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Public Perception and Acceptability toward Domestic Rainwater Harvesting in Golestan, Limits to Up-Scaling

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ABSTRACT This study tries to make a distinction between factors affecting adopters and non-adopters of domestic rainwater harvesting (DRWH) in Golestan Province, Iran. In order to better comprehend the differences, nine dimensions were considered in this study, including (1) social background (including respondents' demographics, water sources, issues in accessing water sources, primary awareness of the DRWH systems, information communication channels, and their dwellings characteristics), (2) economic and financial scale (including construction, maintenance, investment rate of return), (3) scale (including law and regulation) (4) social scale (effect of social determiners on person's decision making), (5) compliance with every day's needs,(6) past experience, (7) image (importance of adopting DRWH systems on person's social image and position), (8) providence (person's outlook of the future), and (9) risk adoption. Results show that the surveyed groups vary remarkably in terms of considered dimensions. It seems that lack of experience and observation are the underlying reason of low adoption rate in this area.

Key words: R*ainwater harvesting, Public attitude, adoption, Diffusion of innovation*

1 INTRODUCTION

In order to keep up with climate change, population growth, and water shortage, it is needed to expand current water sources or develop new ones. Developed water sources have only limited capacity, and indeed, over exploitation of these sources could deteriorate water quantity and quality. On the other hand, although construction of costly and huge water infrastructures such as dams could result in short-term remediation of water shortage, long-term consequences of these chains of actions could no longer be justified. Hence, in line with developing these structures to satisfy rapid growth in water demand, we have to strive for finding simple, economically feasible alternative water sources to remove the pressure on large-scale hydrological cycle.

One of the solutions into the future may be small-scale rainwater harvesting. Even though collecting rainfall as one prime way to deal with water scarcity and climate change has not until recently been paid due attention to, however, a long history lies in the development of this technology. In West Asia, it could be traced even to eight thousand years, in Palestine

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to four thousand years, and in Greece to three thousand years (Msangi, 2013).

A major application for stored rainwater has been agriculture thus far; yet, other applications such as domestics are not irrelevant. Provided a proper management on water sector, this technique is of extra potential to tackle water scarcity and climate change driver water shortage (Msangi, 2013). Aladenola and Adeboye (2010) state that with a suitable water storage capacity, rainwater harvesting is able to cover a major proportion of water shortage. Abdulla and Al-Shareef (2009) carried out an assessment of the potential rainwater harvesting in Jordan and calculated it to be some of 6 million cubic meters. With proper attention, domestic rainwater harvesting (hereafter DRWH) is capable of reducing 20% water demand pressure on the main water distribution network.

Despite abundant benefits to collect rainfall, there is no great willingness to adopt and use it. The reasons for this, depending on the situation, can be derived from several aspects. One of these issues is its priority for people. One of the reasons of less promotion of DRWH systems in Zambia was the lack of priority in people's cultural and social context (Handia *et al.*, 2003), while in China twelve factors was reported to inhibit promoting rain water harvesting (He *et al.*, 2007). The level of education, labor, public relation, extension officers, participation in cooperative programs and public opinion on the technology have been described as the main factors. Oweis *et al.* (2012) also noted the pale role of extension officials, public faith in the workforce needed to implement the project, cost, system incompatibility with the needs of users as the main reasons for the reluctance of people to use rainwater harvesting methods. As mentioned above and with respect to the conducted research, depending on the situation, this lack of interest might have had a myriad of underlying factors.

These findings are mainly based on the responses provided by the non-adopters of DRWH systems. However, little is known about why adopters of these systems chose to adopt it. On the other hand, much less is known about what are the main differences between adopters and non-adopters of DRWH systems. There is also insufficient evidence on what are the differences of both groups in terms of core areas of decision making. Thus, the current study compares the different ways people approach the concept and application of domestic rain harvesting. This study benefits from a large sample size with a great deal of social and geographic variations and this makes the results of the study more comprehensive. Golestan province, currently being one of the rare places where people traditionally collect rain from their roofs for drinking purposes, proved an interesting as the case study.

2 MATERIALS AND METHODS

2.1 Study area

Golestan province with an area exceeding 20,000 $km^2$and a population of 1.7 million (Statistical Centre of Iran, 2011), is located in the north-east of Iran. It enjoys mild weather and a temperate climate in the southern part, most of the year. Geographically, it is divided into two sections: the plains and the Alborz mountains range. However, there is quite an evident trend in precipitation and vegetation cover in the south-north and west-east directions.

Some villages of the province, located mainly in the central and northern parts, are still deprived of water supply network, and they traditionally harvest rainwater from the roofs of their dwellings into cubic or cylindrical water reservoirs locally called Lari. Some villages could be looked to find traces of rooftop rainwater harvesting even though they have access to main water supply network. Even in some extreme examples, some villagers in the southern part of the province are happy with collecting pure rainwater into small barrels for domestic uses, such as making tea and cooking. Location of the villages visited during the study and the cases in which DRWH systems are still in use is provided in Figure 1 and Table 1.

