Agricultural Water Management 281 (2023) 108258

Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com/locate/agwat

An analysis of why rehabilitation and balancing programs for aquifers do not meet water organizations' targets (a case study of the Qazvin aquifer in Iran)

Masoumeh Hashemi [a,b,*,1], Hamed Mazandarani Zadeh [c], Mahdi Zarghami [d,e], Betelhem W. Demeke [g], Razieh Taraghi Delgarm [f]

[a] Remote Sensing Research Center, Sharif University of Technology, Tehran, Iran
[b] Plants, Soils, & Climate Department , Utah State University, Logan, USA
[c] Water Sciences and Engineering Department, Imam Khomeini International University, Qazvin, Iran
[d] Faculty of Civil Engineering and Institute of Environment, University of Tabriz, Tabriz, Iran
[e] Policy Research Institute, Sharif University of Technology, Tehran, Iran
[f] School of Civil and Environmental Engineering, Amirkabir University. of Technology (Tehran Polytechnic), Tehran, Iran
[g] Department of Civil, Construction and Environmental Engineering, University of Alabama, Tuscaloosa, AL 35401, USA

ARTICLE INFO

Handling Editor - B.E. Clothier

Keywords:
Groundwater resources
Revival and balancing plan
Stakeholder
Effectiveness
Cooperative behavior

ABSTRACT

Iran experiences insufficient precipitation, resulting in excessive use of groundwater resources, leading to negative water balances in many plains. As a result, the Ministry of Energy began implementing the Groundwater Rehabilitation and Balancing Plan (GRBP) in 2006 to replenish the aquifers. The plan includes measures such as Blocking Illegal Wells (BIW), Equipping Wells with Volumetric Meters (EWVM), Increasing Patrol and Control (IPC), and inspecting the degree of exploitation of groundwater, etc. In this study, researchers examined the level of social agreement between farmers and experts on the effectiveness of the Ministry of Energy's policies for the GRBP and assessed the farmers' response to droughts in this descriptive-analytic study. The data were collected using questionnaires designed in Likert scale, and they were analyzed in R programming language using the t-test, independent-sample t-test, and Friedman test. It was found that 84% and 58% of the farmers have negative attitudes towards BIW and IPC respectively. Farmers have demonstrated the greatest level of cooperation (90%), towards the use of pressured irrigation system (IPIS). The study revealed that farmers and experts disagree about the effectiveness of all measures in reviving and balancing groundwater resources. Farmers are not willing to cooperate with the government on the implementation of measures that limit their agricultural freedom. According to Friedman's results, unlike farmers, experts prefer structural and procedural measures, such as blocking unauthorized wells, instead of relying on educational methods and culturalization. This study demonstrates how understating and discrediting farmers' roles in sustainable water resources and constructing a monocentric governance system has led to the current situation, which is not ideal for groundwater sustainability.

1. Introduction

The majority of Iran is located on the world's desert belt. This, in addition to rapid population growth in the 21st century and food insecurity, has created controversy over natural resources in Iran (Sadeghi et al., 2004; Parhizkari et al., 2015; Jafarzadeh et al., 2016; Yadegari et al., 2018).

In Iran, like a lot of arid and semi-arid countries, groundwater is the main resource for domestic, industrial, and agricultural uses. Recently, accelerating urbanization, industrialization and climate changes pose

Abbreviations: GRBP, Groundwater Rehabilitation and Balancing Plan; BIW, Blocking Illegal Wells; EWVM, Equipping Wells with Volumetric Meters; IPC, Increasing Patrol and Control; QP, Qazvin Plain; QA, Qazvin Aquifer; t_{Os}, One Sample t test; t_{Is}, independent sample t test; FM, Friedman; K-S, Kolmogorov-Smirnov.

* Corresponding author at: Remote Sensing Research Center, Sharif University of Technology, Tehran, Iran
E-mail address: hashemitame@sharif.edu (M. Hashemi).
[1] ORCID: 0000-0001-8649-5208

https://doi.org/10.1016/j.agwat.2023.108258
Received 31 August 2022; Received in revised form 25 February 2023; Accepted 27 February 2023
Available online 14 March 2023

threats to the quantity and quality of groundwater (Huan et al., 2018). Untapped exploitation and increasing water withdrawal from aquifers aggravate the threat to groundwater resources (Jafarzadeh et al., 2016). The cumulative groundwater depletion has risen from 65 to 109 billion cubic meters in the period of 1994–2014. Water abstraction in 291 out of 609 main aquifers in Iran has been banned, due to over-exploitation of aquifers (Moridi, 2017).

To prevent this harmful process and preserve resources, it is necessary to implement reduction and balancing policies. The successful implementation of these policies needs cooperation among all stakeholders (Gregory and Leo, 2003; Mohammadi kangarani and Rafsanjani Nezhad, 2015; Curtis et al., 2014; Prager et al., 2015; Qobadpour et al., 2018; Valizadeh et al., 2017, Higuchi et al., 2020). The effectiveness of policies depends on the social agreement and cooperation among farmers and the government. The experts' and planners' better understanding of farmers' behavior and attitude, and vice versa, is fundamental to the success of any management policy, therefore identifying factors influencing farmers' motivation in social participation is one of the most important components of any project (Savari and Shokati Amghani, 2021).

A study undertaken by Afshar identified factors such as the economic status of exploiters, collectivist spirit, the scope of farming, education, attitudes toward participatory irrigation management, and the age of farmers are the most important factors in their willingness to participate in irrigation management. The study concluded that before a water supply organization can be established, conducting attitude assessment surveys, selecting leading people with appropriate characteristics, improving irrigation facilities and their active and sustainable participation will attract the participation of users in irrigation management (Afshar and Zarafshani, 2011).

The results of a study of five irrigation networks, showed that the small size of land plots and the low income of network operators are the cause of miss management problems in these networks (Montazer and Hedarian, 2000). A study by Karbasi et al. on the relationship and participation of researchers and farmers in the wheat production process showed that gaining farmers trust relies on measures such as raising the level of experience and skills of experts, timely consultation of farmers and experts, visiting professional experts and supervisors and motivating farmers to cooperate with experts (Karbasi et al., 2010). Using different methods of production and transfer technology is not only a way to develop the participation and further interaction of researchers and farmers, but also change the attitude of farmers and increase their awareness (Croxton, 1999). In their study regarding farmers' satisfaction with the agricultural extension services in northwestern Ethiopia, Elias et al. identified that about 45% of farmers were dissatisfied with the extension services, which showed that this program needs to be improved. Also, their results showed that the development of demand-driven extension services instead of supply-based services is more effective (Elias et al., 2016).

Bashirzadeh et al. analyzed the existing relationships between important water sectors in Iran using Ucint and NetDraw software and network analysis and identified the main stakeholders as well as the most vulnerable ones. The study revealed that some sectors, such as farmers, water cooperatives, and the Land and Water Organization, are not sufficiently connected with others. The efficiency of water policy in Tehran, assessed using network analysis methods and components of governance, was found to be low due to the lack of balanced distribution of power and lack of coordination and communication between water authorities, and not paying attention to the good governance component in water management (Bashirzadeh et al., 2009).

