University of Birjand

Water Harvesting Research Vol. 4, No. 1, Spring & Summer 2021, Original Paper p. 40-53

10.22077/JWHR.2021.3457.1036

Assessing the Status and Importance of Rainwater Harvesting from Public Perceptions (Case Study: Six Regional Capital Cities of Iran)

Vahedberdi Sheikh[a*]

[a]Associate Professor., Watershed Management Department, Gorgan University of Agricultural Sciences and Natural Resources.

[*] Corresponding Author, E-mail address: sheikh@gau.ac.ir
Received: 11 June 2020/ **Revised**: 5 September 2020/ **Accepted**: 19 September 2020

Abstract

Ancient Iranian civilization flourished in an arid and desertic landscape for thousands of years merely due to special water harvesting and management systems. However, currently the country faces a challenging water resources crisis. Since perception of importance of a subject or technology is key factor in its adoption, this study attempts to inquire into perception of Iranian citizens on the importance and necessity of rainwater harvesting. Therefore, 187 respondents from six regional capital cities were interviewed on their RWH experience, knowledge and opinions on the significance and benefits of RWA. The face-to-face questionnaire administration mode was used for the survey. Results indicates that there is a low level of RWH experience and knowledge among the current generation of Iranian, whereas more than 70 and 40% have no RWH experience and information. Respectively. However, there is a high inclination (80%) towards RWH adoption provided that financial supports shall be available. Since more than 51% of the respondents perceive RWH is highly and very highly necessary in large public and commercial buildings, RWH should start from these buildings. More than half of the respondents believe that rainwater is useful for domestic water supply. The respondents perceive that the reduction of water bills (30% of respondents) and alleviation of water shortage crisis (55% of respondents) are the most important advantages of RWH for private households and general public, respectively. More than one-third of the respondents conceive that main beneficiary of RWH will be agriculture sector.

Keywords: water scarcity, RWH experience, advantages, perception, adoption, questionnaire.

1- Introduction

Like in many regions of the world, water is a scarce resource in almost - all over the country Iran. Revealed by occasional or regular failure and disruption of the water supply systems, especially during summer months, many areas of the country suffer from the chronic water scarcity or acute water shortage crisis. The best way for managing these conditions is to capture and store the water above the ground (reservoirs) or underground (artificial cisterns and natural aquifers) in abundance times and use later in shortage spells: meaning Rain Water Harvesting (RWH). It is the process of rainwater collection, conveyance, filtration for multiple future uses (Morey et al., 2016; Sheikh et al., 2017) including many indoor and outdoor uses (Sheikh, 2020a) such as laundry washing, toilet flushing, showering, car washing, garden and crop irrigation and livestock watering (Lancaster, 2019).

Rainwater harvesting is not a new approach for water resources management. The history of this traditional method dates back to more than 4000 years ago in Southeast Asian countries such as China and India (Lo and Gould, 2015).

In the Middle East water harvesting for domestic and agricultural water supply has long history of about 9000 years (Taghavi – Jeloudar and Han, 2013). In Southern Mesopotamia it dates back as early as 4500 BC (Prinz, 1996) and in the Negev desert, micro-catchment runoff collection for irrigation farming has been in practice since the 10th century BC (Shanan, 2000).

Although RWH has been practiced from prehistoric times for agriculture and domestic water supply in rural areas, but as an alternative and innovative method of domestic water supply and sustainable management of stormwater in urban areas has recently gained renewed and increasing interest and importance among water resources planners in some countries and cities around the world by rethinking in policies and regulations (Sheikh, et al., 2020b). Considering the harvested rainwater as an extra valuable water resource, RWH is assumed one of the best water management practices especially for developing regions (Helmreich and Horn, 2009; Lange et al., 2012) to not only solve the increasing demand for water supply, but also to improve the quantity and quality of water resources, particularly in urban environments that release many forms of pollutant into the receiving waterbodies (Izanlo and Sheikh, 2019).

Arid and desertic climate condition of the region had motivated the ancient Iranian to develop various kinds of water harvesting and conservation techniques such as rooftop RWH system called Lari (Jafari Shalamzari et al., 2016b) and valley bed earth bund floodwater harvesting system called Sowma (Sheikh, 2012) in the Golestan province in northeast of Iran; indigenous run-off farming systems of Bandsar in the South and Razavi Khorasan provinces in east and northeast of Iran (Nazar Samani et al., 2014; Tabatabaee Yazdi and Aliabadi, 2017) and Khooshab in the Sistan & Baluchestan province in southeast of Iran (Nazar Samani et al., 2014); Degar as an old simple earthen pond of flood control system in the southern coastal plains (Jafari et al., 2018), the traditional rainwater harvesting system of Siraf in Boushehr province which had been practiced by Iranian about eight centuries ago in northern coasts of the Persian Gulf through digging out of puddles in mountain slopes (Mohajeri, 2010), and a unique kind of cistern, so-called Ab-anbar, that was commonly built in pre-modern era in central and eastern deserts of Iran (Saeidian, 2013).

As shortly described above, many different techniques of small scale rainwater harvesting and utilization as well as other traditional methods of sustainable water resources management technologies have been historically and successfully practiced all over the country Iran until mid-20th century when rapidly increasing modernization of both the industrial and agricultural sectors of the country has been initiated (Madani, 2014, Saeedi and Goodarzi, 2020). The consequences of these rushes in modernization and socio-economic development have prompted the policy-makers and water resources planners to opt for dam construction and water hoarding in large open reservoirs for more than half a century and more ironically, inter-basin water transfer during the last decade as the main national strategy regarding water resources management. The outcomes and impacts of these unsustainable policies and strategies in the water sector, have emerged as many forms of environmental crisis such as shrinkage of wetlands and internal lakes, permanent rivers dry-ups, more frequent dust storms, groundwater depletion, brine aquifer intrusion, land degradation and subsidence, water quality degradation, desertification and social conflicts among water user communities (Motagh et al., 2008; Madani, et al, 2016; Michel, 2017; Moridi, 2017). Therefore, many parts of Iran, especially urban areas, are currently experiencing water stress, whereas more than 500 cities across the country are challenging with serious risk of potable water shortage (Chiu et al., 2020, Saeedi and Goodarzi, 2020).

