriculture management in each region and enhancing the contribution of farmers and other social capacities in water management
- Establishing water market and controlling the water rights
- Reforming water governance structure and empowering country's Department of Environment
- Revision in country's policies on geographical distribution of population
- Reducing urbanization growth
- Supporting of farmers and rural population by investment in agriculture section to enhance the efficiency

Results of this study showed that the country of Iran is currently in water crisis condition and this crisis will become deeper over time. This crisis can affect the economy of the country and consequently produce political and social problems. Since more than 90% of countries renewable water is being consumed in agriculture\(^1\,^7\), therefore any disturbance in water supply of the country will affect the agriculture section and consequently can threat food security.

Since the nature of a great part of Iran is arid and semi-arid therefore water was always an issue for this country's inhabitants. In the past times the people of this country were mostly using the traditional sustainable structures namely qanat which was a series of wells connected by underground tunnels\(^7\) but at present time due to the continuous droughts the output of qanats has been remarkably declined\(^4\,^4\).

Water shortage will damage people's livelihood especially in villages and cause them to migrate to metropolitans\(^4\) and this migration will negatively affect rural areas which are the most important economic and demographic component of each country\(^4\,\,^4\).

By reducing surface and groundwater along with population growth, the equilibrium between water availability and its demand got damaged therefore restoring the balance between water supply and its demand is the first step in confronting the water crisis of Iran.

The most amount of Iran's freshwater is being used in agriculture section, yet water efficiency is very low which mainly is due to traditional irrigation system, inefficient water conveyance system and inappropriate cropping pattern\(^1\,^3\).

Protecting the current water resources is one of the main steps in facing the water crisis of the country. Reducing water demands through consumption pattern reform, especially in agriculture, and restoring the balance between water supply and its demand is of a great
importance. Especially nowadays in which many zones of the country are facing negative balance in their underground aquifers due to over-withdrawal.

4. Conclusion

Through this study it can be concluded that the country of Iran is in a severe water stress which affects its economy, agriculture, society and food security. Increase in water demand because of the population growth particularly in urban areas, decrease in water supply due to consecutive droughts, mismanagement and inappropriate cropping pattern in agriculture have disturbed the balance of water availability and its demand. Since the agriculture sector uses the vast majority of the country’s water therefore a great effort must be made to reform water conveyance system and water consumption in agriculture sector. Continuance of water crisis along with mismanagement will result in serious damage to economy of the country.

5. References

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