

A Review on the Water Sector in Iran: Current Forecasts, Scenario and Sustainability Issues

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Abstract – The water sector in Iran has to date paid scanty attention to the issue of climate and is often unaware of its effects on future water resources. Studies will be needed to determine the effects of water shortage and draw up adaptation solutions. Forecasts are not optimistic. Models for Iran water resources indicate that amount of water per capita will decrease than 1000 cubic meters in 2025 and Iran will enter a serious water crisis. In this paper weather conditions, precipitations and water resources state of six main basins of Iran are discussed. Main reasons of water issue in Iran are population growth, ineffective agriculture and poor management of water resources and the effect of each one of them are studied. Finally, effective strategies to collation and prevent the adverse socio-economic and political conditions, result of mismanagement and inefficient use of water resources are discussed. It is necessary to create a national action plan to ensure the security of access to safe water for all.

Keywords – Water, Resources, Capita, Consumption, Iran

I. INTRODUCTION

The Islamic Republic of Iran covers a total area more than 1.6 million km² [13]. Iran is a country with mostly hot and dry climate. Iran's latitude is located on the arid and semi-arid belt of earth [14]. This is due to the general circulation of air on the Earth. Warm and moist air from the equator moves to the poles and gradually loses its moisture due to rainfall [11]. Except a few areas of the country (border of the Khazar Sea), Other areas evaporation rate are higher than the actual amount of rainfall. For example, the annual average rainfall in Yazd is 60 mm while environmental evaporating rate in this area is 3900mm. This means that if there is a free surface of water in Yazd, the average height evaporates annually is 4 meters [11].

In the past century, rapid population growth, cause the decline in per capita renewable water. Accordingly, the amount of 13000 cubic meters per capita in 1921, dropped to about 1400 cubic meters in 2013 [1]. If the trend continues, the situation will be worse in future.

Annual rainfall ranges in Iran, vary from less than 50 mm in the deserts to 2275 mm in Rasht near the Khazar Sea [15]. The average annual rainfall is 250 mm [16] and approximately 90 percent of the country has arid or semi-arid climate. About 23 percent of the rain falls in spring, 4 percent in summer, 23 percent in autumn and 50 percent in winter [2]. While the global average of precipitation is 850 mm that is more than three times greater than Iran's rainfall [3]. Fig.1 shows Iran's main hydrological basins.

FIGURE 1
Major basins in Iran



Figure 1: The hydraulic basins of Iran [2]

Total renewable water resources of Iran are 130 billion cubic meters (BCS) [17]. Studies show that in 2007 the total renewable water resources of about 89.5 billion cubic meters used in agriculture, industry, mining and domestic. As it is shown in fig.2, 83 billion cubic meters (93%) in agriculture sector, 5.5 billion cubic meters (6%) in domestic sector, and rest is allocated to the industrial sector and other miscellaneous needs [4].

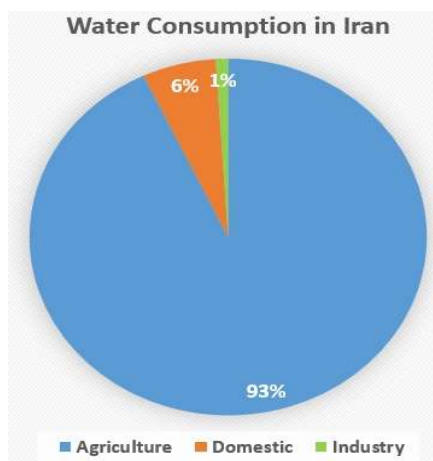


Figure 2: Pie chart of water consumption in Iran

The usual approach to ranking countries, in terms of water resources available per capita. For example, according to the Falkmark [5] water stress index, it is said that a country or region is in "water stress", when water resources annual per capita be less than 1700 cubic meters. At a level between 1000 until 1700 cubic meters per capita, periodic or limited water resources can be expected. When the water resources of less than 1000 cubic meters per capita, the country is facing with "lack of water". According to international predictions

[1], in 2025 Iran's water resources will be less than 1400 cubic meters per capita and this means entering water crisis.

Nevertheless, Iran's water sector is facing several limitations and problems which could, if not properly handled, limit the dynamic of economic growth and even will become the biggest security threat in many cities and regions.

Water sector must conduct a large-scale program of studies and investigations to understand the current and future impact of climate change, identify and quantify associated costs and its interactions with water and specify adequate solutions for adaptation.

This paper describes situation of water in Iran and specify inventory of water resources and water demands, presents strategic development of the sectors of water and analyzes the interactions between water and consumption pattern.