Despite that, the threat of water scarcity crisis looms large, but there are many opportunities and innovative solutions that can be adopted to halt or reverse the ongoing unsustainable trends. RWH is believed as the most sustainable promising solution to supply water for domestic

uses in rural and urban areas as well as supplementary irrigation water for small scale agriculture (Helmreich and Horn, 2009; Vohland and Barry, 2009; Lange et al., 2012; Rahman et al., 2014) and urban landscape irrigation (Saeedi and Goodarzi, 2020). However, for successful adoption of an alternative and innovative approach or technology, assessment of the target community's knowledge and perception about different aspects of that approach or technology, specially the analysis of the perception of the importance and necessity is vital. Thus, understanding public perceptions of RWH systems as alternative water sources and causes of their agreement-disagreement are imperative to sustainable development. Because, achieving an acceptable and common-sense solution is the best strategy for accompanying people with government policies (Omole and Okunowo, 2016). The perceived importance is a strong indicator of the intention of adoption of sustainable facilities management practices (Lee and Kang, 2013).

To this end, in this study, RWH experience and knowledge, opinions on RWH importance and benefits as well as inclination to adopt, invest on and install domestic RWH systems among the citizens of six regional capital cities across the arid and semi-arid country of Iran has been investigated. Although after the introduction of modern and technocratic water resources management approaches, the RWH has gradually lost its privilege among the new generations of Iranian from mid-20th century but currently emerging and ever-increasing trends of water- related or induced challenges and crisis throughout of the country has necessitated the rethinking in water management approaches and techniques. The main objectives of this study include: 1) to assess the current water supply condition, 2) to explore the current status of RWH adoption, 3)to analyze perceived importance and necessity of RWH, and 4) to specify the maim advantages and beneficiaries of RWH from the respondents' viewpoints.

2- Materials and methods

To conduct this study, a researcher made structured questionnaire was used. The questionnaire consists of different sets of questions (40 queries) to discover the public knowledge, perceptions and attitudes towards water resources and uses, RWH importance, necessity, advantages and usefulness, knowledge and experience of using RWHS, barriers against adoption of RWHS, perceived usage of collected rainwater and the way in which the collected water can be utilized, perceived concerns and incentives to install, promote and maintain RWHS and economic and institutional perceptions of RWH. However, in the current paper, the current status of RWH, opinions on RWH importance, necessity, advantages and main beneficiaries have been explored. Other aspects have been addressed and presented in another paper (Sheikh, 2020a).

The face-to-face questionnaire administration mode (Mellenbergh, 2008) was used for live interviews and discussions. The survey was carried out in six Iranian provincial capitals including Bojnord, Gorgan, Ilam, Mashhad, Shiraz and Urmia (Figure 1 and Table 1). A total of 187 respondents were selected on a random basis from different groups of the grassroots including school teachers, civil servants, pensioners, shop clerks, and housewives were interviewed during the public survey.

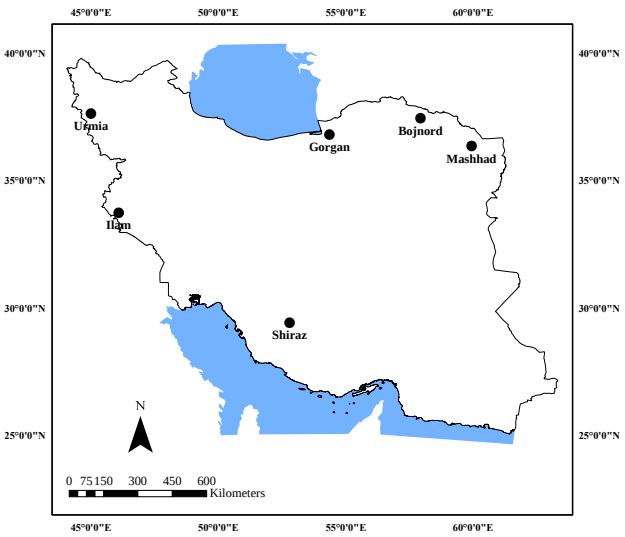

Fig. 1. The spatial distribution of the survey locations

Table 1. General information of survey locations

City	Province	Population	Elevation (m. a.s.l)	Annual Precipitation (mm)	Annual Mean Temperature (^{o}C)	No. of respondents
Bojnord	North Khorasan	229000	1070	256	13.4	33
Gorgan	Golestan	350000	150	650	17	30
Ilam	Ilam	194000	1427	620	13	31
Mashhad	Razavi Khorasan	3000000	1050	230	15.7	30
Shiraz	Fars	1565000	1500	335	18	33
Urmia	West Azarbaijan	736000	1332	340	9.8	30

3- Results and discussion

a. Water supply condition

Adoption of RWH in a community is related to the knowledge and perception of people about source and supply of domestic water (Vohland and Barry, 2009). Therefore, the questionnaire survey was started by interrogating knowledge and perception of public respondents about domestic water source and supply condition. As shown in Figure (2), although about 18 percent of respondents do not aware of the source of the water they are supplied, approximately half of the all respondents agree that main source of their supplied water is groundwater which corresponds well to the officially reported average value of 52 percent across the country (Iran Water Resources Management Company, 2020). According to provincial grey reports, about 40, 95, 70, 60, 80 and 50 percent of domestic water demands of the Bojnord, Gorgan, Ilam, Mashhad, Shiraz and Urmia cities are supplied from groundwater resources. Inaccurate perception of respondents about main source of domestic water supply in Shiraz and Urmia can be partly attributed to the rivers of Khorramroud and Shahrchai that pass and flow through these cities, respectively.