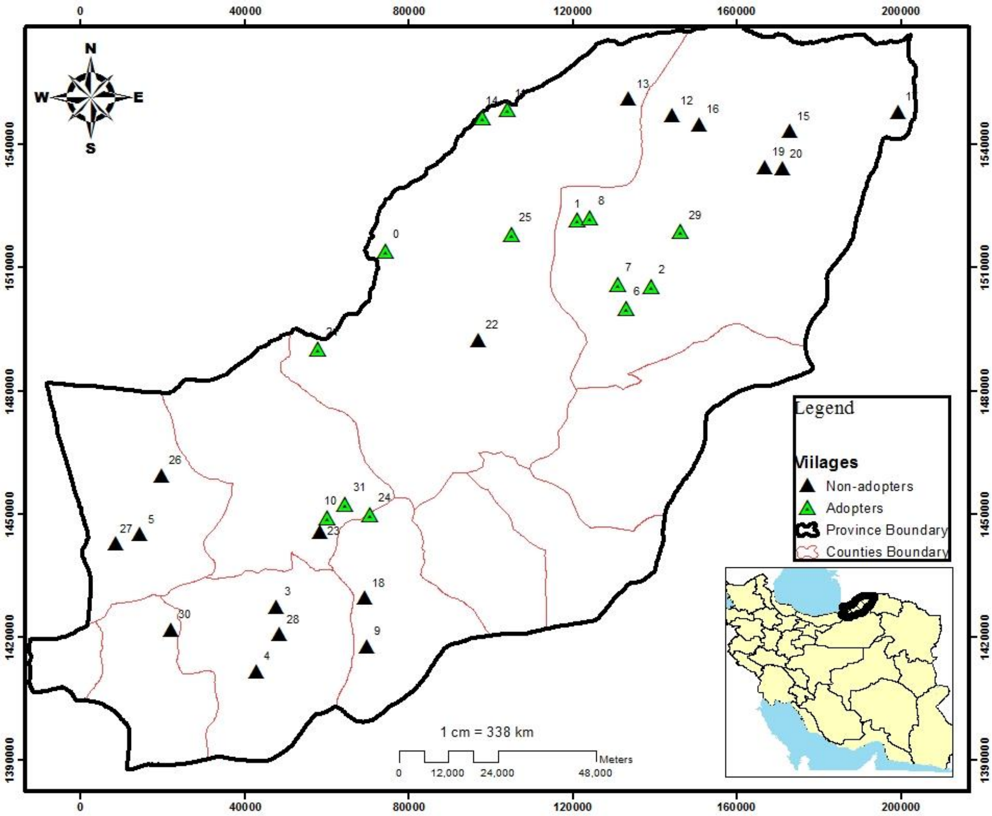

Figure 1 Location of villages surveyed in the current study based on being adopters and non-adopters of DRWH systems

Table 1 Names and numerical identifiers of the villages in Figure 1

FID	Name	FID	Name	FID	Name
0	Dashli Boroun	11	Qelaq Burteh	22	Cheper Ghoymeh
1	Ughchi Bozorg	12	Qarahgol Sharghi	23	Kord
2	Sheikh La	13	Korand	24	Bahalke Dashli
3	Jelin	14	Kollijeh	25	Aq Band
4	Ziarat	15	Ghar Qijigh	26	Kelleh Post
5	Basir Abad	16	Hemat Abad	27	Khaje Nafas
6	Tamar Ghaghoozi	17	Ghazan Ghayeh	28	Nowmal
7	Yali Bodagh	18	Mohammad Abad	29	Aq Chatal
8	Gachisoo	19	Baba Shemlek	30	Eslam Abad
9	Mahian	20	Chenaran	31	Gerey Davaji
10	Uch Tappeh	21	Tengli		

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2.2 Development of the survey

The survey is developed based on prior studies on public perception of domestic rainwater harvesting systems in other countries. The survey is divided into two main parts: (1) the respondents' social background, (2) their attitudes toward different aspects of DRWH systems adoption or rejection. There were also binary (yes/no), multi-optional and open questions in the study tool to have a comprehensive picture of what is determining a certain person's attitude towards domestic rainwater harvesting.

The data on the social background was collected to assess if the survey sample was representative of the province population, and to identify main differences among adopters and non-adopters of DRWH systems. Questionnaires were organized into ten sections as follows: (1) social background (including respondents' demographics, water sources, issues in accessing water sources, their primary awareness of the DRWH systems, information communication channels, and their dwellings characteristics), (2) economic and financial scale (including construction, maintenance, investment rate of return), (3) environmental scale (importance of environment conservation, impact of water shortage and etc.), (4) institutional scale (including law and regulation), (5) social scale (effect of social determiners on person's decision making), (5) compliance with every day's needs, (6) past experience, (7) image (importance of adopting DRWH systems on person's social image and position), (8) providence (person's anticipation of the future), and (9) risk adoption. The possible answers to the questions about were yes/no, multiple-choice, and open answers. The interviewer explained details of the questions to the respondents without giving hints or suggestions on the possible answers.

A reliability analysis for the first set of questionnaires (n=30) for specific scales yielded an average Cronbach's α coefficient of 0.722 and 0.700. This indicates that the questionnaire is of good internal consistency and likely to provide reliable and valid information.

2.3 Data collection and processing

Data collection was carried out during 6 months from Jan. 2015 to Sep. 2015. Results were tabulated in Microsoft Excel and analyzed in R software. In regards to questions about perception, five options were given (based on the Likert Scale) a score of 5 through 1 (4 being most important). The answers were aggregated for both adopters and non-adopters as Eq. 1:

$$W_j = \frac{\sum Option\ scores}{n} \quad (1)$$

Where W represents the aggregated average of Likert scores (ALS), i the question and n the number of respondents. Aggregated means were compared by applying a t-test to compare the adopters and non-adopters on that question. The results of binary questions were compared by Mann-Whitney U Test. Open questions were summarized and illustrated in frequencies and graphs.

3 RESULTS

3.1 Respondents' demography

Table 2 illustrates the general characteristics of respondents. Only one-third of the population (n=121) were adopters of DRWH system. Given that the head of the family were selected as the respondents, few women were included in the sampling procedure. The mean age was 42.7 for the adopters and 40.1 for the nonadopters population, indicating slightly higher age for the adopters. The non-adopters were more educated than the adopters of DRWH system and the occupation of the majority of both groups was farming or raising animals (Table 2).