II. WATER IN IRAN

A. Resources

The spatial distribution of water in Iran, because of natural conditions is very heterogeneous [18]. Fig.3 shows this [2].

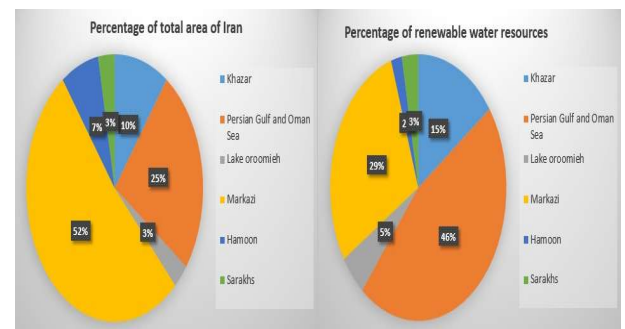


Figure 3: Pie chart of distribution of water in basins of Iran

Rainfall in Iran is highly seasonal, with a rainy season between October and March, leaving the land parched for the remainder of the year. Immense seasonal variations in flow characterize Iran's rivers. For example, the Karun River in Khuzestan carries water during periods of maximum flow that is ten times the amount borne in dry periods. In numerous localities, there may be no precipitation until sudden storms, accompanied by heavy rains, dump almost the entire year's rainfall in a few days. Water shortages are compounded by the unequal distribution of water. Near the Khazar Sea, rainfall averages about 1280 mm per year, but in the Central Plateau and in the lowlands to the south it seldom exceeds 100 mm [6]. Fig.4 presents distribution of rainfall in Iran.

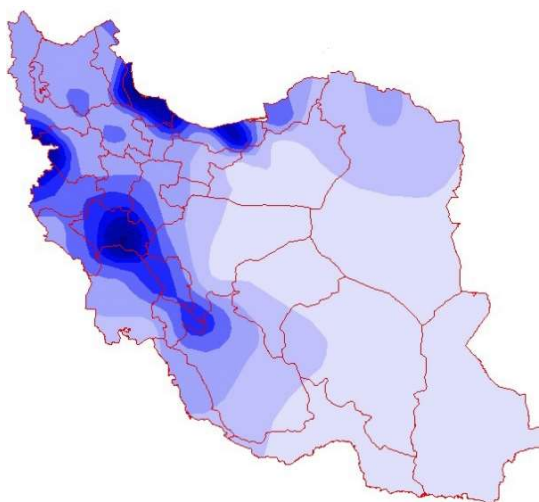


Figure 4: Precipitation distribution in Iran [7]

Fig.5 shows amount of precipitation in basins of Iran.

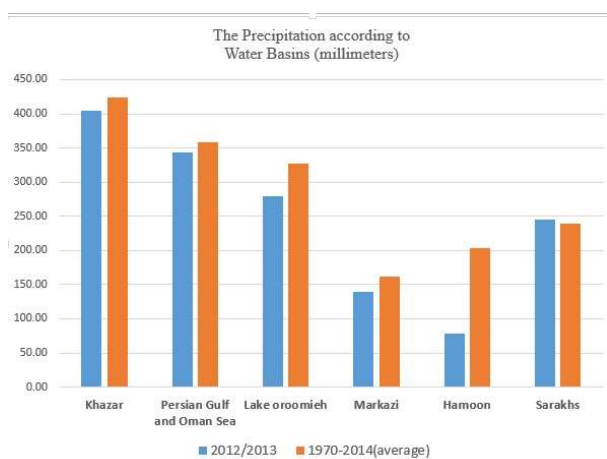


Figure 5: Bar graph of amount of rainfall in basins of Iran

Groundwater is said to waters that accumulated in saturated layers of ground. Although the amount of water locked up in groundwater is a small percentage of all of earth's water, it represents a large percentage of total freshwater on earth. About 1.7 percent of all of earth's water is groundwater and about 30.1 percent of freshwater on earth occurs as groundwater [19].

Underground sources of water are fed directly or indirectly from surface water and rainfall, so the sustainable use of these resources means limited conception of them. In recent years in many countries, water withdrawals from groundwater sources were more than the annual feeding of them. This means the extraction and use of ground water that is stored in aquifers for thousands of years. This groundwater

levels have dropped in the region and eventually at some point every day that there will be no water for extraction. Falling groundwater levels and drying means downstream areas (areas with less height of the water in the aquifers under the effect of gravity on their side flow) and the loss of wells, aqueducts and fountains of it. Fig.6 represent global crisis of groundwater and shows countries situations.