Studies showed that the success of farmers' participation in the implementation of any water resources management policy depends on the actual involvement of farmers associations (Sheikh et al., 2016). The implementation of such a plan has many stages and takes a long time, therefore in developing such plans, attention should be paid to the attitude and interest of the users (Montazer and Hedarian, 2000). Regarding the level of acceptance of pressurized irrigation technologies by farmers in Dashtestan city, a study showed that the knowledge variable has the highest impact, among other variables such as agriculture, economics, technic, individual, psychology, and support affecting the acceptance of pressurized irrigation technology (Behbahani Motlagh et al., 2017). A study by Zawojska led to the development of a model that showed the relationship between farmers' trust and the different dimensions of the agencies' performance on restructuring and modernization of the irrigation network representatives in Poland. This model showed that farmers' trust and satisfaction with these institutions had a relationship with how agencies work and the level of services and programs provided by Agencies (Zawojska, 2010).

Investigation of farmers' satisfaction with the installation of smart meters on water wells in the Mahidasht region of Kermanshah province by Ghobadpour et al. using a questionnaire showed that farmer's satisfaction is impacted by factors such as farmers' attitude towards water protection, understanding the value of water protection, fair installation of meters, the usefulness of meters, income, the farmer's opinion of his/her impact on water protection, access to resources needed for the protection of water, education, and training after meter installation (Qobadpour et al., 2018). Research carried out by Alipour et al. regarding the status of the Groundwater Rehabilitation and Balancing Plan (GRBP) in the Neishabour plain in Iran showed that there is no necessary infrastructure to implement the project. Problems such as delays in information and annual statistics of protection, mistakes in the water budget, use of different methods to calculate water balance, uninformed statistics of illegal wells and even legal withdrawals and unavailability of funds and patrols and inspections groups' salaries have made the project difficult (Alipour et al., 2016).

Donya and Sarraf assessed the status of the plan with a view of integrated water resources management from respective of the structural-administrative and social-economic systems to find solutions to the existing challenges. According to the analysis, the formation of joint working groups of the Ministry of Energy and the Judicial system to remove obstacles and review to accelerate the judicial process in this area and also create incentive packages to improve the cultivation pattern with changes in administrative structure and policy of defining the guidelines of the plan are among the necessities for reviewing the plan in order to promote and achieve great goals (Donyaei and Sarraf, 2018).

There is a pressing need to address these problems because a considerable amount of Iranian irrigation water comes from groundwater, resulting in a negative balance in many aquifers. Therefore, the GRBP has been developed by the Ministry of Energy to prevent the decline of groundwater levels. The plan is being implemented in the plains of Iran such the as Qazvin Aquifer(QP).

QP is one of the plains known for widespread agricultural production, which, like many other plains in Iran, has a negative groundwater balance. The agricultural sector of this region, by contributing 2.38% of the value added to the total agricultural sector, is the second-largest producer of agricultural and horticultural products in Iran (Qazvin economic affairs and finance, 2015) and accounts for more than 93% of the total water consumption in the plain (Abkhan consulting engineers, 2013).

The implementation of the GRBP has been a costly project. For instance, in QP, the cost of 15 inspection patrols to prevent violations of water resources for 24 months has been one million dollars. Three million dollars have been spent in 12 months to block illegal wells and 1.5 million dollars to equip 1000 wells with a volumetric meter. Even though more than 10 years have passed since the start of the GRBP, the aquifer continues to experience the same annual water level decline. Due to such high costs without any improvement of the groundwater level, the evaluation of the project during implementation, the identification of potential strengths and weaknesses, and efforts to encourage the strengths and reduce the weaknesses are essential. To do this, we have investigated the opinions of farmers and experts about the management measures of the GRBP in QP by analysis of data collected using questionnaires. The study provides useful information for the Ministry of Energy, the Ministry of Agriculture-Jahad, exporters, and farmers.

2. Data and methods

2.1. Study area

2.1.1. Location of study area

Qazvin province, with a total area of 15821 square kilometers, is located between a longitude of 48°45′E to 50°50′E and a latitude of 35°37′ to 36° 45′, in the northern and western half of the Salt Lake catchment of Iran (Fig. 1). The mountainous and the plain areas in the plain amount to an area of 4492 and 5059 square kilometers respectively. The elevations within the plain range from 2902 to 1131 m. Fig. 1 shows the climatic classification, location of water resources, and cropping pattern in the research area.

2.1.2. Challenges to the groundwater resources of the study area

Groundwater resources of QP are under serious threat. Fig. 2 shows the changes in the unit hydrograph of the groundwater table over a 21-year period from 1998 to 2018. The period could be divided into two periods, before and after the implementation of the GRBP. As shown in Fig. 2, the groundwater table continues to decline after the implementation of the GRBP. The aquifer has an annual negative balance of 314 million cubic meters and the withdrawal rate of renewable water is 1.26 m (Abkhan consulting engineers, 2013).

2.2. Data tool

2.2.1. Questionnaire

Separate questionnaires were developed for farmers and experts in the study. In order to validate the questionnaire, a 15-member panel of academicians and officials was invited to participate. They have experience in sociology, agriculture, economics, hydrology, hydrogeology, and social hydrology, the scientists on the panel have also worked on assessing the projects, and officials from the Regional Water Company and the Center for Agriculture and Natural Resources Research and Education also participated. People who helped revise the questionnaires were not asked to complete the questionnaire.

The farmers' questionnaire contains two main parts while the experts' questionnaire contains three main parts. These questions were designed to evaluate farmers and expert reactions to groundwater reclamation and conservation strategies during droughts. Accordingly, questionnaires with 21 questions for farmers and 12 questions for experts were developed. In the case of farmers, as a result of their illiteracy, a face-to-face method was used; in the case of experts, it was used to avoid misunderstandings, to receive precise answers, and to save their time.

The first part of both the farmers' and experts' questionnaires contain questions that assess independent research variables (Table 1).

