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Investigating the Participation Rate of Local Communities to the Extraction of Rainwater from the Roof Surfaces (District of Mashhad City)

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ABSTRACT

Due to the climatic conditions and the occurrence of long-term droughts, water supply and optimal use of it, especially in rural areas, have a particular priority. The main objective of this study is to investigate the participation of villagers in extracting rainwater from the roof to provide a part of the used water. The research hopes that by promoting the culture of optimun use of atmospheric precipitation, in addition to providing a part of the needs of the villagers, especially villagers who are watered by a tanker, they will reduce the pressure on the groundwater resources that are exposed to atmospheric hazards. The present research is applied research, in terms of nature, descriptive and analytical. Information gathering has been carried out with two methods, field and library. The statistical population consists of 57 villages over 20 households from Razavieh district of Mashhad (N=724) using the Cochran formula in a systematic random sampling method 251 households were selected as the sample. Data collection tool was a questionnaire with a total of 28 questions. For data analysis, one-sample t-tests, the Kolmogorov-Smirnov and Wilcoxon test were used. The results show that the local communities not only has a high incentive to participate in this project, but also realize the importance of using it as an easy method to deal with the dehydration crisis and reduce dependence on centralized water supply systems to remote locations such as water pipelines, dams, wells, aqueducts, water tankers and stationary surface renewals and demand for financial and technical support from public and private institutions to resolve particular problems, especially in the context of a worn-out habitat. Among the solutions emphasized in this paper is the creation of the spirit of participation in the villagers and the dissemination of optimal exploitation culture from atmospheric precipitation through public education and has the greatest benefit to the poor and low-income people in the country side.

Keywords Rainwater harvesting, Roof watershed, Rural planning, Razavieh section, Mashhad city.

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INTRODUCTION

Climate change, shortage of atmospheric precipitation, increasing global population and consequently, increasing environmental pollution, against relatively stable and irreplaceable resources of renewable water, have caused concern to government officials and experts in water affairs and in the political, social and economic arenas is the subject of discussion and special attention of the day. The sensitivity of this issue is to a degree that some scholars have stated that it is likely that the future of white gold (water) will be as important as black gold (oil) (Ahmadian 2009). In the near future, national, regional and international conflicts and tensions will increase over the water issue and it is not overlooked that future wars will be on water resources (Bazi 2010). The drought in recent years has faced a lot of countries in the waterless crisis. There is no article that has written about the development of Iran and at the beginning, it did not talk about the dry and semi-arid weather (Al Yasin 2005). The strategic situation, lack of resources, unbalanced distribution, sharing and lack of water resources replacement, as well as the lack of international governing rules on common waters, exacerbate the crisis and turn it into a source of violence (Faghani 1997). The average annual rainfall in the world is between 850 and 900 mm, while in our country, it does not exceed 250 to 350 mm. Therefore, we have to plan and coordinate the development programs of our beloved country on the basis of it. The lack of water has caused economic and social activities of the villagers with a problem and eliminated some of the sources of their income. They also have to leave their villages and their homes and migrate to large cities for work and other activities in order to earn a living. Many nomadic communities who have been involved in livestock breeding, due to repeated droughts, lack of drinking water for both livestock and for themselves, the shortage of fodder and hardness of this kind of life, have to leave pastures and migrate to cities and villages that have the plan for nomadic settlement and integration (Kiani Sefat and Moghadamnia 2013). The lack of pattern for water consumption associated with the prevalent use of underground utilization or the use of pumps Diesel and electro-pumps, which have caused a sharp drop in groundwater table levels, resulting in the drying of springs and gutters and has faced water supply with serious and acute problems. This issue, coupled with the lack of easy water resources and water extraction in many rural areas, as the lack or shortage of surface and underground water resources has led to using traditional methods, water is again being redefined through available resources such as collect rainwater. Today, various scientific and governmental associations and various private sectors have been formed in this field and have been active. The purpose of such this scientific groups is to promote the culture of optimal use of atmospheric precipitation and encourage people to use rainwater swimming pool systems so that the most emphasis is on collecting rainwater from the basin of the roofs in rural areas to provide water for home use (Ghodousi 1997). Given that water shortages in our country, especially in arid and semi-arid regions, are a serious and persistent crisis, it is imperative that the inhabitants of these areas have information about saving and consuming even one drop of water (Nabi Pey Lashkarian et al. 2006). Various methods are available for water supply and storage, among which rainwater harvesting systems are accepted in many parts of the world as a practical way to minimize drought risk (Shadmehri et al. 2017). Since rainfall, albeit in a small amount, occurs almost everywhere, before it is flooded or in the course of its flow, it becomes contaminated, it can be collected and used with water extraction methods. Unlike centralized systems such as dams that require high investment and advanced technology, rainwater harvesting systems can be used everywhere (Tabatabai et al. 2010). Extraction of rainwater from the roof is a simple and low-cost technology that can complement other water resources, especially in areas where less water is available, or they have few underground reserves or that it is surface resources are muddy in the rainy season. We know that rainfall cannot be managed on its own, especially in arid and semi-arid regions. The prevailing conditions in the regions climate make it extremely important to use limited quantities. People in such areas try to store water in barrels, tanks, pits and others (Rashidi et al. 2013). Rainwater harvesting from the roofs has the advantage that water is collected before it reaches ground and pollution. By collecting water from the bottom of the clouds, from the roof of the house, clean water can be delivered

