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WATER SECURITY AND DROUGHT ON AGRICULTURAL SECTOR AND RURAL REGIONS IN SOUTH EAST OF IRAN: SITUATIONS AND PROBLEMS

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Abstract: There is no doubt that drought has a major impact on farm families around the world. Drought is the most complex of all natural hazards, and more people are affected by it than any other hazard. There is a broad acknowledgement among policymakers that ground water over exploitation is now a serious challenge. Globally the agricultural sector is the biggest water user, but has as well the highest water saving potential. Increasing water efficiency and consequently water savings could be achieved by the applications. Water is an important resource for human society and protection of this natural resource efficiently has become one of the main challenges of this century. According to Iran's geographic information, the country is located in a semi-arid region on the earth. Therefore, it can easily be claimed that the limitation of water resources is one of the major factors in the agricultural development of Iran. Main instrument for gathering information in this article was qualitative research methods and place-based approaches that used in domain of this research during 2010 – 2017. In this article discussing various aspects of water security and drought on agricultural sector and rural regions in south east of Iran and finally present solutions in this order.

Keywords: Water Security, Drought, Agricultural Sector, Rural Regions, Iran

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1. Introduction

For agricultural production, water security denotes that water should be available at a sustainable, stable rate and at a reasonable cost. However, acceptable, sustainable, stable rate and reasonable cost are not fixed concepts (Malekian et al., 2017).

Iran is a country of over 1.5 million km2 (making it the 18th largest country in the world) with a population of around 80 million. It experiences various climatic conditions due to its range of geographical regimes. Its long-term average annual rainfall is in the range of 224–275 mm/year, making Iran one of the most arid regions of the world. By way of comparison, annual precipitation in Iran is less than one third of the world average (ca 990 mm). The lack of water is a major limitation for agricultural development. The pressure on water resources is increasing as demands for water consumption expand. Increases in population, socially demanded rises in living standards, and the expansion

of irrigated agriculture have drastically increased water use to the extent that the sustainability of the water resources of Iran is being threatened. A review of long-term annual precipitation trends (over a 32 year period) indicated that in some parts of Iran drought has a return frequency of every 5–7 years, while the national expectation was every 20–30 years. Drought can therefore be regarded as a normal part of the Iranian environment. Nevertheless, the latest (and at the time of writing in 2011 still current) drought is unparalleled over that time and millions of people residing in the 18 most drought-affected provinces have been seriously affected. Below is a discussion of the most important impacts of the drought in Iran (Keshavarz et al., 2013).

Iran, as a developing country, is located in arid and semi-arid areas in which water scarcity is a major issue and regarding to the highest level of water shortage is in the agricultural sector, the need for efficient use, or in other words, management of agricultural water is inevitable. Agricultural water management is a systematic approach to control water in the farm and it leads to the provision of crop irrigation and drainage while there are physical, social and governmental problems in production systems. The aim of the effective management of agricultural water is to increase economic performance with reduced consumption of water and energy. So, agricultural water management in areas that are facing the problem of water shortage seems to be more important to expect maximum efficiency from the minimum water resources. Undoubtedly, understanding the factors affecting agricultural water management can provide management strategies in agricultural water (Samian et al., 2015).

The development policy and conflict literatures highlight the important influence of ''high-value'' natural resources on sustainable development, conflict, and security at multiple scales. While the physical attributes of these commodities can vary greatly, high-value natural resources generally refer to those commodities that in their natural state have the potential to yield substantial revenues. Classic examples are diamonds, oil, natural gas, gold, uranium, coltan, and several precious gems and minerals. When well-managed, these valuable resources can be the cornerstone of economic prosperity, substantially raising living standards, facilitating socio-economic equality and the reduction of state dependence on foreign aid (Douglas and Alie, 2014).

There is no doubt that drought has a major impact on farm families around the world. Drought is the most complex of all natural hazards, and more people are affected by it than any other hazard (Keshavarz et al., 2013). Globally the agricultural sector is the biggest water user, but has as well the highest water saving potential. Increasing water efficiency and consequently water savings could be achieved by the application of this concept (Treitler, 2012). Water is an important resource for human society and protection of this natural resource efficiently has become one of the main challenges of this century. According to Iran's geographic information, the country is located in a semi-arid region on the earth. Therefore, it can easily be claimed that the limitation of water resources is one of the major factors in the agricultural development of Iran. The atmospheric precipitation (70% rain and 30% snow) brings the total up to 450 billion m3 of water. In the present situation, about 269 m3 of this figure is lost in different forms; however, 30 and 35% of this is devoted to urban areas and agriculture, respectively. On the other hand, 93% of the total water resources are used in agricultural sector, and less than 7% is allocated to municipal and industrial uses. Therefore, the proper water management in this sector is essential and plays a critical role in the sustainable development of agriculture (Samian et al., 2015).