Figure 6: The global groundwater crisis and serious situation of Iran [8]

Fig.7 shows drought regions and has a significant relationship with Fig.6.

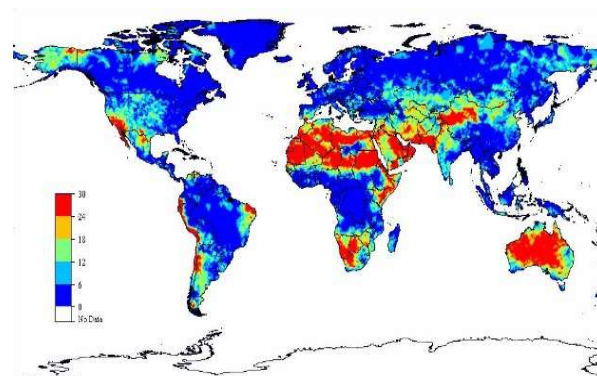


Figure 7: Droughts Global mapping and serious situation of Iran [7]

Fig.8 shows the countries that Water threat is serious for them.

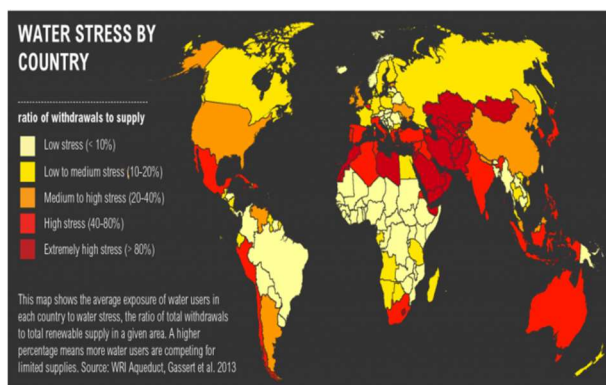


Figure 8: Water stress by country and serious situation of Iran [8]

B. Current use of water resources

The total renewable freshwater of the country and the total returned water from consumption are respectively estimated at 130 BCM and 29 BCM [3]. The total water withdrawal in Iran was estimated at about 70 BCM (billion cubic meters) in 1993, rising to 93.3 BCM in 2004 of which 40.0 BCM from surface water, 53.1 BCM from groundwater (qanats and wells) and 0.2 BCM desalinated water [2]. Although annual abstraction from aquifers (57 BCM in 1993, 53 BCM in 2004) is already more than the estimated safe yield (46 BCM) [2]. Of the 4.3 BCM/year in 1993 (6.2 in 2004) used for domestic purposes, 61% is supplied from surface water and 39% from groundwater [9]. Fig.9 shows water withdrawal by source in 2004.

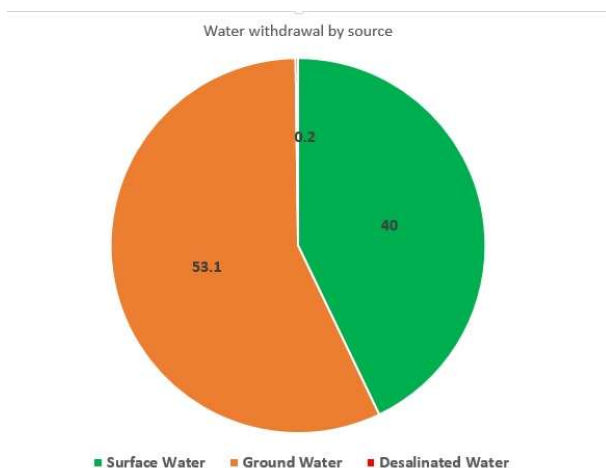


Figure 9: Pie chart of water withdrawal by source in Iran (93.3BCM in 2004)

C. Reasons of water crisis in Iran

Water crisis in Iran is influenced by three main factors: population growth, ineffective agriculture, development thirst and poor management [3].

Rapid population growth and poor dispersion are two main causes of the current crisis. Rapid population growth, reducing per capita water available and the rapid growth of urbanization, the concentration of 70% of the population in cities and continue to migrate to the metropolis for greater prosperity and more and more pressure on water resources. Population growth without serious policies to control population density and facilities and stop the process of urbanization, can exacerbate the crisis.

While only 15 percent of the area is under cultivation, about 93 percent of water use in agriculture. This despite the fact that only 10 percent of GNP¹ comes from agriculture and 17 percent of workforce is in this sector.