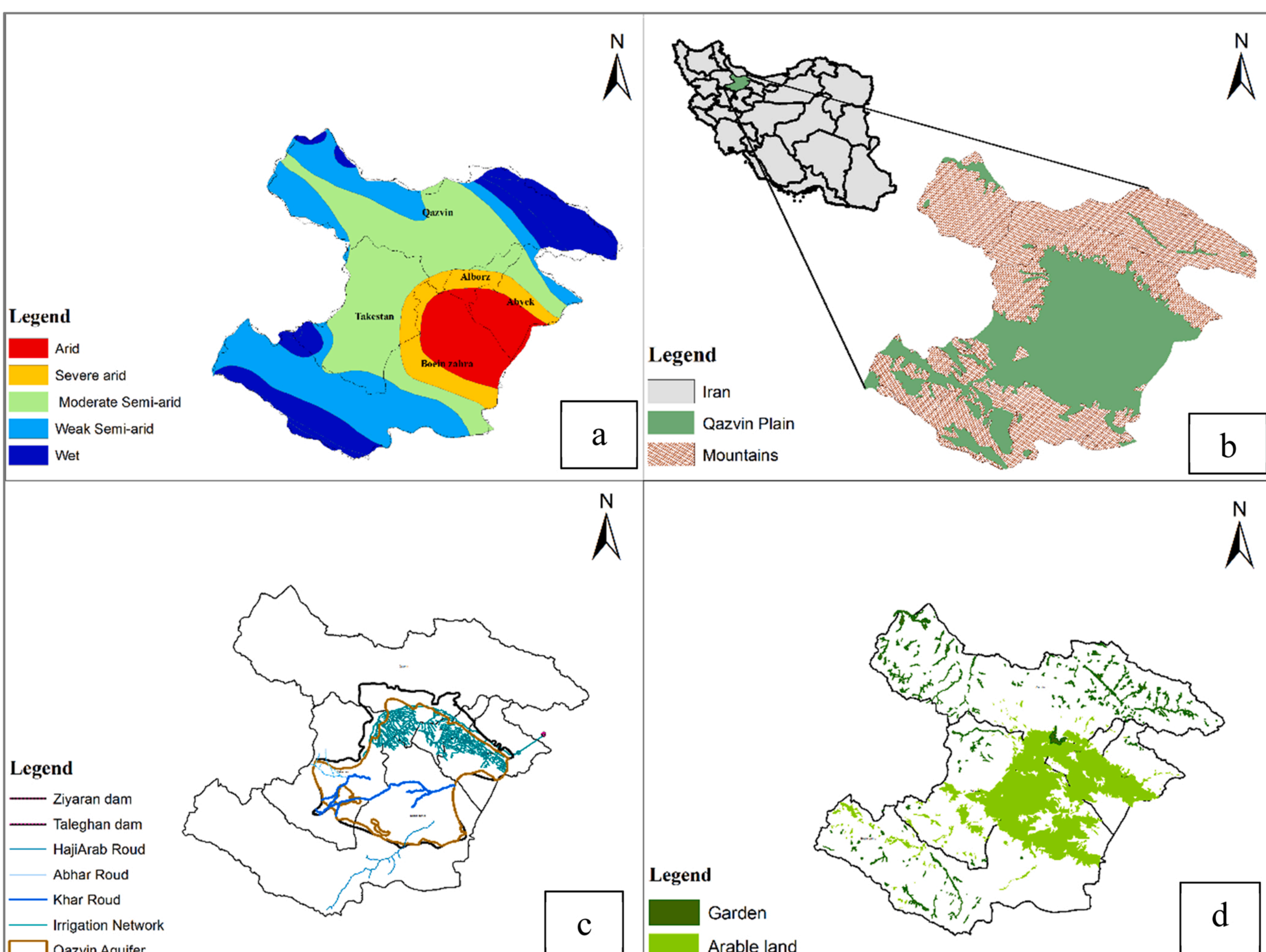

Fig. 1. Detailed map of study area with (a) Climate classification, (b) Mountains and plains, (c) Water bodies, and (d) Orchards and arable land.

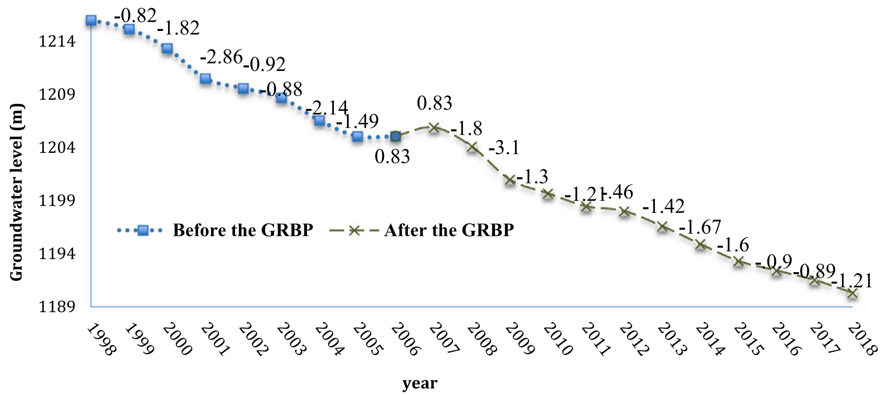

Fig. 2. Groundwater level fluctuation of Qazvin Aquifer (Qazvin Regional Water Company).

Table 1
Responses of the Experts About the Reaction of the Farmers.

Farmer's questionnaire	Expert's questionnaire
1. First Part	1. First Part
✓ Age ✓ Education ✓ Income	✓ Education ✓ Work experience
2. Second part 21. First subpart	2. Second part 2.1 First subpart
✓ Effectiveness of the measures implemented to revive and balance groundwater resources ✓ Effectiveness of the measures implemented to revive and balance groundwater resources on farmers' income	✓ Farmers' reaction to the measures implemented to revive and balance groundwater resources ✓ Effectiveness of the measures implemented to revive and balance groundwater resources ✓ Effectiveness of the measures implemented to revive and balance groundwater resources in improving farmers' income
22. Second subpart	2.2 Second Subpart
✓ Actions taken in response to agricultural drought ✓ Selected approaches in the absence of agriculture which is currently the main livelihood of the farmers	✓ Actions taken in response to agricultural drought ✓ Selected approaches in the absence of agriculture which is currently the main livelihood of the farmers
	3. Third part
	✓ Determination of the ranks of nine policies based on their effectiveness in preserving groundwater resources

In the second part of the questionnaire of farmers and experts, containing two subparts, the dependent research variables were assessed through a set of questions with five-choice answers from 'very low' to 'very high' in the form of a Likert scale. The questionnaire of experts contains a third section designed to investigate their opinion about the effectiveness of the nine strategies implemented to conserve groundwater resources. The detailed structure and the content of the questionnaire of both farmers and experts are given in (Table 1) below.

In this study, the statistical populations were farmers, and experts from agricultural-Jihad experts and regional water companies in the cities Buin Zahra, Takestan, Alborz, Qazvin and Abyek located on QA. Due to the dispersion of the farmers, in small cities such as Abyek and Buin Zahra, 10 villages and other cities, 20 villages have been selected to determine the sample of the farmers. Villages that have been impacted by all GRBP strategies are randomly selected in each city. Experts were selected from all service centers and offices of Qazvin Agriculture-Jihad Organization and Qazvin Regional Water Company that have been involved in implementing GRBP. Multi-stage random sampling was employed to select the target sample from the five cities in QA. This survey was conducted with 290 farmers and 100 experts according to the Krejcie and Morgan methods (Krejcie and Morgan, 1970). In the case of farmers, as a result of their illiteracy, a face-to-face method was used; in the case of experts, it was used to avoid misunderstandings, to receive precise answers, and to save their time.

2.3. Used statistical tests to analyze the data

Kolmogorov-Smirnov normality (K-S) test (Chakravati, Laha, and Roy, 1967)was used in this study to determine the most appropriate analysis method for the data distribution. K-S test results showed all variables except the last question of the expert's questionnaire followed the normal distribution at 95% confidence level.