The issue of water security has attracted increasing attention over the past years (Malekian et al., 2017). Growing water scarcity is increasingly constraining food production, causing adverse impacts on the goals of food security and human well-being. Several groups, including UNESCO's Institute for Water Education and the Asia-Pacific Water Forum, have made water security a central research theme. In the past decade, the issue of water security has also come to the fore in several water management agendas, particularly associated with bioterrorism concerns. The growing attention for water security has resulted in a significant increase in the employment of 'water security' scholars within the academic community. Clearly, water security is of utmost importance, especially in the agricultural sector: agriculture uses approximately 70% of renewable water resources worldwide and will continue to be the largest user of freshwater resources through 2050 for all regions. Furthermore, in water scarce countries, irrigation is vital to enhance crop production. However, the growing water scarcity is putting pressure on irrigation systems, yield, and quality. Moreover, water insecurity has irreparable effects on raw materials production, rural employment opportunities, rural development, etc. Consequently, any discussion about agriculture is incomplete without consideration of water availability (Malekian et al., 2017).

Natural attributes, socioeconomic attributes, and cultural attributes were recurring elements of the agricultural water resources security concept. In addition, agricultural water resources security includes food security, agro environmental security, agro economic security, rural society security, etc.

Water poverty index (WPI) including five key indices,

namely resources, access, capacity, utilization, and environment, to evaluate regional water security.

Not only researchers, but also societal actors put different accents when assessing water security. International organizations, such as the Global Water Partnership and the World Economic Forum, have, for instance, presented different definitions of water security. However, it is not clear where these definitions come from and how they are, or are not, related. For example, in a study in Korea mentioned that water use, water quality and integrating the laws which are related to improving water use are all important factors in water management and comprehensive rules should be developed in the field of water management (Samian et al., 2015). There is a broad acknowledgement among policymakers that ground water over exploitation is now a serious challenge (Malekian et al., 2017) showed in Figure 1.

Figure 1. A deep well for extracting water from about 100m depth, plus an agricultural pool for storage of water and fish breeding and a new garden that established beside of it during 5 years ago. It must note that amount of salt in this underground water is very high and only resistive plants such as Jujube and pistacia can grow by this water. These are placed about 20 km distance from Birjand, center of South Khorasan Province in east of Iran (2011 & 2017).

Since many countries for years have been faced with a serious crisis due to shortage of water resources on one hand and on other hand due to population growth and economic and social development, it can be said that water problems in the future would be more and more and water would be undoubtedly an important issue. Based on the UN Commission on Sustainable Development, the growth of water demand in 2025 would be equivalent to 212% of demand in 1990, which means the need to consume water will be more than the country's water resource. Water is a critical resource for farmers, and ensuring access to water is very important for reducing poverty in rural areas because poverty reduction will lead to food security. There is no agriculture and food security without water; this is an important message from a member of the International Federation of Agricultural Producers (Samian et al., 2015).

There have been important adverse distributional effects and issues of sustainability have been raised. An additional approach is increasing crop productivity with respect to water. That is, producing more crop or value per volume of water applied, as discussed above under bridging the yield gap. The third option is to reallocate water toward higher value uses through intra-sector transfers. Limiting the irrigated area under a particular crop would reduce evapotranspiration. Alternatively, water could be diverted toward higher value crops through inter-sector transfers (transfers to municipal supplies, for instance; Lele et al., 2013). In this regard, in dried regions of Iran, it must produce plants that are resistive to dried conditions and for producing their cash and valuable yields do not need a lot of amount of water such as saffron and barberry as seen in Figure 2, Figure 3, Figure 4 and Figure 5.

Figure 2. Gardens of saffron as a cash crop and resistive to dried conditions that for producing its valuable yield do not need a lot of amount of water plus its high resistance to very cold and warm temperatures and environmental hard conditions. In the Gol and Freeze villages –55 km distance to Birjand, center of South Khorasan Province-east of Iran (Pictures by author. Nov 4, 2013; Golmohammadi, 2005-2017).

Figure 3. Planting of barberry that resistance to dried conditions as a main source of income in sustainable rural livelihood in desert regions - with a poor farmer that dead in 2014. In a disadvantaged rural region (Zirg village- 50 km distance to Birjand) in South Khorasan Province in -east of Iran (By author, Oct 7, 2012).

Figure 4. Resistant and living of seven hundreds age medical plant of Terebinth / Turpentine tree in drought conditions in South Khorasan Province in east of Iran – from near and far view (By author Jun 2012).

Figure 5. Establishing a great and modern Jujube garden as a cash plant – about 15 ha – besides Bagheran mountains region in 7 KMs distance to Birjand, center of South Khorasan Province, east of Iran, since 4 years ago to present. By using modern dropping irrigation system for increasing productivity of water and reducing the wastages of valuable water in this modern garden (May 15 - 29, 2017).

2. Obstacles of the Agricultural Water Management in Iran

The major obstacles of the success of agricultural water management Iran are lack of providing subsidies and financial support for farmers and users' enterprises. Having the government technical support is essential, especially for small WUAs (Water User Associations), because they have so many financial challenges in the new irrigation system. Failure to provide necessary training to farmers on irrigation management is an important problem in the field of water management success. The responsibility of farmers for maintenance of canals and water resources is as an effective component in water management. The components of successful water management in Iran divided in several categories that include management, physical (cropping pattern, the number of components, climate, irrigation method, etc.), economy (finance, insurance, difficult access to inputs, etc.), social (consumer behavior, neighbors, responsibility of sponsoring, non-agricultural income, etc.) and institutional components (ownership of water resources, lack of law enforcement, rental of water resource). Crop insurance agent in the form of economic agent, coordinate between governmental organizations in the form of institutional agent, and supportive government policies. The role of education in promoting and increasing the efficiency of agricultural water considered the role of extension and education important. Lack of the irrigation management is due to low irrigation efficiency and the role of education in promoting and improving irrigation management and irrigation efficiency is remarkable. Increasing farmers' knowledge and skills through various training and extension programs (with new methods and considering the recent developments in the agricultural world) as important actions which should be considered in the programs of improving water use efficiency in Iran (Samian et al., 2015).