The results of inquiry about domestic water supply condition has been presented in Figure (3). As seen, despite being located in arid and semi-arid region of the world, in none of the studied cities water rationing in dry seasons has been reported. However, except the Shiraz city, in other cities occasional disconnection in domestic water supply system during dry seasons has been declared.

In half of the studied cities, about 40 percent of respondents have experienced water supply disruption in dry seasons, which is more pronounced in the Gorgan city where receives the highest annual precipitation among the studied cities. As an average, about three fourths of respondents have not experienced domestic water supply disconnection and rationing even in dry spells. In other words, water supply condition in urban areas of Iran is fairly good and this most oftentimes or permanent access of citizens to a low-priced municipal water prevents them to actually perceive the reality of water resources scarcity in the local and national scales. These water scarcity invisibility results in the user's illusion of water abundance and unrealistic consumers assumption that water can be endlessly oversupplied (Habashiani, 2011). Although access to fresh water is a universal and free human right, but misconception of endless oversupply of water arising from water scarcity invisibility has continuously resulted in various forms of water crisis in different areas across the globe. Access to fresh water is considered to be a universal and free human right, but

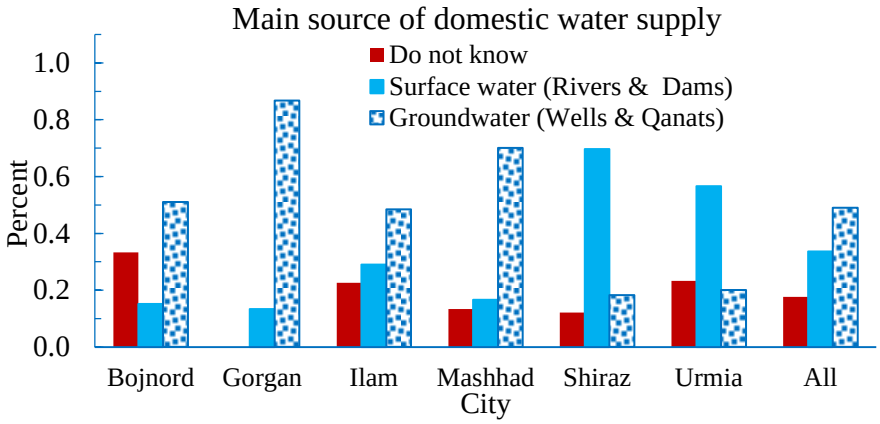

Fig. 2. Assessment of public perception about main source of domestic water supply

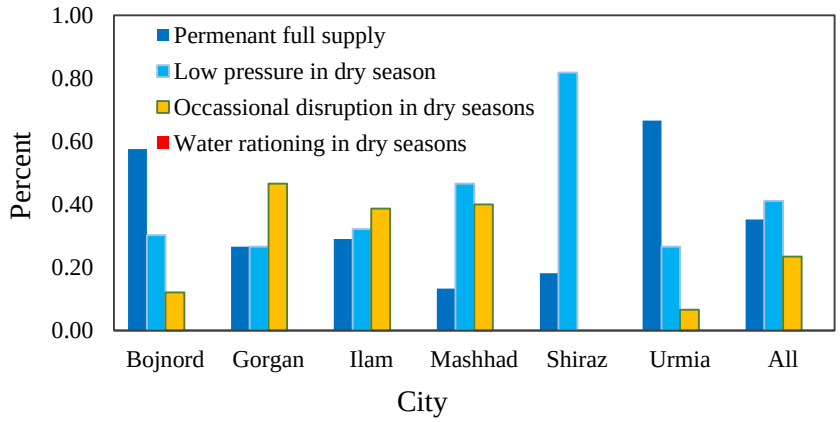

Fig. 3. General condition of domestic water supply system

Status of RWH adoption

RWH experience and interest among the studied Iranian regional capital cities have been summarized in Table (2). To this end, the respondents were posed with five queries including experience of and familiarity with RWH, willingness to invest and install RWH and willingness to use harvested rainwater. As seen, there is low level of experience and familiarity with RWH among the current generation of Iranian citizens, despite that their ancestors survived the arid and desertic condition of the country for several millennia through applying various traditional techniques of rainwater harvesting and water management and conservation. Only about 15 percent of all respondents have prior or present experience of using RWH system. It is highest in the Shiraz and Mashhad cities. This is while, the theory of diffusion of innovations emphasizes on idiosyncrasies of the adopters' experience as a key element of operationalizing innovations (White, 2009; Rogers, 2010). Despite limited prior or present experience, about 70 percent of respondents of each city are interested to use RWH and the level of disbelief to RWH is negligible, except in the Gorgan city where its respondents have declared the highest domestic water supply disruption. Regarding the familiarity with RWH, although the overall level is very low, but the Mashhad citizens have shown the highest level of familiarity among all the studied cities and the Gorgan citizens are the next ones. The Shiraz and Urmia citizens have expressed the least familiarity with RWH.