Table 2 Social background of respondents in Golestan grouped by adoption and non-adoption status

Demographic characteristics	Adopters	Non-adopters	Demographic characteristics	Adopters	Non-adopters
Number in each category	121 (31.7%)	259 (68.3%)	Education		
			Illiterate	9(7%)	6(2%)
			Primary education	28(23%)	78(30%)
			High school	68(56%)	109(42%)
			Associate degree	5(4%)	18(7%)
			Bachelor	11(10%)	41(16%)
			Master	-	7(3%)
Gender			Occupation		
Male	99%	100%	Farming and animal husbandry	98(81%)	165(64%)
Female	1%	-	Government	11(9%)	52(20%)
			Worker	11(9%)	41(15.7%)
			Self employed	1(1%)	-
			Unemployed	-	1(0.3%)
Age			Relative family dimension (years)		
20-30	20(17%)	53(20%)	<7	12%	13%
30-40	26(21%)	74(29%)	7-12	15%	18%
40-50	34(28%)	74(29%)	12-20	24%	14%
50-60	29(24%)	41(16%)	20-50	39%	42%
60-70	12(10%)	17(6%)	>50	11%	13%

3.2 Respondents' residence characteristics

The preliminary analysis of the residence owned by either adopters or non-adopters of DRWH system showed that houses owned by the adopters in most cases had no yards and no walls or boundary existed between two adjacent houses (Table 3) and the area was somehow distinguished by the locals with invisible lines. Yet, a large distance existed between adjacent houses in case of adopters' houses, which implies that place is of minor importance for a major part of the adopters of DRWH systems. On the other hand, all the houses for the non-adopter population were divided by walls and a differentiated house and yard could be discerned. About 80% of the roofing material used in the dwellings of the adopters was composed of corrugated galvanized iron. Unlike other materials, this is believed to be most suitable material for the harvesting of rainwater. For non-adopters though, asphalt roll roofing was most common cases.

Table 3 characteristics of the residence of adopters and non-adopters of DRWH systems

Settlement characteristics	Adopters	Non-adopters
Residence area(m)		
<150	60(50%)	100(39%)
150-300	53(44%)	152(59%)
300-450	8(6%)	7(2%)
Residence roof material		
Corrugated galvanized iron	97 (80%)	36(14%)
Asbestos and color-bond steel sheeting	15(12%)	137(53%)
Asphalt roll roofing	9(8%)	86(33%)

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3.3 Access to water

Table 4 provides detailed information concerning sources of water used by the adopters and non-adopters of DRWH systems, its accessibility and relative costs. About 40% of the total water provision for adopters was met by rainwater harvesting, which in most cases was augmented by water transported regularly by the government or irregularly by private tankers (26%). Given that saline ground water was dominant in the northern Golestan province, only 7% had domestic wells at their dwellings. Likewise, no water was being collected from rivers, creeks or springs. Water network currently provides one-fourth of the total water demand of the adopters and this is due to increase in the upcoming years by the policy of providing deprived areas with tap water.

In the case of non-adopters, half of the water supply was provided with the tap water, followed by domestic wells and water transportation (commonly private tankers). All other water sources provided merely 7% of water demand.

Interviewed adopters and non-adopters households reported respectively 6.17 and 3.03 months interruption in accessing their major water source. This interruption consisted of two to three or maybe several days without water service or access to transported water as well as low water pressure. The interruption is exacerbated during summer and autumn seasons.

In response to the question "how often do you encounter interruptions in accessing your major water source", 56% of the adopters selected "much" to "very much" options in comparison with 24% for the non-adopters. Thus, adopters considered water shortage in their community to be a bigger problem while over two-thirds of the non-adopters had never experienced severe water shortage (by selecting "very little" and "little" options).

Table 4 Sources of water used by the adopters and non-adopters of DRWH systems to satisfy drinking needs

Residence water source	Adopters	Non-adopters
Water source		
Tap water	66(22%)	258(50%)
Domestic well	22(7%)	93(18%)
Transporting water (by government or privately)	79(26%)	88(17%)
Rainwater harvesting	121(40%)	-
Bottled water	16(5%)	38(7%)
Springs and rivers	-	38(7%)
Annual absence of proper access to water sources (average months)	6.17	3.03
Difficulty in water provision		
Very little	2(2%)	94(36%)
Little	17(14%)	65(25%)
Somewhat	34(28%)	37(14%)
Much	36(30%)	54(21%)
Very much	31(26%)	9(3%)
Water provision cost (Rials × 1000)		
Minimum	45,000	12,000
Maximum	200,000	275,000
Average	63,320	15,510

[DOR: 20.1001.1.23222700.2016.4.3.1.6]

In extreme conditions, both the adopter and non-adopter households had to purchase water from water tankers. This costs adopters and non-adopters 630,000 and 150,000 Rials annually on average. This water transportation for the adopters would be used for drinking while the non-adopters purchase water primarily for their livestock. The water purchase happened more frequently in drier parts, i.e. northern parts of the province and a general trend existed in the southern-northern direction in Golestan in a sense that by traveling to the north of the province, more people encountered having paid for extra water tankers.

In terms of water quality, 41.4% of the adopters were satisfied compared with 58.6% unsatisfied. This changed to 77.2% satisfied and 22.7% unsatisfied in the non-adopter population. Thus, level of satisfaction with water quality was significantly different between the adopters and non-adopters of DRWH systems (Table 5).