The main causes of low efficiency of irrigation in Iran are: low level of education of farmers about water, soil and crops, small plots of land and acreage (less than 5 ha), lack of land leveling, lack of proper management of water and irrigation, and, the use of traditional methods of irrigation. The following components as the limitations of the use of pressurized irrigation system in Iran: impossibility of using salt water, the relatively high initial investment requirements, training requirements for optimal use of irrigation facilities, being time-consuming (in terms of the evaluation process, selection of appropriate system, design, delivery, installation and commissioning of the system), impossibility of performance and economic justification in small and scattered pieces of land, restrictions on some products, and rapid depreciation of field parts. Some challenges in the optimal use of water in Iran are

such as lack of inappropriate land leveling and configuration, the diversity of crops grown on a farm, lack of water requirement to each crop, lack of education and promotion of farmers and water users to make optimal use of water. Factors such as inappropriate irrigation and flooding of agricultural land and to penetrate the water deep into the earth as the most important problems related to the agricultural water loss in Iran (Samian et al., 2015) which sampled Figure 6, Figure 7 and Figure 8.

Figure 6. Seasonal floods that not properly storing as a main source of water for resistant and living people in drought conditions. Floods and their physical and environmental damages and loss of valuable water after a long period of drought in South Khorasan Province - East of Iran (By author, Feb. 2012).

Figure 7. Long period of drought in South Khorasan Province in -east of Iran and some watershed management projects for confronting to them and storage of floods (By author, 2010).

Figure 8. Traditional Cisterns as one of the main tools of indigenous knowledge of local people for resistant and living people in drought conditions in Birjand city, and in Sarayan city historical heritage, and in Bojd village- 10 km distance to Birjand city, in two sides of Asphalt road, that belonging to 1000 years ago. For storage snow and water in winter for utilizing it in summer and dried seasons, South Khorasan Province, east of Iran (April 2012 & 2014).

3. Basis for Various Definitions of Water Security

In Australia, well-known as having the world's most arid climate, water security is commonly being defined as a concern about water availability (quantity) to be addressed by the national and state governments through a variety of mechanisms. The World Bank also defined water security on the basis of the positivist paradigm, referring to the annual supply of 1 m3 of healthy drinking water for people, 100 m3 of clean water for personal hygiene, and 1000 m3 of water for agricultural, industrial, and environmental production. Thus, 1101 m3 of water annually for each person would provide water security. Moreover, the national water thresholds classification asserted that countries with less than 1000 m3 of water available annually per person are chronically stressed and those with less than 500 m3 per year are beyond the water barrier.

The US Environmental Protection Agency, for instance, defined water security as prevention and protection against terrorism.

The Falkenmark Index, was defined as the amount of water available in a country per capita. Based on that index, a threshold value of 1700 m3 renewable water resources per capita per year is considered a no stress situation. Water supplies between 1000 and 1700 m3 lead to water stress. When supply falls below 1000 m3 per capita per year, a country is said to experience water scarcity, and, below 500 m3 per capita per year, absolute scarcity (Malekian et al., 2017). On the basis of the positivist perspective, the rural water livelihoods index (RWLI), including four key dimensions;

- Access to basic water services
- Crop and livestock water security
- Clean and healthy water environment
- Secure and equitable water entitlement.

Water poverty as an index (WPI) to evaluate regional water security, includes five key indices: resources (R), access (A), capacity (C), utilization (U), and environment (E).

Each key index consists of several sub-indices. From the WPI results, graded water security for individual farms, using the mean deviation grading method. Water security is considered a complex problem because of the involvement of many actors with different backgrounds, interests, and opportunities, and therefore with different perspectives of both problems and solutions that all have been constructed in numerous interactions. A distinction can be made between real water security as a first order reality and perceived water security as a second-order reality (Malekian et al., 2017).

4. Agricultural Water Security

Agricultural water security is considered a dynamic concept, which means that its interpretation may vary among farmers, even within the same location and in similar situations. Interpretations depend on who perceives it, which actors have been involved in securing water, and what is perceived as secure. Farmers in the same place and with the same water accessibility have similar perceptions of water security in the agricultural sector. Agricultural water security is constituted from specific conversational backgrounds (cultures, traditions, and institutions) and present in the media in which we are socialized. Perceptions of agricultural water security may vary among farmers within the same location and in similar situations.

Water security in agricultural contexts is conceptualized as the process of securing vulnerable farmers from the structural violence caused by the political, social, and natural impediments to adequate water supplies needed for sustainable agriculture, while simultaneously ensuring that the means by which water security is achieved neither deprives others nor degrades affected ecosystems or the environment.