Table 2. Current status of RWH among Iranian citizens

Question/Criteria	Response options	Bojnord	Gorgan	Ilam	Mashhad	Shiraz	Urmia	All
Experience of RWH use	Yes, previously	0.03	0.10	0.13	0.13	0.18	0.10	0.11
	Yes, currently	0.00	0.07	0.06	0.07	0.03	0.03	0.05
	Not yet, but interested	0.70	0.67	0.68	0.70	0.70	0.73	**0.70**
	Not yet, not interested	0.03	0.03	0.00	0.07	0.03	0.03	0.03
	I did not know It can be useful	0.24	0.00	0.06	0.03	0.06	0.07	0.08
	I do not believe it is necessary	0.00	0.13	0.06	0.00	0.00	0.03	0.04
Level of familiarity with RWH	No info	0.30	0.30	0.42	0.10	0.64	0.63	**0.40**
	Very little	0.45	0.20	0.16	0.13	0.27	0.17	0.24
	Little	0.09	0.23	0.13	0.10	0.03	0.03	0.10
	Moderate	0.12	0.17	0.16	0.47	0.00	0.07	0.16
	Much	0.03	0.07	0.06	0.17	0.00	0.00	0.05
	Very Much	0.00	0.03	0.06	0.03	0.06	0.10	0.05
Willingness to use harvested rainwater	Yes, I use it currently	0.00	0.03	0.03	0.07	0.00	0.00	0.02
	Yes	0.36	0.53	0.55	0.77	0.30	0.47	**0.49**
	Not sure	0.36	0.33	0.32	0.13	0.61	0.40	0.36
	No	0.27	0.10	0.10	0.03	0.09	0.13	0.12
Willingness to invest on RWH	I cannot afford	0.24	0.37	0.52	0.30	0.39	0.50	**0.39**
	Only in case of receiving low interest loan	0.48	0.40	0.16	0.33	0.48	0.33	0.37
	As much as 200 USD	0.24	0.20	0.19	0.17	0.12	0.17	0.18
	200 - 1000 USD	0.03	0.03	0.13	0.20	0.00	0.00	0.06
	More than 1000 USD	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Willingness to install RWHS provided financial support	Not sure	0.33	0.03	0.19	0.07	0.00	0.30	0.16
	Yes	0.64	0.93	0.77	0.93	0.97	0.57	**0.80**
	No	0.03	0.03	0.03	0.00	0.03	0.13	0.04

A small minority of citizens in Mashhad, Gorgan and Ilam are currently using the harvested rainwater, but there is a remarkable willingness to use harvested rainwater among the Iranian citizens, particularly in the above-mentioned cities. However, a majority of respondents either can not afford to invest on RWH or are willing to invest only if they receive low interest loans. Consequently, a large majority of the Iranian citizens are inclined to install RWH provided that they are given financial support. This perception is in agreement with findings of Roebuck et al. (2011) and it is concluded without significant financial support, installation of the domestic RWH system is unlikely to be cost effective. To this end, many governments in the developed and developing countries around the world support the RWH adoption through technical support and financial incentives such as in Australia (Rahman et al., 2012; Chubaka et al., 2017), Belgium (Domenech and Sauri, 2011), Brazil (Teston et al., 2018), Germany (Herrmann and Schmida, 2000; Schuetze, 2013), India (Solanki, 2016), Japan (Furumai et al., 2008), Malaysia (Lani et al., 2018), Mexico (Fuentes-Galván et al., 2018), South Korea (Han, 2013), Spain (Domenech and Sauri, 2011), UK (Ward et al., 2013) and USA (Meehan & Moore, 2014). Therefore, the water and municipal authorities of the country are strongly recommended to develop policy instruments and supporting regulations and incentives to promote RWH adoption as a sustainable solution to water resources management and conservation and consistent adaptation approach to climate change (Shastri et al., 2019). Therefore, despite the fact that the rate of RWH adoption has dwindled among the Iranian citizen over times, there is currently a

high potential for promoting RWH through information sharing and providing incentives. Information sharing and awareness raising will improve the level of familiarity of the citizens with innovative techniques of RWH and providing financial support will enable them to invest, design and install innovative RWH systems to meet their needs and expectations.

b. Importance and necessity of RWH

The adoption and promotion of an innovative technology or system without understanding and realizing the importance and necessity of it from users' viewpoints will not succeed at all. To this end, the necessity and usefulness of the RWHS were assessed from the public respondents' viewpoints and presented in Figure (4).

As shown in Figure (4), the importance, necessity and usefulness of RWHS have not been strongly realized by the Iranian citizen. This is not an unexpected result considering the widespread and continuous supply of heavily subsidized good quality municipal piped water to almost all the citizens (Madani, et al., 2016). Therefore, it is of utmost importance to increase the awareness and understanding of whole public with respect to water resources condition through presenting and highlighting the facts and figures of water resources and sensitizing and attracting attention of all the respective authorities, NGOs and grassroots to design and implement immediate measures for sustainable management, utilization and conservation of increasingly scarce freshwater resources. Although domestic sector uses about 6 – 7 percent of national water withdrawal, average per capita consumption of water is about 250 liters per day which is two times more than global average (Madani, et al., 2016). The average annual water consumption in Iran is approximately 8% higher than the total sustainable water supply and up to 80% of the total population of the country is under water stress (Mesgaran and Azadi, 2018; Chiu et al., 2020). The agriculture sector by producing 10% of national GDP and engaging 21% of the labor force consumes 92% of total water withdrawal (Michel, 2017, Moridi, 2017). Due to population growth, per capita renewable water resources of the country have already fallen below the Falkenmark water stress index of 1700 cubic meters per year and up to 80% of the renewable water is currently withdrawn (Moridi, 2017) leading the country towards water bankruptcy (Madani et al, 2016). Although RWH is not a new concept, but the development of new designs, materials and appliances for innovative domestic RWH systems is now becoming a reality. Since, the perceived importance is a strong indicator of the intention of adoption of innovative approaches and practices, understanding and promoting the importance and necessity of sustainable water resources management and conservation, such as innovative RWH techniques and systems from the users' perspective is a key element in coping with water scarcity crisis, particularly in arid and semi-arid regions (Lee and Kang, 2013).