Table 5 Satisfaction with water source quality among groups

Question	Average Ranking		Z	U	Sig
	Adopters	Non-adopters			
Level of satisfaction with current water source quality and quantity	143.96	211.33	-6.786	10015	0.00

3.4 Communication channels

The data collection instruments required the respondents (household heads) to choose the sources of information they used in relation to DRWH systems from a list of seven items. Direct observation, parents and friends-colleagues were the sole sources of information among the adopters (Figure 2). Non-adopters also reported using direct observation, parents, and friends-colleagues as the main sources of information, but they also noted newspapers, media, and NGOs as the supplementary sources; there was no report on the importance of extension programs as the source of information in either case. Results suggest that the non-adopters, being more educated than the adopters on average, use a more diverse communication channels to gain information about DRWH systems (Figure 2). However, only 56% (147) of the non-adopters were aware of the existence of such water provision systems, while 44% (112) respondents reported having no information about such systems.

3.5 Effects of economic and financial determiners

Table 6 shows an overview of the difference between the adopters and non-adopters of DRWH systems in terms of economic factors. Averages provided in the table are aggregated scores calculated from the Likert-scale options chosen by the respondents. The options covered a range of “unimportant” to “very important”. Data suggest a general differentiation between the two groups. The mean comparison showed that non-adopters rated cost and economy issues as a stronger influence on their decision making than the adopters did. In the case of the rate of return option, there was no difference between the two groups, indicating that only current investment and return was at stake when adopting or rejecting DRWH systems.

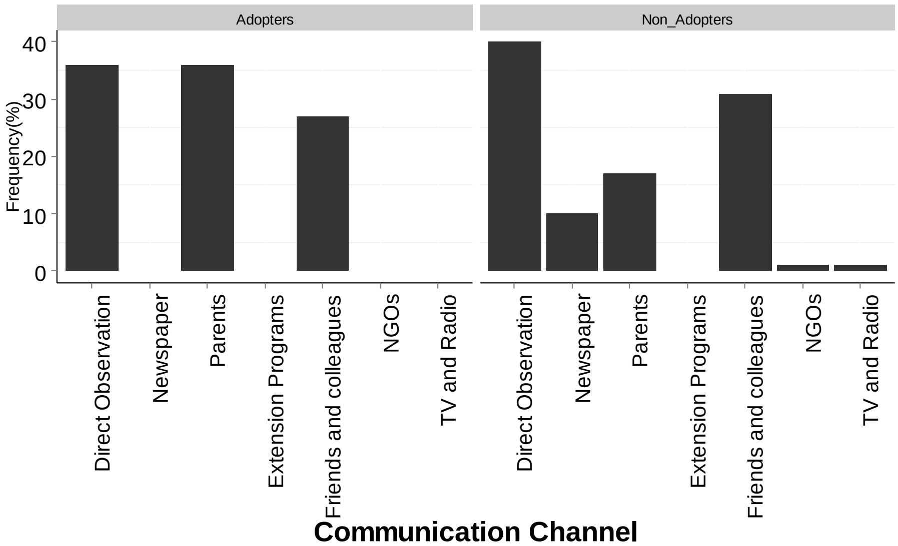

Figure 2 Communication channels used by adopters and non-adopters of DRW systems in Golestan Province

Table 6 Power of economic variables in explaining different behaviors of adopters and non-adopters

Question	Average Option		t-test	P-Value
	Adopters	Non-adopters		
Construction Costs	2.76	3.27	-4.58	0.000
Maintenance Costs	2.79	3.08	-2.69	0.007
Savings	2.83	3.10	-2.69	0.007
Access to credit and loan	2.77	3.22	-3.50	0.000
Rate of return	2.66	2.89	-1.69	0.091

3.6 Effects of environmental determiners

Table 7 summarizes descriptive data for all items in the environmental scale. Both adopters and non-adopters are concerned with the importance of conserving the environment. However, in response to the question asking “if you knew that constructing large water provision infrastructures (such as dams) could lead to environmental degradation, to what extent would it have an influence on your decision to adopt DRWH systems?”, both groups chose “little importance” to ‘of moderate importance”. There was no significant difference between the two groups for this question.

Table 7 Power of environmental variables in explaining different behaviors of adopters and non-adopters

Question	Average Option		t-test	**P-Value**
	Adopters	Non-adopters		
Importance of conserving the environment	4.23	4.22	0.08	0.93
Importance of current droughts	2.18	2.51	-2.77	0.00
Importance of probable future droughts	3.02	2.71	2.38	0.01
High quality of rainwater for different purposes	2.70	2.79	-0.65	0.51
The consequences of building large water dams	2.92	3.02	-0.94	0.34

Both groups were concerned about the potential consequences of climate change on their water provision. They all proposed different signs of climate change in their dwelling area, as illustrated in Figure 3. Droughts and reduced rainfall were themost frequent response. They also noted that seasons shifting in the province and the warmer winter. In some cases, a small number of respondents linked other signs like the emergence of pests (such as Moroccan grasshopper) to climate change. Both groups were asked whether the current and anticipated droughts could have had any influence on their adoption of DRWH systems. Data suggest that anticipated draughts are of higher importance than the current ones for both groups. This is supported by the less importance given to the current droughts.

When asked "whether stored rainwater had a better quality for washing purposes which would lead to less use of detergents", both groups responded that this had little impact on their accepting or rejecting DRWH systems.