Water security also include securing vulnerable farmers from the structural violence caused by political, social, and natural factors, and seeking to identify the effects of power, inequality, and conflict on the availability of water for them. Agricultural water security has cultural attributes, indicating that different groups have different expectations about the yield and value of agriculture and, thus of the water quantity and quality that should be pursued. In other words, different groups of stakeholders have distinct demands for water quality and quantity and make use of different approaches to access water; they also have different responses to the question whether the agricultural water resources are safe, and what the safety level of agricultural water resources is or should be. Consequently, perceptions of water security in agricultural contexts are based on farmers' own assessments including their fears (or absence of fear) concerning threats and future conflicts regarding water (Figure 9; Malekian et al., 2017).

Figure 9. Some locally and medium dam projects that recently building for gathering and storing seasonal floods as a main source of water for resistant and living people in drought conditions in South Khorasan Province in -East of Iran (and author Jun 2011).

5. Role of Dams

Throughout the world, an important strategy for harnessing water has traditionally been the construction of multipurpose dams. They have served the needs of agriculture, energy and growing cities, and helped protect populations from flood hazards, particularly in Asia, where such hazards have increased measurably. Indeed the largest such investments have been in China and the most assistance for the construction of dams by the World Bank has been in South Asia. Increasingly, international assistance agencies have questioned the development of new dams on the basis of their economic, social and environmental benefits. Yet countries have continued to invest in dams, albeit with different levels of efficiency and effectiveness. For instance, China's water strategy, based on damming rivers, is by no means free of controversy and contains several anomalies. Beyond building dams, which tends to have a strong appeal among national policymakers, increasing the supply of water also means the need to increase the efficiency and productivity of the water used in agriculture. Increasing water use efficiency calls for reducing water losses in transmission and the non-beneficial use of water (i.e. reducing leakage or evaporative losses in water conveyance and application; Lele et al., 2013).

6. Methodology

Location area of this research is villages around Birjand - centre of South Khorasan province. The present study has been done by author of this article during 2015 – 2017 years in a disadvantaged rural regions in south Khorasan province, east of Iran (please see appendix). For writing this article utilized from recent and most important articles in domain of the research namely water security, drought, agricultural sector, rural regions and Iran. Main instrument for gathering information in this article was qulititative research methods and place-based approaches, using in-depth semi structured interviews and participatory observation to understand stakeholders' perceptions of water security in agricultural sector. Plus utilizing discussions, experiments, documents, pictures, and nonformal interviewing with villagers, related officers, specialists and professors in domain of this research during 2010 – 2017. All of the pictures of the article have been gathered with personal attendance of researcher in these desert, dried and disadvantaged rural regions in South Khorasan province. Also in the end of the article, present pictures of International Wetland of Hamoon in South East of Iran (Sistan and Balouchestan province), that after good rainfalls in winter and spring 2016 & 2017, this International Wetland of Hamoon, again filling from water. After long periods of drought that caused dried completely in

2009-2015. Filling from water of this wetland has caused many of rural people returned to their villages and beginning farming and working again. The objectives of the research include;

- Identifying the situation of water resource management in South Khorasan province;
- Identifying the key components of effective water resource management in region; and
- Surveying the viewpoints of agricultural specialists and farmers about improving water resource management in South Khorasan province.

7. Integrated Water Fee (IWF)

Integrated Water Fee (IWF) as an integrated approach water management becomes very complex as it should consider the interests of all stakeholders. Not only environmental, ecological effects of any water management action are important, economic, social and cultural impacts need to be considered. However, the strength of the effects is varying from region to region. Any management decision has different effects in each region. Therefore integrated water management approach can only be implemented successfully, when it follows decentralizing principles. This indicates the need of establishment of regional, river basin based institutions that are complementing national entities. Obviously, such new and complementing structures require additional investments that are rarely budgeted in public households of fragile and developing countries and regions. Hence, additional funds must be allocated to ensure the financial sustainability of an integrated water resource approach. The suppliers, either private or public, make only profit on high water consumption, while saving water would reduce the income and hence lead to budget stress. Therefore water suppliers promote high, even wasting water consumption. Several experiences in the recent past have shown that saving water under the current tariff system lead either to higher water tariffs or public budget deficits. IWF is based on the concepts of Water Footprint and virtual water. It is widely known and accepted that water is embedded into any product. For instance, on a worldwide average the volume of 1300 m3 of water is needed to produce one ton of wheat. While the Slovakian farmers only need about 570m3 for one ton of wheat, Ethiopian farmers need more than six times more of water than Slovakia to produce the same amount of wheat. This reflects the bad soil and climate conditions for wheat in Ethiopia. However, many other crops find ideal conditions in Ethiopia to grow excellent with low water consumption needed. In an ideal world and purely water world inefficiently produced crops would be substituted by water efficient products and could therefore ease the increasing water problems throughout the globe. Unfortunately, this ideal world does not exist. (Treitler, 2012).All the efficiency increasing strategies in agriculture, which use water better, have important income distribution and economy-wide policy and political implications across states, over time and among the different classes of farmers. Exporters win and the hungry lose. In short, the various policy choices and their impacts on producers and consumers are intimately related to the issues of governance and accountability to the public for results on development outcomes at large (Figure 10; Lele et al., 2013).