without the need for pumping and spending the cost of transferring water from remote areas at home (Ghasemi 2010). The existing records of rainwater harvesting show that this method has been carried out since 4500 BC in some parts of the world and currently is running in many developing countries facing a water shortage crisis in rural and urban areas and in recent years have become crucial determinants for supplying a part of the water needed. Shadmehri et al. (2017) explored the potential of rainwater harvesting from the surface of buildings and in collecting water from the surface of the roofs of District 9 of Mashhad Municipality concluded that in the rainy months, the application of this system in residential homes, in the years with medium, lowest and highest rainfall can provide respectively up to 31, 26, 66% of the monthly water demand. Zolfaghari (2016) in an article entitled–A look at the methods of collecting rainwater for domestic use, emphasizes on the importance and necessity of paying attention to the use of rainwater as an auxiliary resources of domestic water consumption in urban and rural environments and a practical method of collecting rainwater from suitable pond surfaces, especially roofs. The challenges faced by authorities in providing safe and sustainable water and forecast future fresh water crisis situations, means that all possible options for supplying fresh water, including ecological and harmless environmental methods, such as rainwater harvesting should not be avoided in any way. Saadoddin et al. (2014) presents an article on the feasibility study methods of implementing rainwater harvesting system in Gorgan University of Agricultural Sciences. The collected water was from various roofs and also for analyzing the economic justification the benefit-cost ratio analysis has been used. Provided suggestions: Trap sediment and clean it regularly, clean the internal walls of the reservoir before the onset of the rainfall season, train and promote the use of this system for household use. Zehtabiyan et al. (2013), in an article reviewing the method of collecting rainwater from intake level systems, studying the method of reservoir precipitation by tin roofs and the efficiency and cost-effectiveness of this method compared with other methods and achieved these results : Rainwater harvesting by tin roofs is less costly than other methods and rainwater quality is far better than other systems. Majid Zaboli (2012), studying about collecting rainwater from the roof is a good way to provide water in arid areas, with emphasizing that collecting rainwater from the roof as an important source of freshwater that can solve many of the dehydration problems in Iran. The results of this method are considered in reducing costs and savings. Kordovani and Kordpour (2012), in an exploratory study on the optimal use of water resources (rainwater storage from the roof) tried to provide the required annual water demand for Javanrood Meteorological Station. In a pilot experiment, rain water was collected from a basin in a 6000 l reservoir and the proposals are as follows : By implementing the plan, in addition to providing water to the villagers, we will no longer see the phenomena of water rationing and migration and the destruction of industries and production units. Shahini (2011), with the article of Rainwater harvesting from the basma waters of the basin watershed, has emphasised to the scientific management of this method, which in addition to providing a valuable water source, can help to development of arid and deprived regions. The Public Infrastructure Company (2016), in a study with new rainwater management method, entitled—The Green and Sharing Resource Infrastructure, St Paul's City recently embedded a sophisticated and innovative rainwater system to manage rainwater in the city. This new system uses rainwater as a source to irrigate the plants and trees of the city and prevent from direct water entry with all its pollution to ponds around the Mississippi river and city. Rostad (2016) studied the performance of the rainwater harvesting system from the roof in four USA metropolises and these results have been achieved that a normal water collection system with a roof area of about 100 square meters and connected to a reservoir of 5 cubic meters can reduce up to more than 65% need for drinking water and thus prevent runoff and damage resulting from it. In an exploratory study, with collecting and using rainwater from the roof, during introducing the method of collecting and storing rain water, and providing a model for the use of collected rainwater from the roof for use in irrigation of grasslands, concluded this results: There is 17.4% savings potential compared to when urban water resources has been used directly. Zilinakowa (2014), in a study of rainwater management and adaptation to the sustainable design of the building, set to continued growth of the population