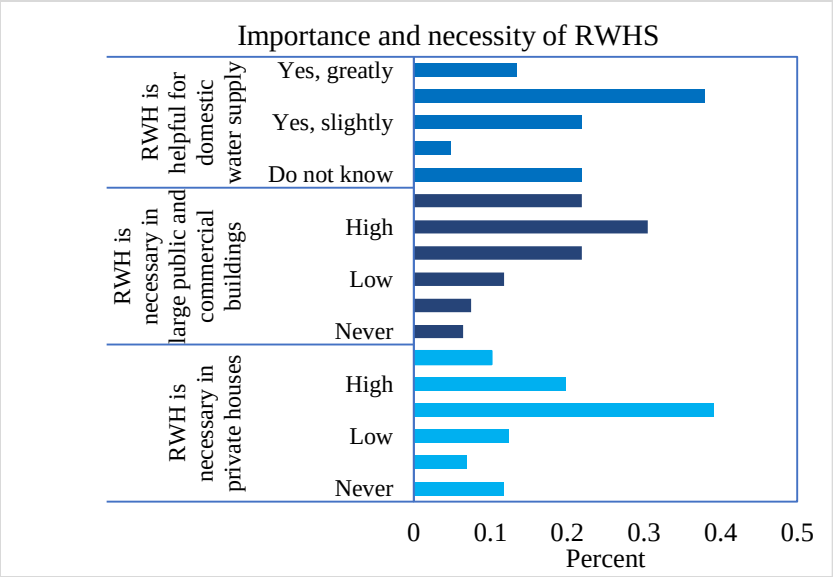

Fig. 4. Iranian citizens opinions regarding the importance and usefulness of the RWHS

c. Advantages and beneficiaries of RWH

Several advantages and benefits for rainwater harvesting reported in the literature include reducing floods and soil erosion, decreasing water demand, reducing water bills, improving the quality and quantity of groundwater, saving water and energy, reducing surface water pollution, a limited energy requirement for water treatment associated with conventional technologies and simple and sustainable technology (Gould and Nissen-Petersen, 1999; Mannel et al., 2014; Rahman et al., 2014; Lo and Gould, 2015; Qi et al., 2019). However, it has some disadvantages or barriers which should be carefully considered, a few to mention include high installation and maintenance costs, technical skills requirement, irregularity in precipitation timing and amount, quality and waterborne disease control and space limitation for storage system (Mwamila, et al., 2016; Selabe and Minyoi, 2018). The intensity and magnitude of the perceived advantages and benefits vary depending the climatic condition, fresh water availability, access, price and quality condition and socio-economic condition in the target area. Assessment of the advantages and beneficiaries from the public viewpoints plays a key role in planning for promotion of RWH adoption. To this end, different questions (criteria) and statements (options) were defined as advantages of RWH adoption and the respondents were inquired to evaluate or scale them. The results of survey on advantages and benefits of RWH have been presented in Table 3 and Figure 5. As seen in Table 3, a limited proportion of all respondents selected the options of "supply of water with low dissolved ions" and "private ownership and control" as the main advantages of RWH at household level. However, rainwater contains very low amount of dissolved water (Lancaster, 2019) and it has been reported as a privilege in the related literature (Rahman et al., 2014; Jafari Shalamzari et al., 2016a; Solanki, 2016; Memarian et al., 2017). Only about 18 percent of all respondents agree that simplicity of the RWH system is its main advantage.

Table 3. Advantages and beneficiaries of RWH systems

Question/Criteria	Response options	Bojnord	Gorgan	Ilam	Mashhad	Shiraz	Urmia	All
Advantages to private households	Simple technology	0.09	0.20	0.26	0.30	0.09	0.13	0.18
	Supply of water with low dissolved ions	0.21	0.23	0.19	0.07	0.06	0.07	0.14
	Reduction of water bills	0.39	0.27	0.26	0.23	0.39	0.27	**0.30**

	(tariffs)							
	Private ownership and control	0.12	0.07	0.10	0.07	0.18	0.23	0.13
	Helpful storage for disruption and rationing periods	0.18	0.23	0.19	0.33	0.27	0.30	0.25
Advantages to public: reduction of	Water shortage crisis	0.61	0.80	0.48	0.57	0.45	0.37	**0.55**
	Water pollution crisis	0.03	0.03	0.06	0.07	0.09	0.10	0.06
	Flooding and inundation	0.09	0.03	0.13	0.03	0.15	0.23	0.11
	Environment pollution	0.03	0.00	0.03	0.07	0.06	0.07	0.04
	Climate change impacts	0.15	0.03	0.19	0.03	0.03	0.10	0.09
	Dry-up of lakes and rivers	0.06	0.10	0.03	0.00	0.15	0.07	0.07
	Groundwater depletion	0.03	0.00	0.06	0.23	0.06	0.07	0.07
Main beneficiary sectors of RWH system adoption	Domestic users	0.45	0.43	0.19	0.13	0.03	0.03	0.21
	Service providers	0.18	0.13	0.29	0.27	0.12	0.13	0.19
	Industry	0.00	0.10	0.03	0.00	0.09	0.17	0.06
	Agriculture	0.36	0.07	0.35	0.37	0.52	0.40	**0.35**
	Environment	0.00	0.27	0.13	0.23	0.24	0.27	0.19

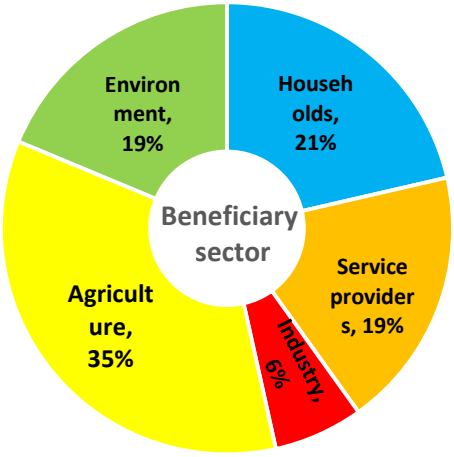

Fig. 5. Perceived beneficiaries of RWH

One out every of four respondents agree that helpfulness of RWH during municipal water disruption and rationing periods is its main advantage. The highest proportion (30%) of respondents have chosen the "reduction of water bills" as the main advantage of RWH. In fact, the respondents perceive this advantage as the most important advantage of RWH at the private household scale. However, at public scale, more than half of all respondents agree that RWH can be most useful to solve water shortage crisis and about 10 percent also opted for reduction of flooding and inundation problem as the most useful effect of RWH. These two effects are usually considered as dual benefits of RWH at community level (Ward et al., 2008, Zhang et al., 2009; Gee and Hunt, 2016; Tavakol-Davani et al., 2016). Most interesting and unexpected result of this part of the survey is that respondents regard the agriculture as the main beneficiary sector of RWH in urban areas and the domestic sector as the next one. The only exception is seen in the city of Gorgan where annual precipitation is the highest (more than 600 mm) and agriculture is not mainly dependent upon irrigation. This is while the agriculture sector consumes about 92 percent of total renewable water resources of the country only to provide 21% of the jobs and to produce about 10% of the national GDP. This public perception with respect to main beneficiaries of RWH might be caused by the populist actions of the government in supporting the agriculture sector through heavy subsidizations of water and energy and adoption of highly technocratic approach in