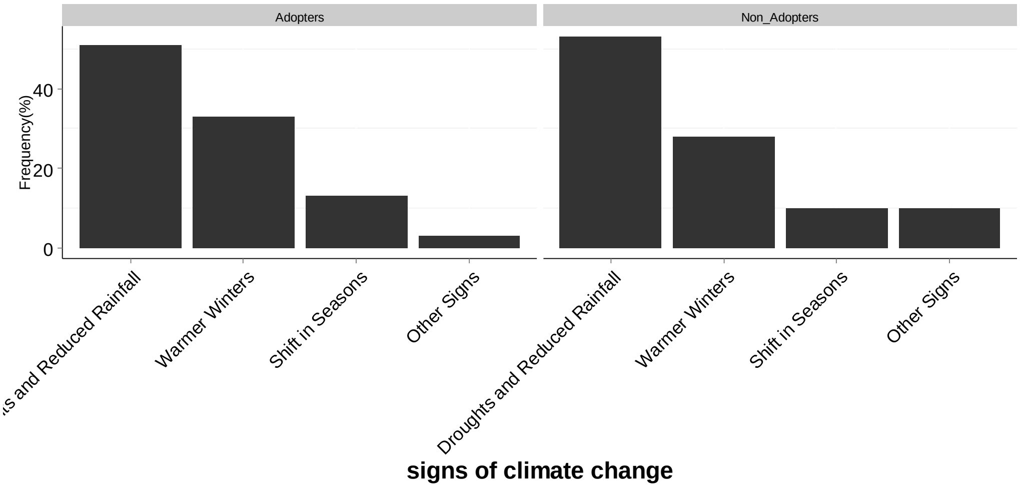

Figure 3 Signs of climate change proposed by the adopters and non-adopters of DRWH systems

3.7 Effects of institutional determiners

When asked "whether the respondents opt for governmental support for adopting DRWH systems and whether this support would favor the extension of such systems among the communities of Golestan province", approximately 61% (n=74) of the adopters reported the importance of the government, while 38% (n=47) had objections to the importance of such leadership. However, among the non-adopters the negative was 55% (n=144) and 45% (n=115) was positive. Results offer that there is a significant difference between the adopters and non-adopters in terms of government support (Table 8).

Table 8 Responses to the question "whether government could play a role in extending DRWH systems"

Question	Average Ranking		Z	U	Sig
	Adopters	Non-adopters			
In your opinion, does government support play a role in extending DRWH systems?	212.36	179.64	-3.123	12857	0.00

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This "importance" was rated from "unimportant" to "very important" on a Likert-scale, which indicated that adopters believed more firmly in the role of government in extending the utilization of DRWH systems (Table 9). There was a general tendency in both groups to have a deep-rooted prejudice against extension officers due to a general conflict background among administration organizations and the natural resources beneficiaries in the area. This could adversely affect the adoption of conservational technologies introduced by the government organizations. Adopters also fairly believed (average Likert scale (ALS) 3.06) that specialized governmental bureaus could facilitate the extension of such technologies, while non-adopters didn't not believe in the importance of this water harvesting technology to have a distinct management authority (ALS 2057) and, hence, DRWH experts could do no favor extending the utilization of such systems. Although having the same ALS, adopters holds the view that they can tackle any upcoming issues in the process of designing, installing, utilizing, and even maintaining DRWH systems.

Table 9 Power of institutional variables in explaining different behaviors of adopters and non-adopters

Question	Average Option		t-test	P-Value
	Adopters	Non-adopters		
Government support significance	3.58	3.06	4.11	0.00
Trusting extension officers	2.31	2.56	-2.26	0.02
Existence of specialized government organization	3.06	2.57	4.00	0.00
Access to DRWH experts	2.84	2.67	1.28	0.19
Mandating DRWH installation	3.38	3.42	-0.33	0.73

3.8 Effect of social determiners

Table 10 summarizes descriptive data for all of the items proposed in the social scale. The adopters of DRWH systems tend to have dialogues on their decision on adopting these systems and using them, while significantly different from non-adopters who do not normally want to communicate about their decision in adopting it. Among different social groups, no especial factor had the dominant influence on the decision-makingprocess of both groups. Turning now back to the results of communication channels, media did not have a significant influence on the decision-making, too. Daily contact with the other adopters of DRWH systems was obviously higher among the adopters and this could further facilitate the adoption of these systems by the current users. Being more frequently in touch with the other adopters implicitly means observing more DRWH systems in a daily manner. Adopters also pointed out that observation could meaningfully influence their decision making, which was significantly stronger than the answer chosen by the non-adopter individuals. The results suggest that observation is a major determiner of adopting the technology.

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Table 10 Power of social variables in explaining different behaviors of adopters and non-adopters

Question	Average Option		t-test	P-Value
	Adopters	Non-adopters		
Willingness to have dialogue about DRWH systems	3.26	2.68	5.11	0.00
Dominance of family on decision-making	3.36	3.01	3.04	0.00
Dominance of neighbors on decision-making	3.35	3.13	2.01	0.04
Dominance of friends on decision-making	3.36	3.05	3.00	0.00
Dominance of colleagues on decision making	2.94	2.89	0.43	0.66
Dominance of media on decision making	2.32	2.48	-1.28	0.19
Level of daily contact with DRWH users	3.69	2.36	10.68	0.00
Effect of observation on adoption	3.76	3.49	2.29	0.02

3.9 Compliance with everyday needs

Table 11 provides an overview of the answers by the respondents on whether they encounter any restrictions in fitting their current water sources with their purposes, and whether DRWH systems could ease these issues. Among the adopters, 41.4% (n=50) are satisfied with their current water source quality, while 58.6% (71) opposed it. On the contrary, 77.2% (n=200) were satisfied, versus 22.7% (n=59) unsatisfied. Surprisingly enough, 70.24% (n=85) of the adopters believe that DRWH systems not only brings no limitation but also alleviate water quality issues, which was significantly different from the non-adopters (81.8% or n=212) who were reactionary or conservative to the potential utilization of DRWH systems in enhancing water quality issues.