Based on the result of the K-S test, one sample t-test and independent t-test were used for the farmers questionnaire and first two parts of the expert questionnaire which followed normal distribution data, and Friedman test for the last question of the expert questionnaire. To test whether farmers' and experts' average opinions regarding each of the study variables are statistically different from the hypothesized mean (M=3), an One Sample t-test (t_{OS}) is performed (Kent State University Libraries, 2017). An independent sample t-test (t_{IS}) is then performed to compare the means of two independent groups (farmers and experts) (Kent State University Libraries, 2017). The Friedman (FM) test is conducted at the end of the analysis, which is a non-parametric statistical test similar to repeated measures ANOVA. It is used for comparing and ranking the mean of K strategies (Friedman, 1937). Hence, we used FM test to rank the data collected from the last question in the expert questionnaire. The tests were all performed in the R programming language at a 95% confidence level.

3. Results and discussions

3.1. Respondents ' Information

A. The experts

According to the collected data, 84% of the experts are male, 25% of the respondents have 6–10 years of experience and 52% of them have a master's degree. Most of them are expected to have the necessary ability to make decisions due to their work experience and high level of education.

B. The Farmers

The average age of the farmers is 45 years old and most of them are in the age group of 30–50 years, which indicates that they are mostly in the educable and young age group. In terms of gender, all respondents except one were male. The level of education of 74% of the farmers is secondary education or less. Analysis of data related to the variable "having or not having a non-agricultural job" showed that 84% of the farmers have agriculture as their main occupation and 38% of them have jobs other than agriculture.

In order to assess the acceptability of agricultural jobs among the farmers, the willingness of the farmers' children for future agricultural jobs was investigated. Options for obstacles to continue farming included: insufficient income, water crisis, lack of agricultural knowledge, and interest and attractiveness of other jobs. It is found that 66% of respondents' children are unwilling to continue farming for two reasons: insufficient income and water crisis. As the statistical results showed, the farming community of QP is composed of relatively young people who are forced to migrate to cities and the capital due to a lack of job security and insufficient income. Therefore, creating jobs in other industries and fields such as tourism, handicrafts, carpet weaving, and animal husbandry that do not require higher knowledge and education, in addition to conserving water resources, can prevent social harm caused by water shortages in the future.

3.2. Evaluation of the effectiveness of the implemented strategies

3.2.1. The level of farmers' cooperation

To evaluate the effectiveness of the implemented strategies on the rehabilitation and balancing of groundwater resources, the experts' opinions on the reaction of the farmers to the implemented strategies in the region, including Blocking Illegal Wells (BIW), Equipping Wells with Volumetric Meters (EWVM), Increasing Patrol and Control (IPC), and Implementing Pressured Irrigation System (IPIS) was examined (Table 2).

Table 2 illustrates that 83% of the experts believe that the farmers did not cooperate with BIW in order to preserve groundwater resources, and 17% believed in the farmers' cooperative behavior. Half of the experts believe that the farmers have cooperated by equipping wells with volumetric and smart meters and 42% of them believe that the farmers are cooperative towards IPC. According to most of the experts, 90% of the farmers have cooperated with the measure of applying pressurized irrigation systems. According to the experts, the farmers do not cooperate with any strategy that led to the reduction of water extraction and areas under cultivation. As a result, the feasibility of such schemes will be fraught with difficulty, lawlessness, and sometimes heavy financial and social costs. Thus, considering the cooperative behavior of the farmers towards the application of pressurized irrigation systems the expansion of this system without affecting the area under cultivation should be given more attention and support by the government.

3.2.2. Evaluating the effectiveness of the strategies implemented

In this section, the opinion of farmers and experts on the effectiveness of measures taken in maintaining groundwater resources were examined (Table 3). Also, to determine the level of awareness of the perspective of the farmers by the experts, the answers obtained were tested using t_{Is} (Table 4).

3.2.2.1. Analysis of the experts' opinion. The average response of the experts to the impact of measures such as BIW (t(99) = 4.45, p = .000), EWVM (t(99) = 5.26, p = .000), IPC (t(99) = 3.61, p = .000), and IPIS (t(99) = 2.88, p = .005) taken to maintain groundwater resources differed significantly from the theoretical average (M=3). According to experts, their impacts have been high.

Table 2
Responses of the Experts About the Reaction of the Farmers (%).

Strategies	Cooperation	Non-cooperation
BIW	17	83
EWVM	50	50
IPC	42	58
IPIS	90	10

BIW: Blocking Illegal Wells; EWVM: Equipping Wells with Volumetric Meters; IPC: Increasing Patrol and Control; IPIS: Implementing Pressured Irrigation System

Table 3
t_{Os} results of the effectiveness of the procedure implemented in order to revive and balance groundwater resources.

Variables	Experts				Farmers			
	M	*SD*	*t*	P	*M*	*SD*	*t*	P
BIW	3.52	1.17	4.45	.000	3.02	1.70	0.21	.83
EWVM	3.51	0.97	5.26	.000	3.05	1.60	0.51	.61
IPC	3.38	1.05	3.61	.000	2.67	1.51	-3.77	.000
IPIS	3.29	1.01	2.88	.005	4.02	1.38	12.66	.000

BIW: Blocking Illegal Wells; EWVM: Equipping Wells with Volumetric Meters; IPC: Increasing Patrol and Control; IPIS: Implementing Pressured Irrigation System

Table 4
t_{Is} results of the effectiveness of the procedure implemented in order to revive and balance groundwater resources.

Variables	Experts		Farmers		*t*	*P*
	M	*Standard error of the mean*	*M*	*Standard error of the mean*		
BIW	3.52	0.12	3.02	0.10	3.25	.001
EWVM	3.51	0.10	3.05	0.09	3.42	.001
IPC	3.38	0.11	2.67	0.09	5.19	.000
IPIS	3.29	0.10	4.02	0.08	-5.68	.000

BIW: Blocking Illegal Wells; EWVM: Equipping Wells with Volumetric Meters; IPC: Increasing Patrol and Control; IPIS: Implementing Pressured Irrigation System

3.2.2.2. Analysis of the farmers' opinion. According to the t_{Os} obtained, there is no significant difference between the average farmer's opinion and the theoretical average (M=3) of the two proposed measures: BIW (t (289) = 0.21, p = .83) and EWVM (t(289) = 0.51, p = .61). According to the farmers, the reason for the ineffectiveness of these methods is the lack of comprehensiveness of the plan throughout the region, as well as the intermittent neutrality of government officials in the proper implementation of these strategies which lead to farmers breaking the rules of the system. The method and guidelines used to execute GRBP cause farmers to move to other places or options where there is a lack of rules and government practices because they do not want to reduce the area of cropland or change the cropping pattern.

Additionally, the mean of the farmers' response on the two measures of IPC and IPIS have significant differences from the theoretical average (M=3). This difference is negative for IPC strategy, which indicates the inefficiency of this measure on the restoration of aquifers according to the farmers, (t(289) = −3.77, p = .000. The difference of the actions of IPIS is positive, which indicates the effectiveness of this action on the restoration of the aquifer from the perspective of the farmers, t(289) = 12.66, p = .000.

3.2.2.3. The level of agreement between experts and farmers. Table 4 shows that farmers (M=3.02, SEM=0.10) differ from experts (M=3.52, SEM=0.12) regarding the impact of blocking illegal wells on groundwater quantity, t(388) = 3.25, p = .001. The average value of farmers' opinions (M=3.05, SEM=0.09) about EWVM was lower than the average value of experts (M=3.51, SEM=0.10), according to an independent test, t(388) = 3.42, p = 0.001. Thus, farmers did not believe the measure would end the negative balance. Compared with the average opinions of farmers (M=2.67, SEM=0.09), experts thought (M=3.38, SEM=0.11) patrols and control should be increased, t(388) = 5.19, p = .000. In addition, farmers (M=4.02, SEM=0.08) and experts (M=3.29, SEM=0.10) disagreed about IPIS' effectiveness, t(388) = −5.68, p = .000.