water management such as dam construction and inter-basin water transfer to supply irrigation water demand of dry, thirsty and less fertile lands (Madani, 2014; Madani et al, 2016; Michel, 2017 and Moridi et al., 2017). Although domestic sector enjoys continuous, cheap and high-quality water, but interprovincial and intervillage conflicts and disputes among farmers and other water users has been seriously exacerbated on water allocation, despite the country's push for self-sufficiency in staples production and promotion of the livelihood of the rural farmers.

4- Conclusions

Population growth, urbanization, industrialization and climate change intensify the water resources challenges, particularly in arid regions. To address the issue, during 20th century, highly technocratic approach or hydraulic mission paradigm to water resources management was adopted to tame rivers by dams and dikes, install large irrigation schemes and urban water infrastructures (2009). However, this approach resulted in many forms of environmental destruction at local, regional and global scale that led to rethinking on water resources management paradigm shifts towards more ecological and environmentally friendly approaches and green solutions. Rainwater harvesting is viewed by many as a sustainable and green solution to partially address the water scarcity and flooding problems. It is an ancient and effective water conservation practice that is gaining increasing importance and acceptance now in some countries as an innovative and alternative method to supply water.

Rainwater harvesting concept has a deep root in the history and prehistory of the arid and semi-arid country of Iran, but it has currently little or no place in the culture, policy and management of water resources, despite facing many forms of water related environmental, economic and social crises. Therefore, this study tried to explore viewpoints of citizens of six regional capitals about the importance and necessity of RWH. Because, understanding the perception of importance and feeling of the necessity of an alternative or innovative technology or approach is imperative to promote its adoption among the grassroots. The results of this social survey revealed that, despite their ancestors, the current generation of Iranian lack enough knowledge and information regarding rainwater harvesting and use. The majority of people perceive that the importance and necessity of RWH is high and very high for large public and commercial building complexes and is moderate for private buildings. Most of the respondents think that RWH is somewhat and slightly useful for domestic water supply. Despite low level of knowledge and moderate perception of importance and feeling of necessity of RWH, almost half of the respondents are willing to use the harvested rainwater. Although a large proportion (0.39%) of the respondent declared their lack of financial affordance to install RWH system, but a vast majority (0.80%) of them showed willingness to install RWH provided that financial support is available. Since, the installation cost of RWH is high, alike many forerunner countries in adoption of RWH systems such as Australia, India, USA, UK, Brazil, Mexico, Malaysia and China, the pertinent Iranian government authorities are recommended to provide different types of incentives to promote the adoption of RWH as a sustainable approach to water resources management.

5- Acknowledgments

I would like to express my deep gratitude to the participants (N. Kariminejad, Z. Heydarizadeh, A. Bozorgmehr, A.R. Kalemati, S.J. Miri-Soleyman, M.T. Kashki, and M.R. Molla-Abbasi) of the Non-Conventional Water Resources Management and Utilization PhD course held by the Arid Zone Management Department of Gorgan University of Agricultural Sciences and Natural Resources in 2017, who actively helped me in conducting social survey interviews.

6- Conflicts of Interest

No potential conflict of interest was reported by the authors.

7- References

Chiu, Y.R., Aghaloo, K., & Mohammadi, B. (2020). Incorporating rainwater harvesting systems in Iran's potable water-saving scheme by using a GIS-simulation based decision support system. *Water*, 12, 752; doi:10.3390/w12030752

Chubaka, C.E., Ross, K.E. and Edwards, J.W. (2017). Rainwater for drinking water: A study of household attitudes. *WIT Transactions on Ecology and the Environment*, *216*, pp.299-311.

Domenech, L., & Sauri, D. (2011). A comparative appraisal of the use of rainwater harvesting in single and multi-family buildings of the Metropolitan Area of Barcelona (Spain): Social experience, drinking water savings and economic costs. *Journal of Cleaner Production*, 19: 598–608.

Fuentes-Galván, M.L., Ortiz Medel, J., & Arias Hernández, L.A. (2018). Roof rainwater harvesting in central Mexico: Uses, benefits, and factors of adoption. *Water*, 10(2), 116. https://doi.org/10.3390/w10020116

Furumai, H., Kim, J., Imbe, M., & Okui, H. (2008). Recent application of rainwater storage and harvesting in Japan. In *Proceedings of the 3rd IWA International Rainwater Harvesting and Management Workshop as a part of IWA-Viena World Water Congress & Exhibition*, Vienna, Austria, 11 September 2008; p. 7.

Gee, K. D., & Hunt, W. F. (2016). Enhancing stormwater management benefits of rainwater harvesting via innovative technologies. *Journal of Environmental Engineering*, 142(8): 04016039. doi:10.1061/(asce)ee.1943-7870.0001108.

Gould, J., & Nissen-Petersen, E. (1999). *Rainwater catchment systems for domestic supply: design, construction and implementation*. UK: IT Publications; 335p.

Habashiani, R. (2011). Qanat: a sustainable groundwater supply system. M.Sc. thesis, J*ames Cook University*. 158p.

Han, M. 2013. Progress of multipurpose and proactive rainwater management in Korea. *Environmental Engineering Research*, 18(2): 65-69

Helmreich, B., & Horn, H. (2009). Opportunities in rainwater harvesting. Desalination, 248, 118–124.