Figure 10. Greenhouses as a fundamental approach for confronting to drought conditions and maximum efficiency of utilizing water in agricultural affairs (from outside and inside) on Tabas city, 335 km distance from Birjand, centre of South Khorasan province, and its greenhouse (from outside and inside; May 20, 2014).

8. Types of the Water

The water embedded in products can be blue, green and/or grey water. We define blue water as surface or groundwater, while green water is rainwater or water in the soil, moisture. Grey water is defined as treated domestic or industrial water. Withdrawal of blue water for agricultural purposes and the use of treated water requires infrastructure, while green water is pure natural.

For implementing water based strategy and IWF the government has basically two options: Enforcing the tariff system by law and regulations. A strong government is needed to implement such strategy. Unfortunately, not many governments in developing countries are strong enough to enforce this system.

Because of the mostly unstable political and governmental situations it is advisable to create a favorable environment with a bulk of incentives to attract such system to the farmers. The farmers then would not be enforced to, but rather voluntary participate in the system. The incentives could be a

combination of several offers like machine sharing, cost benefits from joint seed management/purchase, support for irrigation systems, trainings, price guarantees, guaranteed quantities etc. These measurements should stabilize the usually volatile markets in developing countries and give economic security to the famers, but should also provide additional, non-economic benefits (Treitler, 2012).

9. The Short and Long Term Challenges to Achieving Water Security

Conceptions of agricultural water security are conditioned by larger understandings of being and reality. It is still unclear what such understandings mean for perspectives on water security in general and on causes and solutions related to perceived water security risks and problems in agricultural sector in particular. The short- and long-term challenges in the areas of global food and water security are well known. The short term challenge is the near 868 million hungry people that need an assured supply of food. Nearly two-thirds of those hungry people are in Asia, a densely populated region of the world that has been driving global growth, trade and finance since the 1990s. It is also a region where food security has been achieved with increasing reliance on irrigation, with generally positive impacts on food security and poverty reduction. The world's water challenges are just as daunting. Statistics are unreliable and vary, but suggest that an estimated 1.6 billion people are already under severe water stress and an additional 1.2 billion are under medium water stress. By 2050 global food production must increase by 60% to feed the expected global population of 9 billion; much of the population growth will occur in South Asia and sub-Saharan Africa. This is the longer-term challenge (Malekian et al., 2017).

10. Water Security and Water Scarcity

The Global Water Partnership (GWP) (2012) has defined water security as, "Ensuring the availability of adequate and reliable water resources of acceptable quality, to underpin water service provision for all social and economic activities in a manner that is environmentally sustainable; mitigating water-related risks, such as floods, droughts and pollution; addressing the conflicts that may arise from disputes over shared waters, especially in situations of growing stress, and turning them into win-win solutions". The incorporation of risks and conflicts is an evolution from the earlier concept of a "water secure world where there is enough water for household needs, for social and economic development, and for ecosystems" (Lele et al., 2013).

Based on a systematic literature review, three conceptualizations of water security, related to different paradigms, are presented. The results showed that agricultural water security from a positivist paradigm referred to tangible and measurable water-related hazards and threats, such as floods and droughts, pollution, and so forth. A constructivist approach to agricultural water security, constituted by a process of interaction and negotiation, pointed at perceptions of water security of farmers and other stakeholders involved in agricultural sector. A critical approach to agricultural water security focused on the processes of securing vulnerable farmers and others from wider political, social, and natural impediments to sufficient water supplies. In the positivist paradigm, water security is defined as the absence of threats, based on the existence of real and independent threats. Hence, water security has to do with real water-related hazards and threats, such as floods and droughts, pollution, and so forth. From a positivist perspective, water security is placed in a dominant narrative of state security.

3.1. Water Scarcity

Water scarcity is the other side of a water security coin, often a result of physical, economic and institutional failures, each of which needs systematic empirical analysis to educate the public (Malekian et al., 2017).

11. Impacts on sustainability and attempts at reforms

Groundwater resources now account for almost 80% of the recent growth in irrigation in South Asia and they are reaching the limits of exploitation. Flat power tariffs have led to power shortages and outages. These in turn have led to deeper tube wells, deployment of more powerful engines, transformer failures, power voltage fluctuations, high maintenance costs and low energy efficiency for both rural and urban consumers.

In India, noted that the green revolution technologies worked in tandem with groundwater irrigation to create some 40 million ha of irrigated area by 2001. "Much of the increase in India's food production is due to this subsidized electricity". Initially, vibrant water markets stimulated by flat tariffs extended the benefits to poor water buyers. This enabled Indian food production to become more resilient to droughts. But now a large number of states and watersheds have been classified by India's Central Groundwater Board as semi-critical, critical and over-exploited. Yet in 2013 India's Central Electricity Authority reported 18.7 million electrical pumps, up by 15.5% from 2010 (and 0.15 percent in one month).

Additional potential for increased production could be found in the world's rain fed agricultural systems. The

low production capacity of these systems at the present is evidence of the widespread neglect in investment in agricultural research and extension in rain fed areas, rather than any inherent deficiency in potential yields.

On-farm water conservation has received less attention, although recently conservation has been aided by the spread of drip irrigation technologies; there is the proviso that public policies on water exploitation are managed well. The latter can be achieved by adoption of agricultural practices that reduce runoff and increase the infiltration and storage of water in the soil in rain fed agriculture. On a larger scale, small, decentralized water harvesting and storage systems contribute to increasing water availability and agricultural production at the household and community levels (Lele et al., 2013).