As shown in Fig. 2, the trend of water table changes has not changed after the implementation of the GRBP, while according to the experts this plan is considered to be effective and efficient. Unfortunately, the government tends to implement measures that are only temporary solutions without considering the opinion of all stockholders. Such measures wouldn't address the problem. This stresses the importance of formulating management measures that are agreed on by all stakeholders and that treat the root cause of the problem.

3.2.3. The effect of the measures taken on farmers' incomes

The average response of the farmers on the effectiveness of all four measures taken has a significant difference from the theoretical average (Table 5). This difference is positive for the measures BIW ($t(289) = 5.81$, $p = .000$) and EWVM ($t(289) = 5.70$, $p = .000$) and negative for IPC ($t(289) = -3.13$, $p = .002$) indicating a significant and low impact of the measures in the reduction of the income of farmers respectively. The average of the significant difference of IPIS was positive hence, according to the farmers' opinion, had a positive impact on their income, $t(289) = 17.73$, $p = .000$.

Analysis of the results of the previous measures shows that in order to increase the success of the project and the agreement of stakeholders, using pressurized irrigation system while keeping the area under cultivation constant can be implemented as a priority, followed by options such as BIW and EWVM. The farmers and experts believe that the effect of IPC on reducing the drawdown of the aquifer and their income has been low (Table 3, Table 4). Thus, the continuation of the current system of IPC has no justification and it is necessary to apply smart patrolling and controlling and revise the current method.

The analysis of the farmers' behavior shows that they have been cooperative in applying methods that have positively affected their income. This implies that the government should look for solutions that cause the least financial and social harm to the farmer, as they are one of the most vulnerable stakeholders. The government can establish and support low water-consuming industries in arid and semi-arid regions of the country to preserve the employment and livelihood of the farmers. In this way, while controlling the decline of the aquifer, attention can be paid to maintaining the livelihood of the farmers.

3.3. Evaluation of the future of project implementation

3.3.1. Evaluation of the effectiveness of future measures

In this section, possible future measures, including government support for the water market, reduction of import tariffs on agricultural products, and the impact of pre-planting crop prices on the cultivation pattern and the water resources management from the perspective of the farmers and the experts are discussed (Table 6).

3.3.1.1. Analysis of the experts' opinion. As can be seen in Table 6, the mean of the responses of the experts on the two strategies are government support for the water market ($t(99) = 6.44$, $p = .48$) and determining the cultivation pattern based on the specified price of products ($t(99) = 13.08$, $p = .001$) has a significant difference from the theoretical average ($M=3$). The difference is positive, which implies that the effectiveness of each of these strategies on groundwater resources management will be high. In fact, according to the experts, if the price of crops before planting is known, the farmers' acceptance of planting more affordable crops will be high. The mean of the experts' responses on the strategy of reducing import tariffs does not differ significantly ($t(99) = 1.25$, $p = .012$) from the theoretical average($M=3$). This shows that the effectiveness of this strategy on groundwater management will be moderate.

Table 5
Farmers' response on the impact of ground water revival procedures on farmer's income.

Variables	t_{Os}			
	M	*SD*	*t*	*P*
BIW	3.53	1.56	5.81	.000
EWVM	3.48	1.44	5.70	.000
IPC	2.73	1.48	-3.13	.002
IPIS	4.28	1.23	17.73	.000

BIW: Blocking Illegal Wells; EWVM: Equipping Wells with Volumetric Meters; IPC: Increasing Patrol and Control; IPIS: Implementing Pressured Irrigation System

3.3.1.2. Analysis of the farmers' opinion. Examining the effectiveness of the strategies on groundwater resources management from the perspective of the farmers based on the results of t_{Os} in Table 6 shows there are statistically significant differences between the theoretical mean ($M=3$) and the mean response of the farmers on different strategies. The difference between the theoretical mean and the mean farmers' response to the two strategies: government support for the water market ($t(289) = -3.04$, $p = .003$) and the reduction of import tariffs on agricultural products is negative ($t(289) = -8.05$, $p = .000$), which indicates the low impact of these strategies on groundwater resources management. The farmers oppose this strategy because lowering import tariffs on agricultural products will reduce sales of domestic products. The difference between the theoretical mean ($M=3$) and the mean response of the farmers on the strategy of determining the cultivation pattern based on the specified price of crops is positive ($t(289) = 16.53$, $p = .000$), which shows that determining the price in the market before planting the crop, would have a great effect on the cultivation pattern. Similar to research from Hashemi et al. (2019), this study found that the farmers determine the pattern of cultivation based on the most profitable crops.

3.3.1.3. The level of agreement between experts and farmers. As a result of comparing the opinions of experts and farmers about the effectiveness of the above strategies, Table 7 shows that the experts ($M=3.65$, $SEM=0.10$) and farmers ($M=2.73$, $SEM=0.09$) disagree with the government's support for the water market strategy, $t(388) = 6.85$, $p = .000$. The average response of the experts to the strategy was higher than that of the farmers, suggesting that the experts viewed the case as more effective than the farmers. Similar to the strategy of reducing agricultural import tariffs, experts ($M=3.15$, $SEM=0.12$) had a higher average than farmers ($M=2.34$, $SEM=0.08$), $t(388) = 5.58$, $p = .001$.

The results of t_{Is} in Table 7 showed that there is a similarity between the opinions of the experts ($M=4.01$, $SEM=0.08$) and the farmers ($M=4.09$, $SEM=0.07$) about the strategy of determining the cultivation pattern based on the specified price of crops, $t(388) = -0.82$, $p = .41$. Given this issue, if the government sets a guaranteed purchase price for products with high economic value and low water consumption, positive change will be observed in the process of reviving the aquifer.

Measures such as reducing import tariffs on agricultural products and supporting the water market, which have not been considered by the farmers, can play an effective role in reviving the aquifer because they provide information about the price of water and products, and will automatically prevent the planting of products that have no real economic justification. With better information about water prices, the choice of cultivation pattern according to the amount of water consumption, the improvement of water use efficiency, and the use of modern technologies will rapidly accelerate. Reducing import tariffs will also prevent prices from rising too much. In such circumstances, if the government creates a platform for the formation of other industries with less water needs, the farmers will be led to choose the best strategy.

3.4. Farmers' response to water shortages and review of solutions in case of an insufficient farmers' income

3.4.1. The farmers' response to water shortages

From the perspective of farmers and the experts (Table 8), measures proposed to be implemented to address water shortage (drought) are discussed (including planting crops that require less water, reducing the

Table 6
t_{Os} of Effectiveness of Possible Future Proceedings on Groundwater Resources Management.