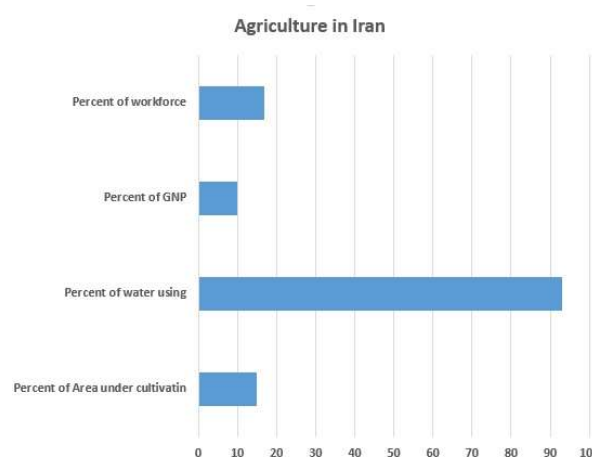


Figure 10: Bar chart of Agriculture in Iran

Environmental Protection Agency estimate speed of using of groundwater resources in Iran, three times higher than the international standard. This excessive withdrawal cause drying up of 297 of the 600 plains of Iran. As well as for failing to audit and improve the water transmission networks, 35 BCM of water is wasting in the transmission. According to WWC's² of Iran and Tehran university's Faculty of Environment report, until September 2015, 40 percent of the water networks was worn out. 13 percent of the total water losses in Iran until this date, was due to this exhaustion.

¹ Gross National Product

² Waste Water Corporation

The most important problems that the management of water resources system is facing at the macro scale, as follows:

- 1) Low irrigation efficiency
- 2) Low price of agricultural water in irrigation networks
- 3) Delivery of non-volumetric water
- 4) Disintegration of agricultural land
- 5) Farmers lack of knowledge with modern irrigation systems and new methods
- 6) Failure to comply with cropping patterns and crop rotation
- 7) Weak management and sometimes mismanagement in planning for the supply, transmission and distribution of water in irrigation networks
- 8) Lack of coordination between administrative systems related to water resources management
- 9) Lack of compliance governance structure in the country and watershed management

III. RESULTS, DISCUSSION AND SOLUTIONS

Obviously, the water problems in Iran are multiple and significant to leave any doubt about this fact that Iran is experiencing a serious water crisis. Immediate actions are required to address the exiting water security problems throughout the country. Several strategies can be pursued to improve the efficiency of the water consumption agriculture, domestic and industry sectors.

First, the inappropriate crop pattern across the country should be revised with respect to the macro-scale food security priorities as well as regional resource availability and economic efficiency conditions [3]. It appears that in many areas, crops and orchards must be tailored to the regional potentials and factors of production.

Second, water and energy prices should be raised meaningfully to be reflective of the true cost of water and energy in each region across the country [3]. Wide pay subsidies for water in the middle east and the lack of accurate measurement of the price of water for domestic use and agricultural sector is an encouraging consumption and the imposing a considerable cost to Public sector. Estimates show that the amount of funds used in Arab countries of middle east about 2 percent of the GDP of the countries. In Iran and other countries in this region that is 1 percent of GDP of countries [10].

Third, the government needs to provide incentive for the formation of regional cooperative agricultural management institutions (e.g., irrigation district, regional farming authorities, regional farmer co-ops) [3]. Now, participatory irrigation management is widely used as a new and powerful way to strengthen stability in the management of agricultural

water consumption. It is introduced to improve the efficiency and effectiveness of irrigation involvement of farmers. Thus enhancing the knowledge, attitude and skills of farmers on how agricultural water management through water users' associations, can be considered one of the major mechanisms for the participation of farmers in overcoming the problem of water scarcity and achieve the objectives of agricultural water management.

Fourth, as much as possible the irrigation of agricultural lands and urban green spaces should be on hours that evaporation rate is minimal. Because of the rate of evaporation in Iran is three times more than global average, this have a significant effect on reducing water consumption.

Fifth, water reusing methods in urban consumption should be employed. For example the water is used for washing hands and face, vegetables, fruits and etc. can be reused for watering pots and gardens. In general, the case that using wastewater in them is possible, should be considered.

IV. CONCLUSION

Looking at the Iran's situation, on one hand 92 percentage contribution of agriculture sector in water consumption (which is so higher than the global average) and on the other hand, ineffective agricultural methods, all serve to exacerbate the crisis and alarming sounds seriously.

It's better to extending views to the future perspectives of water crisis and so as Spiegel [12] points out, and see global business activities started to water, where we see a Icelandic company is preparing and planning for giant ships such as oil tankers to water exporting.

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