12. Governance of Water Security and Water Conflicts at the International Level

Water governance defined mainly at the national level, as "the capability of a social system to mobilize energies, in a coherent manner, for the sustainable development of water resources. The notion includes the ability to design public policies (and mobilize social resources in support of them) which are socially accepted, which have as their goal the sustainable development and use of water resources, and to make their implementation effective by the different actors/stakeholders involved in the process". This definition proves to be useful, but illusive, in terms of finding examples to demonstrate its practice, with a few exceptions such as Morocco. More than 40% of the world's people live in 263 river basins that straddle international borders. Only a third of those basins function under trans-boundary agreements. In 1997 the UN adopted a relatively mild Convention on the Non-Navigable Uses of International Watercourses. It contains a statement of principle that nations should ensure the "sustainable and equitable use of shared rivers".

Currently there is no supra-national authority with jurisdiction over trans-boundary disputes. Under Chapter VII of the UN Charter (threats to security) the UN agencies cannot intervene without the consent of the countries concerned, except in the case of threats to peace. Furthermore countries of unequal size, political power and differing strength of internal governance have different interests in involving international organizations in reaching water agreements. Solutions are becoming politically, socio-culturally and environmentally contextual and hence more country and location specific. Besides, water is by far the most complex resource to manage because it knows no national boundaries and weak states are in a poor shape to manage water either domestically or internationally (Lele et al., 2013).

Many internationally-renowned wetlands and lakes in Iran have completely dried up, e.g. the Hamoun wetland in Sistan and Baluchestan Province, and Lakes Kaftar and Bakhtegan in Fars Province. In all other rivers, water levels have fallen to critical levels. Most of the traditional groundwater irrigation systems (qanats) have experienced reduced discharge or have completely dried up. The increasing number and severity of bushfires and sandstorms has negatively impacted wildlife and the livelihoods of local people. Many plant and animal species are severely affected and some face extinction. Water supplies have been affected in rural and urban areas impacting on 90% of the population. In 12 provinces, people are facing critical shortages of safe drinking water and have to rely on water tankers to deliver water. In many villages, saltwater has percolated into wells making them unusable. In some cases, people have migrated to other villages or cities.

Agriculture typically utilizes around 93% of Iran's total water consumption, of which around half is from surface resources and half from groundwater reserves. Drought is directly affecting more than 2.6 million hectares of irrigated farms and 4 million hectares of rain-fed agriculture. A national assessment of water utilization identified that the rate of extraction from aquifers was more than what was permitted in 223 plains (Keshavarz et al., 2013).

13. Understanding the Social Impacts of Drought in Iran

Over the last decade, Iran has experienced its most prolonged, extensive and severe drought in over 30 years. This drought of 2003–2011 (at least, as it is still ongoing) has affected many farm families and rural communities across most of the central, eastern and southern parts of Iran. Although Iran has a history of drought, critical features of the current drought are not only its widespread nature and severity, but the fact that the impacts of the current drought have been exacerbated by its proximity to the previous drought (1998–2001). Consequently, farm families lacked the opportunity to recover and have therefore been severely affected by the current drought (Keshavarz et al., 2013).

Drought is an insidious phenomenon that is a normal part of the climate in virtually all regions of the world. It results in serious economic, social, and environmental impacts that are complex to understand and difficult to anticipate. Statistics compiled by the secretariat for the International Decade for Natural

Disaster Reduction indicate that drought accounts for 22% of the damage from all disasters worldwide, 33% of the number of persons affected by disasters, and 3% of the number of deaths attributed to natural disasters. Although drought has not been well documented recently, it would appear that the impacts of drought are increasing in magnitude and complexity.

A complicating factor in characterizing drought impacts is that they vary in spatial and temporal scales. Each region is unique, and the response at any point in time is dependent on many factors including in changes in societal characteristics. Thus, the impacts that occur from drought are the result of interplay between a natural event (precipitation deficiency) and social response. Drought differentially affects women and men, and the impacts vary across different types of households. The impacts of drought are diverse and can be direct and indirect. In societies where agriculture is the primary economic activity, the immediate impacts observed are in the form of decreases in surface and groundwater resources which lead to reduced water supply, deterioration in water quality, crop failure, reduced productivity, production shortfalls and associated food crises, and increased livestock and wildlife mortality. The food crises indicate that "rural livelihoods and conditions do not enable people to produce, store and access enough food in non-drought periods and are therefore unable to build up enough buffer to cushion crop and income loss due to drought". This is especially the case with respect to small farmers and landless laborers. People who experience drought hardships adopt various strategies (e.g. technical, economic and social) to cope with the negative consequences of drought. Often they are compelled to borrow money at exorbitant rates or to sell land, livestock and even personal belongings at depressed prices in order to survive.

Drought impacts can be classified as economic, environmental and social. The environmental impacts include damage to natural habitats, reduced forest and crop productivity, increased daytime temperature, increased evapotranspiration, decreased soil productivity, lowered water resources, reduced water quality, increased pollutant concentrations, increased incidence of wildfire, and degradation of landscapes.