Fig. 1. Geographical location of the district and the villages studied, prepared and drawn : Authors 2016.

and the consequent growth in the need for drinking water, which is a global problem and concluded that the effective use of rainwater for toilet use, washing, gardening and thus saving about 50% of drinking water. In general, urban evacuation provides a classy set of modern environmental challenges, including: The need for technical and affordable improvements in existing systems, the need to assess the impact of these systems and need to search for sustainable solutions. Rashidi et al. (2013) investigated the performance and analysis of the pond catchment system in storing rainwater and providing the daily needs of non-drinking water for residents in residential buildings and in different climatic minorities of Iran's weather and concluded that if the volume of the reservoir is calculated based on the conditions of the region and the weather, the rainwater storage in the reservoirs will be maximized and we will have water for more number of days to provide the non-drinking needs of the residents through rainwater harvesting. The threat of a dehydration crisis can also provide an opportunity for plan for the correct and optimal utilization of the minimum available water. The runoff water from storms within a watershed area is a potential water source that can be used as a supplement to meet the needs of water if properly managed, so the importance of research on the use of alternative water sources as well as water saving methods is very necessary. The purpose of this research is to investigate the contribution of local communities to the extraction of rainwater from the roof surfaces. The researcher hopes that through the necessary training and dissemination of culture, the optimal use of atmospheric precipitation, in addition to providing part of the needs of villagers (especially villagers who are watered by tanker), reduce the pressure on the groundwater resources exposed to atmospheric hazards and the possibility of establishing their life by preserving the pattern of agriculture and animal husbandry should be maintained and enforced.

MATERIALS AND METHODS

Range and scope of research

The research was carried out in the north-eastern part of the country in Khorasan Razavi province, Mashhad city, in the district of Razavieh (Fig. 1). According to the Iranian Statistics Center in 2011, the population of the Razavieh section has reached 5,016 people with 13566 families. Razavieh is one of the four parts of Mashhad city. It has three districts of Mayamey, Abravan and Paeen Velayat with a total area of 3876.5 square kilometers and is located between 59 degrees

Table 1. Sample village information (over 20 households) in the studied area. Source : Statistics Center of Iran, with calculations by the author, 2016.

Demographic categories	Number of villages	Number of households	Population (people)	Number of sample villages	Number of sample village households	Spacing distribution of the questionnaire
First class : 20-50 households	13	417	1591	Hossein-Abad	42	20
				Kalateh Abdul	45	20
First class : 51-100 households	15	1000	3814	Mir Bangesh	95	35
First class : 101-250 households	12	1876	7370	Chahak	169	50
				Jalal Abad	108	41
First class : over 250 households	17	8236	32029	Kaal Choghouki	265	85
Total	57	11529	44804	6	724	251

and 40 minutes to 60 degrees and 38 minutes longitude and 35 degrees and 45 minutes to 36 degrees and 25 minutes longitude.