Herrmann, T., & Schmida, U. (2000). Rainwater utilisation in Germany: efficiency, dimensioning, hydraulic and environmental aspects. *Urban Water*, 1(4): 307–316. doi:10.1016/s1462-0758(00)00024-8

Iran Water Resources Management Company. (2020). Deputy for Basic Water Resources Studies. Water resources database. Available online: *http://wrs.wrm.ir/amar/login.asp* (accessed on 13 March 2020).

Izanloo, R. & Sheikh, V.B. (2019). Prioritization of surface runoff management scenarios using TOPSIS method in different weighting conditions (Case study: Bojnord city). *Journal of Water and Wastewater*. dx.doi.org/10.22093/wwj.2017.81822.2381.

Jafari, M., Tavili, A., Panahi, F., Zandi Esfahan, E., & Ghorbani, M. (2018). *Reclamation of Arid Lands*. Springer Nature Switzerlands AG. 267pp.

Jafari Shalamzari, M., Sheikh, V., Sadoddin, A., & Abedi Sarvestani, A. (2016a). Public perception and acceptability toward domestic rainwater harvesting in Golestan, limits to up-scaling, *Ecopersia*, 4(3): 1437-1454.

Jafari Shalamzari, M., Sadoddin, A., Sheikh, V., & Abedi Sarvestani, A. (2016b). Analysis of adaptation determinants of domestic rainwater harvesting systems (DRWHs) in Golestan province, Iran. *Environmental Resources Research*, 4(1): 27 - 43

Lancaster, B., (2019). *Rainwater harvesting for drylands and beyond, volume 1: guiding principles to welcome rain into your life and landscape* (Vol. 1). Rainsource Press.

Lange, J., Husary, S., Gunkel, A., Bastian, D., & Grodek, T. (2012). Potentials and limits of urban rainwater harvesting in the Middle East. *Hydrology & Earth Systems Science*, 16: 715–724.

Lani, N. H., Yusop, Z., & Syafiuddin. A. (2018). A review of rainwater harvesting in Malaysia: prospects and challenges. *Water*, 10, 506; doi:10.3390/w10040506 .

Lee, S. Y., & Kang, M. (2013). Innovation characteristics and intention to adopt sustainable facilities management practices. *Ergonomics*, 56(3), 480–491, http://dx.doi.org/10.1080/00140139.2012.752110

Lo, A. G. & Gould, J. (2015). Rainwater Harvesting: Global Overview. In: Q. Zhu, J. Gould, Y. Li, & C. Ma (eds). *Rainwater Harvesting for Agriculture and Water Supply*, (pp. 213–233). doi:10.1007/978-981-287-964-6_7

Madani, K. (2014). Water management in Iran: what is causing the looming crisis? *Journal of Environmental Studies and Sciences*, 4(4), 315–328. doi:10.1007/s13412-014-0182

Madani, K., AghaKouchak, A., & Mirchi, A. (2016). Iran's socio-economic drought: challenges of a water-bankrupt nation. *Iranian Studies*, 49(6): 997-1016.

Mannel, D., Prozesky, H., & Cloete, T. (2014). Domestic rainwater harvesting: survey of perceptions of users in Kleinmond. Report to the Water Research Commission. *WRC Report* No. TT 604/14 ISBN 978-1-4312-0562-2. 83pp.

Meehan, K. M., & Moore, A. W. (2014). Downspout politics, upstream conflict: Formalizing rainwater harvesting in the United States. *WATER INT'L*, (39): 417- 418.

Mellenbergh, G.J. (2008). Tests and questionnaires: Construction and administration. In: H.J. Adèr & G.J. Mellenbergh (Eds.) *Advising on Research Methods: A consultant's companion* (pp. 211–236). Huizen, The Netherlands: Johannes van Kessel Publishing.

Memarian, H., Hossein Nia, A., Tavasoli, A., Komeh, Z., Tajbakhsh, S.M., Abbasi, A.A. and Parsayi, L., (2016). Health and environmental considerations of rooftop catchment systems (Case study: Aq Ghala, Golestan Province, Iran). *Water Harvesting Research*, *1*(1), pp.1-11.

Mesgaran, M. B., & Azadi, P. (2018). A national adaptation plan for water scarcity in Iran, Working Paper 6, Stanford Iran 2040 Project; *Stanford university: Stanford, CA, USA*, August 2018.

Michel, D. (2017). Iran's impending water crisis. In: D. Reed(ed). *Water, Security and US Foreign Policy* (pp. 168-188). Routledge

Mohajeri, S. (2010). SIRAF- a successful traditional way of water harvesting in Iran. Drynet project funded by the European Union and supported by The Global Mechanism, *United Nation Convention to Combat Desertification*. 9 pp.

Morey, A., Dhurve, B., Haste, V. and Wasnik, B., (2016). Rainwater harvesting system. Int. Res. J. Eng. Technol, 3, pp.2158-2162.

Moridi, A. (2017). State of water resources in Iran. *International Journal of Hydrology*, 1(4):111–114

Motagh, M., Walter, T. R., Sharifi, M. A., Fielding, E., Schenk, A., Anderssohn, J., & Zschau, J. (2008). Land subsidence in Iran caused by widespread water reservoir overexploitation. *Geophysical Research Letters*, 35(16): L16403

Mwamila, T.B., Han, M.Y., & Katambara, Z. (2016). Strategy to overcome barriers of rainwater harvesting, Case study Tanzania. *Journal of Geoscience and Environment Protection*, 4, 13-23. http://dx.doi.org/10.4236/gep.2016.49002.

Nazari Samani, A. A., Khalighi, S., Arabkhedri, M., & Farzadmehr, J. (2014). Indigenous knowledge and techniques of runoff harvesting (Bandsar and Khooshab) in arid and semi-arid regions of Iran. *Journal of Water Resource and Protection*, 6:784-792.

Omole, D.O. & Okunowo, O. S. (2016). People perception of domestic water supply situation in Ogun State, Nigeria. *Research Journal of Applied Sciences, Engineering and Technology*, 12(1): 94-99.