Variables	*Experts*				*Farmers*			
	M	*SD*	*t*	*P*	*M*	*SD*	*t*	*P*
Government support of the water market	3.65	1.01	6.44	.48	2.73	1.51	-3.04	.003
Reducing import tariffs of agricultural product	3.15	1.20	1.25	.012	2.34	1.4	-8.05	.000
Determining cropping patterns based on the specified price of products	4.01	0.77	13.08	.001	4.09	1.13	16.53	.000

Table 7
t_{Is} of Effectiveness of Possible Future Proceedings on Groundwater Resources Management.

Variables	*Experts*		*Farmers*			
	M	*Standard error of the mean*	*M*	*Standard error of the mean*	*t*	*P*
Government support of the water market	3.65	0.10	2.73	0.09	6.85	.000
Reducing import tariffs for agricultural product	3.15	0.12	2.34	0.08	5.58	.000
Determining cropping pattern based on specified price of products	4.01	0.08	4.09	0.07	-0.82	.41

area under cultivation, and avoiding the planting of crops and selling water).

3.4.1.1. Analysis of the experts' opinion. The average of the responses of experts on strategies of avoiding planting crops and selling water (t (99) = −5.65, p = .001), and reducing the area under cultivation (t (99) = −2.55, p = .012) are significantly different from the theoretical average (Table 8). The difference is negative, which shows that the farmers are less inclined to choose these strategies during the dry season. The average of the response of experts on the strategy of planting crops with less water requirement (t(99) = −.071, p = .48) is not significantly different from the theoretical average (M=3), which shows that according to the experts', the farmers' tendency to choose this strategy during the dry season is moderate.

3.4.1.2. Analysis of the farmers' opinion. Based on the t_{Os} given in Table 8, the mean of the responses of the farmers on all of the three strategies deviates significantly from the theoretical average. The difference between the theoretical average and the mean of the response of the farmers on the measure to reduce the area underplanting crops (t (289) = 6.30, p = .000) is a large positive number, showing that the use of this strategy during the dry season will be of interest to the farmers while the use of planting crops with less water requirements (t(289) = −9.04, p = .000) and avoiding planting crops and selling water is of lower interest (t(289) = −20.67, p = .000). The results show that the farmers are not willing to choose the option of no planting under low water conditions. This will lead to further extractions from the aquifer and the creation of a reverse hydraulic gradient. In QP, the reverse gradient near the salt marsh has caused the salt to enter the aquifer. Even under such problems, agriculture continues in the region. This underscores the importance of the farmers' job security and should be given serious consideration by the government through methods such as expanding other occupations when reviewing rehabilitation policies.

3.4.1.3. The level of agreement between experts and farmers. The values of t_{Is}obtained are used to compare the opinions of experts and farmers on measures to be taken during drought. These values indicate that there is no agreement between the opinions of the experts and the farmers towards all the three measures proposed (Table 9). For the strategy of planting crops with less water requirement, the experts' average opinion (M=2.93, SEM=0.10) was higher than the farmers' (M=2.18, SEM=0.09), t(388) = 5.60, p = .000. Additionally, for the strategy of not planting crops and selling water, farmers (M=1.59, SEM=0.07) had a lower average than experts (M=2.42, SEM=0.10), t(388) = 6.76, p = .000. Therefore, experts believe farmers choose these two strategies because they are the most effective. On the other hand, the average opinion of the farmers about the strategy of reducing the area under cultivation (M=3.57, SEM=0.09) is higher than of the experts (M=2.67, SEM=0.13), which indicates that the farmers reduce the area under cultivation in times of drought, t(388) = −5.71, p = .000.

3.4.2. Review of some strategies used in case of insufficient income from agriculture

In this section, the degree of effectiveness of measures such as changing the pattern of cultivation and job, technology development, water purchase and sale of water in the absence of agricultural income is assessed (Table 10).

3.4.2.1. Analysis of experts' opinions. The t_{Os}corresponding to the response of the experts show that the mean of the response of experts on

Table 9
t_{Is} Results About Crop Pattern During Drought or Shortage of Water.

Variables	*Experts*		*Farmers*			
	M	*Standard error of the mean*	*M*	*Standard error of the mean*	*t*	P
Planting crops with less water requirements	2.93	0.10	2.18	0.09	5.60	.000
Reducing cropland	2.67	0.13	3.57	0.09	-5.71	.000
Planting no crops and selling water	2.42	0.10	1.59	0.07	6.76	.000

Table 8
t_{Os} Results About Crop Pattern During Drought or Shortage of Water.

Variables	*Experts*				*Farmers*			
	M	*SD*	*t*	*P*	*M*	*SD*	*t*	*P*
Planting crops with less water requirements	2.93	0.99	-0.71	.48	2.18	1.55	-9.04	.000
Reducing cropland	2.67	1.30	-2.55	.012	3.57	1.55	6.30	.000
Planting no crops and selling water	2.42	1.03	-5.65	.001	1.59	1.17	-20.67	.000

Table 10
t_{Os} Results Provided Inefficient Agricultural Income.

Variables	Experts				Farmers			
	M	*SD*	*T*	*P*	*M*	*SD*	*t*	*P*
Changing crop pattern	3.34	0.92	3.68	.001	2.61	1.61	-4.16	.001
IPIS	3.46	0.89	5.16	.001	2.95	1.76	-0.48	.64
Changing job	2.96	0.96	-0.42	.67	2.57	1.65	-4.49	.001
Purchasing water	2.91	0.98	-0.92	.35	2.76	1.61	-2.55	.01
Selling water	3.08	1.08	0.74	.46	1.34	0.94	-30.02	.001

IPIS: Implementing Pressured Irrigation System

the two management measures changing the pattern of cultivation (t(99) = 3.68, p = .001) and application of pressurized irrigation system (t(99) = 5.16, p = .001) is significantly different from the theoretical average (Table 10). The averages of the response of the experts on the selected solutions: changing job (t(99) = −0.42, p = .67), water purchase (t(99) = −0.92, p = .35) and water sale (t(99) = 0.74, p = .46) do not have a significant difference from the theoretical average (M=3), indicating the low contribution of the solutions to support the farmers.

3.4.2.2. Analysis of farmers' opinion. The results of t_{Os} in Table 10 showed that the average of the response of the farmers on the use of modern irrigation methods in case of insufficient income from agricultural products (t(289) = −0.48, p = .64) is not significantly different from the theoretical average (M=3). This indicates that the farmers do not choose to use the method. According to the farmers, the use of strategies including changing the pattern of cultivation (t(289) = −4.16, p = .001), water sales (t(289) = −30.02, p = .001), changing job (t(289) = −4.49, p = .001), and water purchase (t(289) = −2.55, p = .01) have a significant difference from the theoretical average (3). The negative average difference in all four strategies showed that the use of the strategies is minimal. As the initial information about the farmers showed, most of them do not have a high level of literacy or a specific profession other than agriculture. Thus, agriculture is the only job they can do, and as the results showed, they incline less to change jobs if agriculture does not support them.