The present research is in the field of applied research and in terms of nature and method is within the framework of a descriptive and analytical method. Data collection is done in two types of field and library. According to the statistical population of 57 villages of more than 20 households from Razavieh district of Mashhad city, the sample size was determined by the Cochran formula for 251 households. The main tool of this study was a questionnaire with a total of 28 questions that was done systematically by a random method. Data were analyzed by one-sample t-test, Kolmogorov-Smirnov and Wilcoxon test. In order to ensure the validity of the questionnaire, a questionnaire was prepared after the preparation of preliminary questionnaire based on the permanent techniques of the questionnaire; it was provided to professors and some experts familiar with rural water issues. Then, its corrective comments were applied and finally, the questions related to both hypotheses were determined in the questionnaire. In order to investigate the reliability of the research, as it was stated, information was gathered through systematic random sampling by collecting information from the villagers through a questionnaire. One of the methods for calculating reliability is the use of the Cronbach formula. According to the alpha coefficient obtained in Table 1, the reliability of the questionnaire is evaluated as desirable.

Research questions

1. How much do the villagers work with the rainwater harvesting plans through the basins ? 2. How far are the settlements of the villagers compatible with the plan of rainwater harvesting through the watershed basins?

Research variables

In this research, independent variables are the participation of villagers in the rainwater harvesting plan and the adaptation of rural settlements in this

Table 2. Cronbach's alpha coefficient for research variables. Source: Research findings, 2016.

Row	Chapter header questions	Alpha coefficient
1	Participation of villagers in collecting rainwater	0.712
2	Adaptation of rural settlements in collecting rainwater	0.751

Table 3. Results of the comparison of the average of the research variables with the number 3 by the t-test. Source : Research findings, 2016.

Variable	Average	Standard deviation	Statistics-t	Freedom degrees	p-value	Result
Participation of villagers in the plan for collecting rainwater	3.08	0.73	1.729	255	0.085	Medium
Adaptation of rural settlements in collecting rainwater	2.40	0.46	-20.983	256	0.000	Less than medium

direction and dependent variable, is the collection of rain water (Table 2).

RESULTS AND DISCUSSION

The study of the variables studied in this study consists of more than one item and therefore has a small scale. The data volume, which is more than 30, is based on the central limit theorem, the average of the data have a normal distribution and the parametric t-test can be used to compared the average of the components with the number 3 (Table 3).

Based on the obtained results, it can be seen that the p-value of the test is the comparison of the average. Participation of villagers in the plan for collecting rainwater with the number 3 is greater than 0.05 and the t-statistic is positive, indicating that the average rainwater harvest is medium. But the comparison of the average compatibility of rural settlements in collecting rainwater with the number 3 represents the average value of this variable less than (p-value less than 0.05 and t-statistic negative), therefore, the adaptation of settlements is at the lower level than the average of this issue. Also, the confidence interval of 95% for the average difference of each component with the number 3 is given in the table below. In this table, if the confidence interval contains only positive numbers, it shows that the difference is only positive, so the average has no significant difference with 3 (average), which for participating in collection is such this and if the lower and apper bounds of the confidence interval are both negative numbers, it shows that the average is less than the average (3), which for adaptation of rural settlements in collecting rainwater it can be seen in this regard. Spatial analysis of the variables of research by the detachment of villages is presented in Table 4.

The review of the averages presented in Table 4 and Fig. 2 shows that the village of Chahak is in participation of villagers in the plan for collecting rainwater and the village of Hossein Abad has a higher average relative to other villages relative to the average compatibility of rural settlements in collecting rainwater (Figs. 3 and 4).

Table 4. Mean variables of research (spatial analysis of variables). Source : Research findings, 2016.

Village	Participation of villagers in the plan for collecting rainwater	Adaptation of rural settlements in collecting rainwater
Jalalabad	3.10	2.69
Chahak	3.84	2.35
Hosseinabad	2.59	2.72
Kaal	3.13	2.54
Choghouki	3.13	2.54
Kalate Abdol	1.43	2.09
Mir Bangesh	2.89	1.78
Total	3.08	2.40

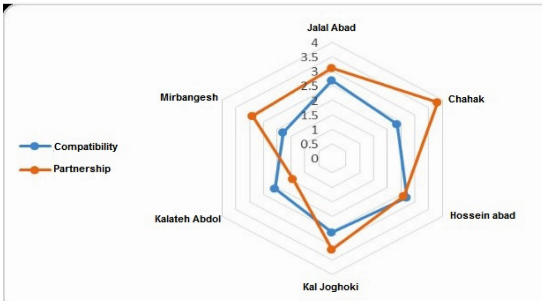

Fig. 2. Average compatibility of rural settlements and their participation in collecting rainwater separately from the village.