Prinz, D. (1996). Water harvesting: past and future. In: Pereira, L. S. (ed.), *Sustainability of Irrigated Agriculture Proceedings*, NATO Advanced Research Workshop, Vimeiro, 21-26.03. Balkema, Rotterdam, 135-144.

Qi, Q., Marwa, J., Mwamila, T. B., Gwenzi, W., & Noubactep, C. (2019). Making rainwater harvesting a key solution for water management: The universality of the Kilimanjaro concept. *Sustainability*, 11, 5606; doi:10.3390/su11205606.

Rahman, A., Dbais, J., Islam, S.M., Eroksuz, E., & Haddad, K. (2012). Rainwater harvesting in large residential buildings in Australia. In: S. Polyzos (Ed), *Urban Development* (pp. 159–178), InTech, Rijeka, Croatia.

Rahman, S., Khan, M. T. R., Akib, S., BinCheDin, N., Biswas, S. K., & Shirazi, S. M. (2014). Sustainability of rainwater harvesting system in terms of water quality. *The Scientific World Journal*, 2014(721357), 10 pages. http://dx.doi.org/10.1155/2014/721357.

Roebuck, R., Oltean-Dumbrava, C. & Tait, S. (2011). Whole life cost performance of domestic rainwater harvesting systems in the United Kingdom. *Water and Environment Journal*, 25: 355–365

Rogers, E. M. (2010). *Diffusion of Innovations*, 4th Edition: Free Press. New York, NY.

Saeedi, I., & Goodarzi, M. (2020). Rainwater harvesting system: A sustainable method for landscape development in semiarid regions,

the case of Malayer University campus in Iran. *Environment, Development and Sustainability,* 22(2), 1579-1598.

Saeidian, A. (2013). Ab-anbar, sustainable traditional water supply system in hot arid regions, remarkable example of Iranian vernacular architecture. *Elixir Sustainable Architecture*, 56A: 13584-13590.

Selabe, M., & Minyoi, M. K. (2018). Perceived barriers to rainwater harvesting as a source of water supply in Botswana: case of Gaborone city. *Botswana Journal of Technology*, 23(1): 86 – 96.

Schuetze, T. (2013). Rainwater harvesting and management: Policy and regulations in Germany. *Water Supply*, 13: 376–385.

Shastri, H., Ghosh, S., Paul, S., Shafizadeh-Moghadam, H., Helbich, M. & Karmakar, S. (2019). Future urban rainfall projections considering the impacts of climate change and urbanization with statistical-dynamical integrated approach. *Climate Dynamics*, 52(9-10): 6033-6051.

Shanan, L. (2000). Runoff, erosion, and the sustainability of ancient irrigation systems in the central Negev desert. In: Hassan et al., (eds), *The Hydrology-Geomorphology Interface: Rainfall, Floods, Sedimentation, Land Use*. A Selection of Papers presented at the Conference on Drainage Basin Dynamics and Morphology Held in Jerusalem, Israel, May 1999, IAHS Press, 75–106.

Sheikh, V.B. (2020a). Perception of domestic rainwater harvesting by Iranian citizens. *Sustainable Cities and Society*. https://doi.org/10.1016/j.scs.2020.102278

Sheikh, V.B. (2020b). Role of governments in expansion of household rainwater harvesting systems: introduction to experiences of some countries. *Iranian Journal of Rainwater Catchment Systems*, 7(3): 49-66

Sheikh, V.B., Jafari Shalamzari, M. & Gholami, A. (2017). *Traditional and Modern Methods of Rainwater Harvesting.* 1st Edition. Gorgan University of Agricultural Sciences and Natural Resources Publications. 433p.

Sheikh, V., Pourali, R., & Asgari, H. R. (2012). Sowma: A traditional surface runoff harvesting practice in arid and semi-arid regions of NE Iran. *The 8th International Symposium*, Agro Environ 1 - 4 May 2012, Wageningen, the Netherlands.

Solanki, K. P. (2016). *The Rainwater (Harvesting and Storage) Bill*. Bill No. 45 of 2016. 7pp.

Tabatabaee Yazdi, J. and Aliabadi, A., (2017). Bandsar agriculture: indigenous runoff-harvesting &climate change resilience in Iranian dry lands. *Water Harvesting Research*, *2*(1), pp.37-42.

Taghavi – Jeloudar, M. & Han, M. (2012). The history and practice of water harvesting in arid areas in Middle East. *The 3rd International Conference on Rainwater Harvesting & Management*, May, 2012, Goseong, Korea.

Tavakol-Davani, H., Goharian, E., Hansen, C. H., Tavakol-Davani, H., Apul, D., & Burian, S. J. 2016. How does climate change affect combined sewer overflow in a system benefiting from rainwater harvesting systems? *Sustainable Cities and Society*, 27: 430-438

Teston, A., Geraldi, M. S., Colasio, B. M., & Ghisi, E. 2018. Rainwater harvesting in buildings in Brazil: A literature review. *Water*, 10(471): 1-25. doi:10.3390/w10040471

Vohland, K., & Barry, B. 2009. A review of in situ rainwater harvesting (RWH) practices modifying landscape functions in African dry lands. *Agricultural Ecosystems and Environment*, 131: 119-127.

Ward, S., Barr, S., Memon, F., & Butler, D. 2013. Rainwater harvesting in the UK: exploring water-user perceptions. *Urban Water Journal*, 10(2): 112–126. doi:10.1080/1573062x.2012.709256

Ward, S., Butler, D., & Memon, F.A. (2008). A pilot study into attitudes towards and perceptions of rainwater harvesting in the UK. *BHS 10th National Hydrology Symposium*, Exeter. UK.

White, I. W. (2009). Decentralized environmental technology adoption: the household experience with rainwater harvesting. PhD thesis, *Griffith School of Environment Science, Environment, Engineering and Technology*. 528 p.

Zhang, Y., Chen, D., Chen, L., & Ashbolt, S. (2009). Potential for rainwater use in high-rise buildings in Australian cities. *Journal of Environmental Management*, 91(1), 222–226. doi:10.1016/j.jenvman.2009.08.008