Table 11 Satisfaction with current water use and potential of DRWH systems in addressing these issues

Question	Average ranking		Z	U	Sig
	Adopters	Non-adopters			
satisfaction with current water source quality and quantity	143.96	211.33	-6.78	10015	0.00
Potential improvement in water quality issues by using DRWH systems	134.73	215.61	-7.34	8907	0.00

Adopters and non-adopters were further asked to rate the potential of DRWH systems in addressing water shortage, now or in the future (Table 12). Adopters hold the view that these systems are able to tackle water shortage to a certain extent. Yet opposed to the non-adopters, adopters believe that the current climatic condition does not allow collecting sufficient water and this stored water, therefore, is not sufficiently reliable. Contrary to the adopters believing that this stored water is hygienic and piping it to the house does not interfere with other water sources quality, non-adopters tend to believe that stored rainwater is not clean enough for drinking and cooking and they rather use it for non-drinking applications like bathing, washing and watering (Figure 4).

Compared with non-adopters, the majority of adopters believe that system complexity and installation does not have any influence on adoption of DRWH systems. Likewise, they particularly had no issues with space for constructing water storage facilities. Interestingly, both groups see construction costs to be an important issue. Adopters also see stored rainwater as a means of gaining independence from other water sources. Stored rainwater is thought by the adopter to be as a simpler water provision method than other water sources. Yet, in response to the question that “to what extent do you believe that construction time could influence a person’s

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willingness to install a DRWH system", both groups agreed that it had no influence on the decision making.

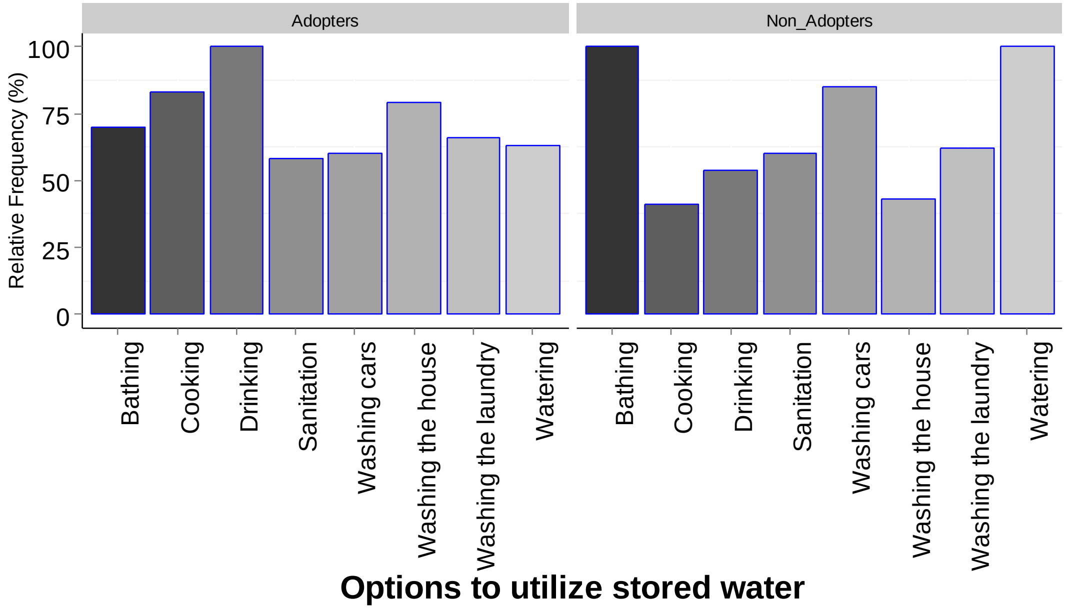

Figure 4 Preferences of adopters and non-adopters of DRWH systems in selecting possible utilizations for stored rainwater

Table 12 Power of compliance with daily needs variables in explaining different behaviors of adopters and non-adopters

Question	Average Option		t-test	P-Value
	Adopters	Non-adopters		
Potential of DRWH to address water shortage	3.59	3.03	4.22	0.00
Potential of DRWH to collect sufficient water given the current climatic condition	2.85	3.37	-4.52	0.00
Reliability of stored water for shortage period	3.17	3.51	-3.18	0.00
Suitability of DRWH for the region	3.85	2.98	6.70	0.00
To what extent DRWH stored water is hygienic	4.04	2.94	8.64	0.00
Potential of combining current and DRWH piping	2.40	2.42	-0.21	0.82
Existence of sufficient installation knowledge	3.82	2.69	9.03	0.00
Access to enough budget for installation	3.03	2.80	1.94	0.05
Availability of space for installation	3.84	3.12	5.69	0.00
Impact of system complexity on decision making	2.14	2.71	-4.85	0.00
Independence from other water sources by using DRWH	3.16	2.80	2.88	0.00
Facilitation made by using DRWH compared with other water sources	3.25	2.71	4.58	0.00
Impact of installation and construction duration time on decision making	2.19	2.39	-1.88	0.05

3.10 Effect of past experience on the adoption of DRWH systems

Table 13 summarizes descriptive data for all of the items proposed in the experience scale. Adopters hold the standpoint that past experiences and utilization of DRWH systems result in the higher adoption rates. On the contrary, mean comparisons show that non-adopters rated past experience as a slight influence on their decision making. No extension program has been offered to both groups so far, so they all rated this question as ‘very little importance’.