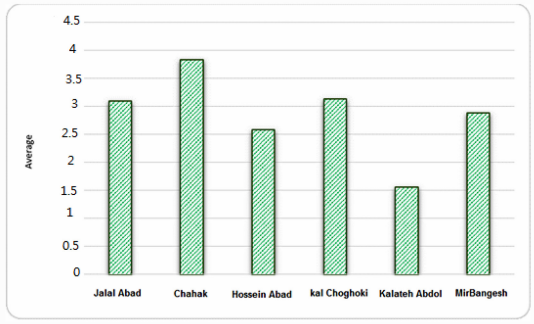

Fig. 3. Comparison of the average participation in collecting rainwater in different villages.

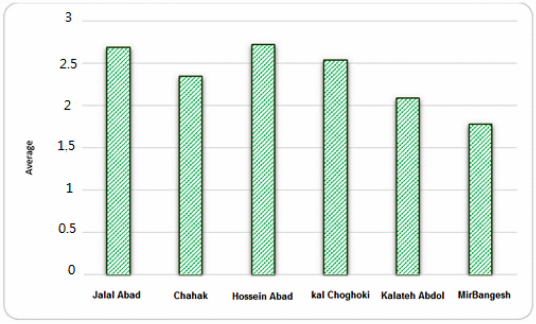

Fig. 4. Comparison of the average compatibility of rural settlements in collecting rainwater separately from villages.

Study of the status of research variables

Regarding the sample size of the villages, firstly, the normalization of variables in villages with sample size less than 30 by Kolmogorov-Smirnov test was studied and then appropriate test was selected (Table 5).

Table 5. The results of the Kolmogorov-Smirnov test in examining the normal variables in villages less than 30. Source : Research findings, 2016.

Village	Sample size	Participation of villagers in collecting rainwater		Adaptation of rural settlements in collecting rainwater	
		Test-statistic	p-value	Test-statistic	p-value
Hosseinabad	20	0.212	0.024	0.148	0.200
Kalate Abdol	20	0.500	0.500	0.243	0.003

Regarding the non-normality of the variable distribution, participation in the collection of rainwater in Hussein Abad and Kalateh Abdul (p-value less than 0.05), for comparing the average water collection in these villages and other villages (based on the central limit theorem). The number 3 of the Wilcoxon test is used. In comparing the average of the variables of adaptation of rural settlements in water collection, considering that the p-value of Kolmogorov test in Kalate Abdol village is less than 0.05, the distribution of data is not normal, so the Wilcoxon test is used to compared the average of this variable in two village of this survey case (Table 6).

Examination of the first hypothesis of the research

In order to compared the average of respondents

Table 6. Results of the comparison of the average of the research variables with the number 3. Source : Research findings, 2016.

Average comparison	Village	Num	Average	Standard deviation	Used test	Test-statistic	Freedom degree	p-value
Participation of villagers in collecting rainwater	Jalalabad	41	3.10	0.28	t-test	2.175	40	0.036
	Chahak	57	3.84	0.54	t-test	11.869	56	0.000
	Hosseinabad	20	2.59	0.72	Wilcoxon	-2.073	-	0.038
	Kaal Choghouki	84	3.13	0.41	t-test	-3.30	83	0.003
	Kalate Abdol	20	1.56	0.12	Wilcoxon	-3.983	-	0.000
	Mir Bangesh	35	2.89	0.16	t-test	-3.833	34	0.001
Adaptation of settlements in collecting rainwater	Jalalabad	41	2.69	0.39	t-test	-5.146	40	0.000
	Chahak	57	2.35	0.38	t-test	-12.997	56	0.000
	Hosseinabad	20	2.72	0.54	t-test	-2.332	19	0.031
	Kaal Choghouki	84	2.54	0.36	t-test	-11.988	83	0.000
	Kalate Abdol	20	2.09	0.17	Wilcoxon	-3.963	-	0.000
	Mir Bangesh	35	1.78	0.21	t-test	-34.100	34	0.000

Table 7. Results of the comparison the average of participation in the rainwater harvesting with the number 3 by the t-test. Source : Research findings, 2016.