3.4.2.3. The level of agreement between experts and farmers. As the results of t_{Is} in Table 11 showed, there is no agreement between the opinions of the experts (M=3.34, SEM=0.09) and the farmers (M=2.61, SEM=0.10) on the choice of strategy changing the cultivation pattern, t(388) = 5.55, p = .000. According to farmers (M=2.95, SEM=0.10), applying pressurized irrigation systems improves their livelihood in contrast to experts (M=3.46, SEM=0.09), t(388) = 3.72, p = .000. In terms of changing jobs, there was no agreement between famers (M=2.57, SEM=0.10) and experts (M=2.96, SEM=0.10), t(388) = 2.89, p = .004. Farmers' opinions on changing jobs were significantly higher than those of experts. Also, both farmers (M=1.34, SEM=0.9) and experts (M=3.08, SEM=1.08) opposed selling water in times of low agricultural income, t(388) = 14.36, p = .000. In the mentioned strategy, the average of the experts' opinion was higher than the farmers', which showed that the experts believe that the farmers support the strategies more than the farmers say they choose those strategies. But the farmers (M=2.76, SEM=0.10) and the experts (M=2.91, SEM=0.10) agreed on the choice of water purchase strategy to further increase income, t(388) = 1.11, p = .226.

Table 11
t_{Is} Results Provided Inefficient Agricultural Income.

Variables	Experts		Farmers			
	M	*Standard error of the mean*	*M*	*Standard error of the mean*	t_{Is}	P
Changing crop pattern	3.34	0.09	2.61	0.10	5.55	.000
IPIS	3.46	0.09	2.95	0.10	3.72	.000
Changing job	2.96	0.10	2.57	0.10	2.89	.004
Purchasing water	2.91	0.10	2.76	0.10	1.11	.226
Selling water	3.08	1.08	1.34	0.9	14.36	.000

IPIS: Implementing Pressured Irrigation System

3.5. Ranks of policies in order of their effectiveness in the rehabilitation of groundwater reserves

The Friedman ranking test was used to compare and rank nine policies based on their effectiveness in the conservation of groundwater reserves based on the opinion of experts. According to the results of the Friedman test, BIW is highly effective and has the first rank while the policy of creating trust between the farmers and managers of the agricultural sector is the least effective one and stood ninth. The ranks of all the nine policies are given in Table 12 below.

Based on the results of Friedman's test presented in Table 12, it can be inferred that the experts prefer investing in the implementation of strategies with structural measures such as blocking unauthorized wells and applying pressurized irrigation systems to policies including nonstructural measures such as building trust and raising awareness. As the results of the previous sections showed, the farmers do not show participatory behavior towards such strategies. Based on the independent t-test, both framers and exporters disagreed on most of the strategies. Given that the implementation of any action requires a series of financial, credit, technical, social, and cultural infrastructures, it seems that the measures envisaged in this plan have been selected without considering all the effective aspects. The policies that are selected as the most effective ones by the experts are only quick fixes that would worsen the problem in the long run instead of reversing the problem, which in management is called a 'fix that backfires' (Braun, 2002).

4. Conclusion

This study investigated the opinion of and agreement between farmers and experts on groundwater rehabilitation strategies implemented in QP by collecting data using two separate questionnaires. The

Table 12
Ranks of Groundwater Conservation Policies.

Policy	Rank
BIW	1
IPIS	2
Changing crop pattern	3
Using smart and volumetric meters	4
Increasing the awareness level of framers to use water effectively (education and extension agriculture)	5
Changing the water transit system to reduce evapotranspiration	6
Using drought resistance plants and introducing new technologies in producing	7
Establishing industries related to agriculture in order to transfer additional workforce to the industries	8
Creating trust between the farmers and managers of the agricultural sector	9

BIW: Blocking Illegal Wells; IPIS: Implementing Pressured Irrigation System opinion of farmers and experts regarding the effectiveness of possible future measures are also investigated. Furthermore, based on the response of the experts, nine policies affecting the conservation of groundwater reserves were ranked based on their degree of effectiveness. By doing so, the study unveils the reasons behind the failure of the groundwater rehabilitation strategies to meet their target of replenishing the groundwater reserve in QP.

The study identified a significant difference of opinion and a lack of social agreement between farmers and experts on the impact and implementation of the plan. The study attributes the following reasons to the failure of the plan to meet its target: preparation of the plan without thorough study of social issues arising from it and lack of sufficient credit to run measures simultaneously.

In Iran, around 80% of farmers have farming land less than 10 ha in size, and 11% have less than one hectare. These farms less than 10 ha make up about 37% of the cultivated area, but produces less than 10% of marked agricultural production (FAOSTAT, 2017). That means many of them are mainly subsistence farmers, and any decision that reduces his or her water rights will be met with a reaction, which needs to be considered at the highest level, as was proven by Yazdanpanah et al. (2014) and Mahdavi (2021). Additionally, farmers with less than 10 ha account for a greater percentage of the irrigated areas (about 50%) (FAOSTAT, 2017). As a result, agriculture sectors (small farms) represent the highest portion of water use, which is not associated with a large economic impact. A conflict exists between farmers and the government, which must be considered in order to find an equilibrium nobody wants to disrupt.

Based on the analysis and interpretation of the results of this study, the following conclusions are made.

✓ A careful and thorough study on the reaction of farmers and their cooperation towards the implementation of groundwater resources rehabilitation policies should precede the implementation of the policies.
✓ Strategies included in the groundwater rehabilitation plan should focus on treatment of the root cause of the problem rather than the symptoms of the problem.
✓ Talking to farmers and convincing them to change their practice should necessarily be done before the implementation of groundwater resources rehabilitation plans.
✓ The consent of all stakeholders involved must be obtained before implementing management measures.

In addition, it is important to mention the limitations of the study. To collect data, researchers have had to travel to different locations, which has taken a lot of time and money. Lack of funding and time constraints have limited research on psychological variables, especially trust. Moreover, farmers' illiteracy impacted the level of questions that we were able to ask.

5. Recommendations

The implementation of the GRBP has different results in different regions depending on the available water resources, diversity of industries, other sources of income and the number of small landowners. In order to improve the plan, the hydraulic, economic, and social parameters should be defined in such a way that the plan has the same result for everyone. Therefore, it is suggested that the implementation of each project be accompanied by social, economic and hydrological evaluation of working groups in the pilot areas to examine the pros and cons of the project according to the hydraulic, economic and social results.

For future research, it is suggested that the cooperation of sociologists and water experts, the degree of effectiveness of the rehabilitation and balancing plan, and the priorities given to each action within the plan be investigated. The study did not assess psychological variables that lead to agreement between farmers and experts. We suggest future studies analyze this research gap.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are openly available in "Hashemi, M. (2023). An analysis of why rehabilitation and balancing programs for aquifers do not meet water organizations' targets (case study of the Qazvin aquifer in Iran), HydroShare, http://www.hydroshare.org/resource/879debb0bc524817a150355c359f435f"