Table 13 Effect of past experiences on the adoption or rejection of DRWH systems

Question	Average Option		t-test	P-Value
	Adopters	Non-adopters		
Level of past direct contacts and experiences with DRWH systems	4.09	2.14	16.57	0.00
Interviewee’s past utilization of DRWH systems	3.94	2.13	16.70	0.00
Frequency of attending extension programs	No extension programs have been provided to adopters and non-adopters of DRWH systems so far			

3.11 Effect of social reflect (image) on the adoption of DRWH systems

Table 14 lists descriptive data for all of the items proposed in the social reflect (image) scale. The mean comparison show that there are differences between the two groups, but the difference is not tipping the scale to the nonadopters side. The resultsuggests that not only both groups do not consider to be the role models in accepting DRWH systems, but also they are not provoked by a sense of pride by the adoption of these systems. Both groups also show that these systems are not, in any way, the symbol of the local population cultural heritage.

Table 14 Effects of social reflectance on the adoption and rejection of DRWH systems

Question	Average Option		t-test	P-Value
	Adopters	Non-adopters		
Importance of being a role-model to the interviewee	2.31	2.59	-2.01	0.04
Provoking a sense of pride by adopting DRWH systems	2.18	2.58	-2.97	0.00
Thinking of DRWH systems as the symbol of region’s culture	2.18	2.18	-0.05	0.95
Adverse impact of DRWH systems on regional Aesthetic value	2.49	2.29	1.68	0.09

3.12 Effect of risk adoption and providence on the adoption of DRWH systems

Table 15 summarizes the aggregated scores of all of the items listed under the risk adoption and providence scales. These scales were respectively comprised of seven and twelve further questions. The results suggest that both groups are highly risk-aware and providence. As the mean comparisons show, both groups are similar in these two scales. On the other hand, the aggregated mean of the Likert Scale options under each question suggests that both groups are highly risk-aware and providence, and hence these scales failed to clearly identify adopters from the non-adopters of DRWH systems.

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Table 15 Results of the effects of risk adoption and providence on the adoption or rejection of DRWH systems

Question	Average Option		t-test	P-Value
	Adopters	Non-adopters		
Risk Adoption	4.03	4.00	0.81	0.41
Providence	3.59	3.56	1.00	0.31

4 DISCUSSION

This study set out to primarily differentiate the factors that influence adopters and non-adopters of DRWH systems in the direction that has caused their specific adopted decisions. It clearly shows that adopters and non-adopters vary in terms of specific scales. Contrary to the commonly-held view that economic and financial scale has the upper hand in the adoption of specific decisions in this context, this study obviously shows that a complex, yet comprehensible, set of factors influence decision-making process. Below, the main distinctive factors between the two groups are provided:

4.1 Demographic determiners

This study found that the adoption of DRWH systems was slightly more dominant among adolescents. It seems that the adoption of this technique is gradually becoming blurred among the younger population. A recent study by He et al. (2007) also shows that age negatively impacts theadoption of rainwater harvesting. Another important finding is that literacy negatively affects adoption of DRWH systems. Adoption and utilization of rainwater harvesting are currently dominant among the poor and the population deprived of facilities. Educated population, somehow, looks down at the utilization of domestic rainwater systems in Golestan, which is in contrasts with other works that show the education level positively influence the adoption of innovations (He et al., 2007; Mariano et al., 2012; Baiyegunhi, 2015).

4.2 Dwellings characteristics

Lack of space and suitable roof material may contribute to the rejection of DRWH systems among the non-adopter population. A major proportion of roof material used in the dwellings of non-adopters is mostly asbestos, color-bond steel sheeting, and asphalt roll roofing, which are not suitable for collecting rainwater. Metal roofs are commonly recommended for rainwater harvesting applications. Rainwater harvested from galvanized iron roofs tends to have lower concentrations of fecal indicator bacteria as compared to other roofing materials. However, concrete tile and cool roofs produced harvested rainwater quality similar to that from the metal roofs, indicating that these roofing materials also are suitable for rainwater harvesting applications (Mendez *et al.*, 2011).

Providing water in the form of distribution network has resulted in a diminishing number of DRWH systems applicators. However, users still having interruptions in accessing this source of water tend to use this water collecting technique as their preferred water provision method. This interruption mainly occurs within the northern parts of the province where water provision still has so many vicissitudes and the provided water quality is not so satisfactory. We also found that low water price could restrain adoption of DRWH systems or its utilization continuance. Notwithstanding, low water quality in some areas offset low water price influence and they are more likely to adopt or continue their use of DRWH systems. Mendez et al. (2011) also found that water price is a major determiner of water conservation adoption.

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4.3 Communication channels, social factor, past experience

As pointed out in the result section, direct observation, parents, friends, and colleagues were the most frequently used sources of information by adopters. Although more diverse, non-adopters use the same pattern in gaining information on the existence and use of DRWH systems. A major implication of this finding is that without sufficient direct observation (past experience), non-adopters normally have little awareness of the nature of domestic rainwater harvesting. As there was no report on the importance of extension programs as the source of information in either case, it seemed that the first stage in up-scaling DRWH systems was the promotion of direct observation through media and extension programs. These two not only promote direct observation of technology, but also enhance public attitude towards potential benefits of DRWH systems. Jara-Rojas et al. (2012)argue that providing extension and education programs will lead to better access to credit and improving the incentive gears to enhancing water management practices.