Economic and social impacts include: reduced household income; shortage of alternative income sources; increased workload; conflict of water access and water use; food insecurity, shortages and associated malnutrition; health impacts and reduced access to health services; reduced access to education; inequitable drought relief and associated stress and conflict; rural to urban migration; impoverishment and reduced quality of life; psychological and emotional impacts including depression, frustration, alienation and suicide; changed family plans such as delaying retirement; and family and community disharmony and disintegration (Keshavarz et al., 2013).

Drought has severe social and economic impacts on farm families, including:

- Economic impacts: such as loss of farm income and reduced income diversity, increased debt, increased on-farm workload and decreased options for off-farm employment.
- Basic needs: including food insecurity and health problems due to drought related stresses and lack of income for adequate health care.
- Education: reduced household expenditure on education, which can especially affect younger members of families who may forego the opportunity to continue their education due to economic constraints.
- Marriage: an increase in the age of marriage and a change in mate selection criteria.
- Conflict and dependency: including increased family and social conflict, social isolation and increased dependency on government assistance.
- Emotional and psychological: including suffering from a sense of hopelessness, failure and loneliness.
- The impact is not the same for all families. In this regard, farm families could be classified into two distinct groups: The less vulnerable and the more vulnerable.

The vulnerable families have suffered more and their resilience has dramatically diminished. It is important to be aware of the gendered and age differential nature of drought and how this plays out in relation to the above impacts. In vulnerable families, some impacts like unemployment, increased on-farm work, malnutrition and hunger, loss of education opportunities, marriage difficulties, social isolation, social and family conflict, depression and hopelessness are disproportionately experienced by women, children and older people.

Both vulnerable and less-vulnerable families tried to adapt to the extended drought by using a range of drought management and coping strategies. However, constraints on the physical, natural and environmental assets prevented the majority of vulnerable families from effective drought mitigation and have forced them to select coping strategies which diminish their livelihood options. It feel that the social experience of drought in Iran is not fundamentally different to the experience elsewhere in the world, and shares remarkable similarity with the experience in Australia, for example (Keshavarz et al., 2013).

14. Conclusion

Security is considered a socio-historical interpretation of reality based on the nature of reality. Agricultural water security is an ambiguous concept that is interpreted in different ways (Malekian et al., 2017).

The government of Iran can implement policies restricting withdrawals of groundwater resources and the prevention of digging of new wells to prevent the loss of water.

The farmers of Iran should be aware of the decline in groundwater levels and they must be encouraged to use water optimally (Samian et al., 2015).

Institutional and legal factors are the most important components affecting the optimal management of agricultural that includes some components like: penalizing unauthorized well users, installation of meters on water wells, blocking unauthorized wells of farms, improvement and dredging aqueducts, etc (Samian et al., 2015).

Water is by far the most complex of natural resources to manage. It has no boundaries and therefore is not amenable to political or administrative restrictions. Nor is it amenable to simple analytical devices, such as centralized or decentralized governance and markets vs. states. It calls for good governance at all levels including, particularly, an understanding of the roles of and linkages between policies and institutions at various political and administrative levels. It requires the involvement of all stakeholders, and their collective impacts on the short and long run outcomes.

It needs a holistic strategy, rather than piecemeal approaches to examine the changing role of water in a rapidly growing economy with demographic pressures on resources which are unprecedented in size and complexity (Lele et al., 2013). To address the tremendous pressure on water it will need central leadership and it will need to ask such radical questions as:

- Should it place a moratorium on future growth in the number of electric pumps in Iran which have already reached a critical level of water exploitation?
- Should it bite the bullet and raise water and power charges slowly and methodically as a way to increase water use efficiency in Iran?
- How should it deal with politically vocal farmer constituencies who demand the short-term palliatives typical, but who do not get the quality of services they deserve in Iran?
- How can it learn from its own successful reforms to scale up systematically in Iran?

Such an approach will call for a strong degree of consensus on solutions among the political and administrative elite. The consensus must be based on strong analytical work, and consensus is not easily achieved in any democracy as the financial crisis in developed countries has made clear. It would call for courageous collective leadership and out of the box thinking. It requires commitment to implementation, systematic monitoring of interventions and results and a greater focus on management with a single minded focus on improved outcomes for the masses, to assure long-term food and water security. Technology will be critical in increasing efficiency, including the new information technology. But technology does not substitute for real leaders, or sound ideologically free policies and institutions. These principles are:

1) clearly defined group boundaries; 2) rules governing the use of collective goods matched to local needs and conditions; 3) ability of most individuals affected by these rules to participate in modifying the rules; 4) the respect by all concerned authorities for the rights of community members to devise their own rules; 5) a system for monitoring members' behavior and a broad based understanding by the community members themselves to undertake this monitoring; 6) a graduated system of sanctions which is enforceable and enforced; 7) the presence of low-cost conflict resolution mechanisms; and 8) and appropriate provision, monitoring, enforcement, conflict resolution and governance activities organized in multiple layers of nested enterprises (Lele et al., 2013).