References

Abkhan Consulting Engineers. (2013). Water budget of Qazvin plain, Ministry of energy, 71pp. (in Farsi).
Afshar, N., Zarafshani, K., 2011. Tendency toward Participatory Irrigation Management (PIM): the case of water user cooperative Sefied-barg and Sarab-bas in Kermanshah province. Iran. Agric. Ext. Educ. J. 6, 99–114.
Alipour, A., Khalil, H., Lagzian, R., 2016. Assessment Effectiveness of Scheme of Revival and Balance Groundwater (case study: Nishabour Plain), in: Iranian National Congress of Irrigation and Drainage, Isfahan, Iran.
Bashirzadeh, M., Araghinejad, S., Mohammadi Kangarani, H., 2009. Investigation of sustainability in implementation network of water resource management through Network Analysis. first Int. Conf. wastewater Treat. water Recycl. new Technol. Find.
Behbahani Motlagh, M., Sharifzadeh, M.-S., Abdollahzadeh, G.-H., Mahboobi, M.-R., 2017. Farmers' adoption behavior of pressurized irrigation technology in dashtestan county. Iran. Agric. Ext. Educ. J. 13, 89–103.
Braun, W., 2002. The system archetypes-the systems modeling workbook. available wwwu.uniklu.ac.at/gossimit/pap/sd/wb sysarch.pdf.
Chakravati, I.M., Laha, R.G., Roy, J., 1967. Handbook of methods of applied statistics, volume i.
Croxton, S., 1999. Users in control: farmer participation in technology research and development. In: Meeting the Challenges of Animal Traction. A Resource Book of the Animal Traction Network for Eastern and Southern Africa (ATNESA), Harare, Zimbabwe. Intermediate Technology Publications, London, pp. 45–50.
Curtis, A., Ross, H., Marshall, G.R., Baldwin, C., Cavaye, J., Freeman, C., Carr, A., Syme, G.J., 2014. The great experiment with devolved NRM governance: lessons from community engagement in Australia and New Zealand since the 1980s. Australas. J. Environ. Manag 21, 175–199.
Donyaei, A., Sarraf, A., 2018. Strategies for the effectiveness of Scheme of revival and balance groundwater from integrated water resources management perspective, in: Conference on Civil Engineering, Architecture and Urban Planning of the Islamic Countries, Tabriz, Iran.
Elias, A., Nohmi, M., Yasunobu, K., Ishida, A., 2016. Farmers' satisfaction with agricultural extension service and its influencing factors: a case study in North West. Ethiop. J. Agric. Sci. Technol. 18, 39–53.
FAOSTAT, R., 2017. FAOSTAT database. Food Agric. Organ. UN.
Friedman, M., 1937. The use of ranks to avoid the assumption of normality implicit in the analysis of variance. J. Am. Stat. Assoc. 32, 675–701.
Gregory, G.D., Leo, M.Di, 2003. Repeated behavior and environmental psychology: the role of personal involvement and habit formation in explaining water consumption 1. J. Appl. Soc. Psychol. 33, 1261–1296.
Hashemi, M., Mazandarani Zadeh, H., Arasteh, P., Zarghami, M., 2019. Economic and Environmental Impacts of Cropping Pattern Elements Using Systems Dynamics. Civ. Eng. J. 5, 1020–1032. https://doi.org/10.28991/cej-2019-03091308.
Higuchi, A., Coq-Huelva, D., Arias-Gutierrezd, R., Alfalla-Luquee, R., 2020. Farmer satisfaction and cocoa cooperative performance: evidence from Tocache Peru. Int. Food Agribus. Manag. Rev. https://doi.org/10.22434/ifamr2019.0166.
Huan, H., Zhang, B.-T., Kong, H., Li, M., Wang, W., Xi, B., Wang, G., 2018. Comprehensive assessment of groundwater pollution risk based on HVF model: a case study in Jilin City of northeast China. Sci. Total Environ. 628, 1518–1530.
Jafarzadeh, A., Khaseii, A., Shahidi, A., 2016. Designing a multiobjective decision-making model to determine optimal crop pattern influenced by climate change phenomenon (case study: Birjand plain). Iran. J. Soil Water Res 47, 849–859.
Karbasi, A., Kanani, T., Khayyati, M., 2010. The investigation of effective factors on farmers participation with wheat supervisors in Zabol township (fuzzy linear regression approach). J. Agric. Econ. Dev. 23 https://doi.org/10.22067/jead2.v1388i2.2532.
Kent State University Libraries. (2017). SPSS tutorials: Independent samples t test. May 172017, Retrieved from ⟨http://libguides.library.kent.edu/SPSS/IndependentTTest⟩.
Krejcie, R.V., Morgan, D.W., 1970. Determining sample size for research activities. Educ. Psychol. Meas. 30, 607–610.

Mahdavi, T., 2021. Application of the 'theory of planned behavior'to understand farmers' intentions to accept water policy options using structural equation modeling. Water Supply 21 (6), 2720–2734.
Mohammadi kangarani, H., Rafsanjani Nezhad, S., 2015. Investigation of policy structure in legal authorities of institutions related to water policy making and management. Public Policy 1, 121–138. https://doi.org/10.22059/ppolicy.2015.57682.
Montazer, A. and Hedarian, A. (2000). Modern approach in managing irrigation networks. Articles Collection Of the 10th Conference Committee of Irrigation and Drainage, Tehran. (in Farsi).
Moridi, A., 2017. State of water resources in Iran. Int. J. Hydrol. 1, 111–114.
Parhizkari, A., Mozaffari, M.M., Shokatfadaee, M., Mahmoodi, A., 2015. Deficit irrigation simultaneously with reduced available water the solution to conservation of water resources in Qazvin plain. J. Water Soil Resour. Conserv. 5, 67–80.
Prager, K., Nienaber, B., Neumann, B., Phillips, A., 2015. How should rural policy be evaluated if it aims to foster community involvement in environmental management? J. Rural Stud. 37, 120–131.
Qazvin economic affairs and finance. (2015). The economy report of Qazvin province. (In Farsi).
Qobadpour, R., Eskandari, F., Jalali, M., 2018. Farmers' satisfaction from installing intelligent flowmeter on underground water wells (the case of Mahidasht County, Kermanshah province). Agric. Econ. Dev. 32.
Sadeghi, S.H., Sharifi, F., E, F., M, R., 2004. Quantitative Evaluation of Watershed Management Measures Performance (case study: sub-basin Keshar- Taleghan Basin). Res. Constr. J.
Savari, M., Shokati Amghani, M., 2021. Factors influencing farmers' adaptation strategies in confronting the drought in Iran. Environ. Dev. Sustain 23, 4949–4972.
Sheikh, M., Redzuan, M., Abu-Samah, A., Magsi, H., Shahwani, M., 2016. Analysis of farmers participation for water management in Sindh province of Pakistan. Pak. J. Agric. Agric. Eng. Vet. Sci. 32, 75–84.
Valizadeh, N., Bijani, M., Abbasi, E., 2017. An environmental psychological analysis of farmers' participatory-oriented behavior toward water conservation. Iran. -Water Resour. Res 13, 17–27.
Yadegari, A., Yousefi, A., Amini, A.M., 2018. Institutional analysis of water governance structure in Iran: a case of Zayande-Rood Basin. Iran. -Water Resour. Res 14, 184–197.
Yazdanpanah, M., Hayati, D., Hochrainer-Stigler, S., Zamani, G.H., 2014. Understanding farmers' intention and behavior regarding water conservation in the Middle-East and North Africa: a case study in Iran. J. Environ. Manag. 135, 63–72.
Zawojska, A., 2010. Determinants of farmers' trust in government agricultural agencies in Poland. Agric. Econ. 56, 266–283.