4.4 Economic factors

We found that cost of construction and other financial factors were rated significantly lower by the adopters, except for the rate of return of the initial investment. To the majority of respondents, the cost of installation of a DRWH system was less important than the adverse consequences of water scarcity in the areas. It was also observed that within some villages even if they had access to tap water, locals were saving up for future installation of rainwater storage tanks. On the contrary, the largest proportion of non-adopters firmly believed that adoption of this technique would cost them arms and legs. They totally object the idea that rainwater harvesting is a potential cost reduction method. Practicing measures to reduce perceived cost among non-adopters could result in increasing diffusion of innovation (Morris *et al.*, 2010).

4.5 Environmental factors

In the case of environmental conservation scale, we found that both adopters and non-adopters held a symbolic view. All respondents rated the importance of conserving the environment “high” to “very high”. However, they rated the question “if you knew that water provision needs construction of large infrastructures like dams that would lead to the destruction of the environment, how much would it affect your decision in adopting DRWH systems?” low to somewhat important. Similarly, the importance of high-quality rainwater in reducing the amount of detergent application also was rated low to somewhat important. This is in contrast to the findings of White (2009) that growing environmental awareness of the community facilitates the adoption of pro-environmental technologies and behaviors as households seek to reduce their ecological footprint.

4.6 Institutional factors

The regulatory environment and governmental institutions more generally can have a powerful effect on technology adoption, often via the ability of a government to “sponsor” a technology (Hall and Khan 2003). In line with this argument, the adopters of DRWH systems believed that government could sponsor the cost, provide advice (hygienic) and facilities. On the other hand, non-adopters didn’t believe that government should, in any way, pay attention to these trivial issues. Another limiting factor in the diffusion of DRWH systems is mistrust to the extension officers. He *et al.* (2007) believes that proper contact with extension officers can result in better information communication, and thus, improve adoption of innovation.

4.7 Compliance with everyday needs

As pointed out in the result section, both groups differ in their perspective of water source's quality and quantity as well as rainwater potential in improving it. It seems that water quantity and quality is one of the main drivers of DRWH adoption. Unlike the non-adopters, the adopters believe that DRWH systems are easy to operate and maintain. Moreover, they commented that rainwater storage enhanced their independence from other water sources while non-adopters believed that adopting this technique could result in a more complex lifestyle. This perceived complexity has adversely affected their attitude towards DRWH. Rogers and Shoemaker (1983) state that complexity and compatibility of the technology determines the adoption and diffusion of technologies. One other primary distinction is that, to the non-adopters, stored rainwater is of lower quality. This perceived threat from using stored rainwater is another important restrictive factor of using such systems.

However, reduced rainfall and droughts in the region have led to the abundance of these systems among the users. But it seems that villagers are more concerned with the short-term consequences of climate change. As Lorenzoni and Pidgeon (2006) put forward, how 'danger' is interpreted will ultimately affect which actions are taken. Results illustrated that both groups are slightly more concerned with the anticipated droughts than the current droughts. This could play a mediating role in expanding the adoption of this technique.

4.8 Social image

Both groups don't believe in the cultural importance of this technique. It is solely viewed as a way to cope with the extreme environment not as to improve the social image. Conversely to the view of White (2009) that adopting rainwater harvesting result in more prestige and honor, both groups in this study do not believe that adopting DRWH systems bring them any sign of pride and prestige. Working on this area could potentially result in the diffusion of rainwater use in Golestan.

The main goal of this study was to assess the factors differentiating the adopters from the non-adopters of DRWH systems in Golestan Province. It seems that scaling scheme used in this study has succeeded in distinguishing these two groups. In order to scale-up DRWH systems, due attention must be paid to identified factors. It seems that investing on extension programs and mass media is the first step in extending rainwater application in this region. The findings of this study have a number of important implications for future practices and extension programs. One step further, the importance of these factors on the decision making should be identified.

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نگرش و پذیرش مردم نسبت به استحصال آب باران در استان گلستان و موانع پیش روی توسعه و ترویج آن

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چکیده: تحقیق حاضر با هدف تعیین عوامل موثر بر پذیرش استحصال خانگی آب باران در استان گلستان در میان پذیرندگان و غیرپذیرندگان این فناوری می‌باشد. به‌منظور درک بهتر جوانب مختلف دخیل بر این امر، نه بعد اصلی در این تحقیق در نظر گرفته شده است که عبارتند از: ۱) پیشینه اجتماعی (شامل ویژگی های جمعیتی، منابع آبی، مشکلات دسترسی به منابع آبی، آگاهی اولیه افراد در خصوص سیستم، کانال‌های انتقال اطلاعات و خصوصیات منازل مسکونی مخاطبی)، ۲) بعد مالی و اقتصادی (شامل هزینه ساخت و نگه‌داری، سود سرمایه)، ۳) بعد زیست محیطی (شامل اهمیت حفاظت محیط زیست، اثر کمبود آب و غیره)، ۴) بعد سازمانی (شامل قوانین و مقررات و سازمان‌های ذیربط)، ۵) تطابق با نیازهای روزمره، ۶) تجارب پیشین در خصوص کار با سیستم، ۷) بازتاب (اهمیت پذیرش این سیستم‌ها بر بازتاب و موقعیت اجتماعی فرد)، ۸) آینده‌نگری (دورنمای فرد در خصوص آینده)، ۹) ریسک‌پذیری. نتایج نشان میدهد که مخاطبان این تحقیق (اعم از کاربران و غیر کاربران)، در ابعاد پیشنهادی، تفاوت معنی‌داری دارند. به نظر می‌رسد که کمبود تجربه و عدم مشاهده، دلایل اصلی نرخ کم‌پذیرش این فناوری در استان گلستان باشند.

کلمات کلیدی: استحصال آب باران، نگرش عمومی، پذیرش، ترویج نوآوری‌ها