Survey	Average	Standard deviation	t-statistic	Freedom degree	p-value	Hypothesis result
Participation of villagers in collecting rainwater	3.08	0.73	1.729	255	0.085	Confirm

Table 8. The results of comparison of rural settlement compatibility with the number 3 by t-test. Source : Research findings, 2016.

Survey	Average	Standard deviation	T-statistic	Freedom degree	p-value	Hypothesis result
Adaptation of rural settlements in collecting rainwater	2.40	0.46	-20.983	256	0.000	Reject

views on the participation and cooperation of villagers in collecting rainwater, with the help of t-test, the average score of comments with number 3 (mid-point) was performed that the result is in the following Table 7.

It is seen that the p-value of the test is greater than 0.05 and the t-statistic is (1.729). Therefore, it can be said that the average of participation in collecting rainwater is medium, so it can be concluded that the first hypothesis is confirmed with a confidence of 95%.

Investigation of the second hypothesis

In order to compared the average of respondents views about the adaptation of settlements with the water collection plan, with the help of the t-test, the average of the comments with the number 3 (middle) was performed, the results of which are also given in the following Table 8.

It can be seen that the p-value of the test is less than 0.05 and the t-statistic is negative (-20.293). Therefore, it can be said that the average of adaptation of rural settlements in collecting rainwater is less than average, so we can conclude that the second hypothesis is rejected with a confidence of 95%.

CONCLUSION

Referring to articles and actions taken in different parts of the world to collect rainwater from the roof surfaces, it appears that there are more or less significant measures taken in different parts of the world in this direction, which can provide useful experiences for us. The results of this study showed that not only villagers have a high incentive to participate in the project, but also realized the importance of this project as a useful, helpful and affordable way to deal with the dehydration crisis and reduce reliance on centralized water supply systems to remote locations, such as plumbing water, dam, wells, aqueduct, water tankers and stagnant surface renewal, but also because of the need for water for drinking and non-drinking purposes, they seek to develop and combine traditional methods of harvesting rainwater with today's knowledge, and they use rainwater drop by drop for their lives. Ultimately, they demand the help and support of local and private institutions in solving problems, especially the habitat worn out texture and assisting in purchasing the basic required equipment of plan. In order to achieve more success in collecting rainwater from the roof, it is suggested that ministries and institutions and relevant organizations such as Ministry of Energy, Ministry of Agriculture, Ministry of the Interior and their sub-groups in the provinces, have an active presence in this field and by providing the necessary training for administrative and executive experts, on the one hand, for the villagers and on the other hand, provide a favorable hypothesis for the development of this plan. At the moment, there is no motivation in the relevant organizations and departments to enter this field and writers two-year

efforts to get the cooperation from organizations and related departments in Khorasan Razavi province did not have any success.The writers specific suggestion is that rural water and wastewater organization of the province. In cooperation with the governor of Mashhad and the organization of Agricultural Jihad, as the smallest action in this regard, provide the necessary equipment, such as a reserve, to run a rainwater harvesting system from the roof to set up as a pilot in one of the targeted villages, which, unfortunately, despite numerous follow-ups, no result was reached. Whereas, the rainwater harvesting in provinces like Khorasan Razavi, the vast majority of its plains, have been declared forbidden as plains many years ago, can reduce the pressure on the water resources of the rural areas to a certain extent and make an effective contribution to reducing the problems of the villages being watered out by tankers. One of the benefits of the rainwater harvesting system is motivating, educating and engaging local people in the successful factors, and it has the greatest benefit for the poor and low income people in the villages.

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