A major determinant of the drought impact experience relates to the amount of assistance available and the mechanisms used to assess eligibility. A shift in drought management from a reactive, crisis management approach to a proactive, risk management approach is essential. More comprehensive schemes to address poverty and to increase family assets are recommended. Typically, vulnerable families, who usually suffer most, are often least eligible or able to receive government support. Therefore, greater justice is needed in determining eligibility for accessing support. This is especially the case because it is observed that most vulnerable families extended their debt during the drought by borrowing money from relatives or moneylenders. The breaking of the drought will not solve their debt crisis in the short-term and they will continue to experience hardship long after the drought breaks while they pay off their debt and rebuild their assets.

While agriculture has remained the main productive activity for vulnerable families, the less-vulnerable group reduced their vulnerability through non-agriculture occupations and investment in off-farm activities. Therefore, the decline in agricultural productivity and loss of farm income as a result of the drought has not been a serious negative impact on

these less-vulnerable families. On the other hand, the income loss increased vulnerability to poverty and loss of assets and belonging for vulnerable families. Thus providing non-agricultural job opportunities in rural areas where drought is a constant threat should be a major objective of policy. The lack of income meant that all families had to cut back on expenditure, even on important things like healthcare. The most vulnerable families were particularly at risk of harming their longterm wellbeing by sacrificing their health during the drought. Therefore healthcare and social support services should be made more accessible to ensure that farm families, especially those most at risk, receive appropriate help.

Due to the inability of younger people to continue their education during the drought, facilitating the continuing education of poor children through subsidized loans and assistance is required. This is particularly important as a future investment for society because the lack of education is a classic poverty trap (Keshavarz et al., 2013).

The limited access to the job opportunities in drought-affected rural areas led to an increase in unemployment, and in some cases, to people seeking work elsewhere. This experience encourages the young people of vulnerable families to want to never return to the farm. This loss of the next generation of potential farmers may lead to an undeveloped form of agriculture that is more vulnerable to future droughts and other natural disasters. Therefore, support should be provided to increase the resilience of young people and to allow them the choice to continue farming in the rural areas.

The emphasis in drought management policy and advice has, in general, been of a technical (agronomic) nature or about financial recovery following drought, with little or no attention being given to the likely experience of social issues or how that may be mitigated. While there should be consideration of agricultural interventions to reduce drought risk, policy makers should also consider possible social risk management actions to reduce the serious negative social consequences of future droughts. The impact of drought on families comes not only from asset losses, but from a vast range of dimensions and policy failures, including, for example, inequitable access to government support services, which has made some farm families more vulnerable during drought.

It is important to realize that vulnerable families experience different economic, social and emotional impacts of drought than less vulnerable families. Thus, the targeting of interventions such as access to skills, education and knowledge, psychological consultations, public health, food security, and nutrition advice to the different groups (with a specific awareness of the more vulnerable) will make drought mitigation more equitable as well as more effective.

As vulnerable families are less likely to implement drought mitigation strategies because of poverty, they will become more vulnerable in future droughts, and consequently they will be forced to adopt different livelihood strategies. Specific programs to enable the more-vulnerable farmers to adopt effective drought preparation measures are needed to prevent a continuation of their predicament.

Finally, drought policy interventions tend to focus on the direct impacts of drought at regional and national levels with insufficient attention to its impacts on households and to the different experiences of different people in the household (Keshavarz et al., 2013).

Agriculture is the biggest water user in Iran. About 90% of all water withdrawal is currently used for agricultural purposes. The balance is mainly domestic water, while industry does not play an important role yet. However, the industrial sector will become a more important player in the water sector.

Finally following approaches present for improving water security and confronting to drought conditions on agricultural sector in the dried rural regions of east of Iran:

- Blocking the unauthorized wells of farms in the dried rural regions of east of Iran. The reality is that unauthorized wells in the city in recent years, force a lot of injuries on the ground water resources and threaten the sustainability of water resources
- Reusing of waste and additional water, having strict rules against those farmers who waste the water
- Penalizing unauthorized well users
- Development greenhouses as a fundamental approach for confronting to drought conditions and maximum efficiency for utilizing water in agricultural affairs
- Development utilizing modern dropping irrigation system – Instead of Traditional irrigation system that caused a high rate in wastages of valuable water- for increasing productivity of water and reducing the wastages of valuable water in farming and gardens
- Development establishment local and small dams for storage seasonal rains and floods
- If we have a systemic look at the factors affecting the optimal management of the agricultural water we would see that institutional and legal factors affect technical factor and farmers' knowledge while technical factor and farmers' knowledge affect economic factor and economic factor influences social factor and all these factors affect each other like a cycle. For example, improving the farmers' income

affects the economic status of them and this, in turn, affects the optimal consumption and using modern method of irrigation. Ultimately, if we keep on this systemic view toward these components and factors we will know that all these elements are interrelated and should not be considered separately.

- Providing and provision circumstances and conditions for a supportive policy, legal, institutional, macro-economic, favorable infrastructural and bureaucratic environment for accessing to and improving water resource management and agricultural water security in South Khorasan province and east of Iran (Figure 11).

Figure 11. Long periods of drought that caused historical dam of Bande Dareh (with 160 years historical background – in domains of Bagheran mountain range and 8 km distance to Birjand city-center of South Khorasan Province - East of Iran) after 50 years dried completely in summer of 2016 (By author, Dec 30. 2016). Note: After good rainfalls in winter and spring 2017, this historical dam of Bande Dareh, again filling from water. (Golmohammadi, 2005-2017).

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