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Assessment of non-monetary facilities in Urmia Lake basin under PES scheme: a rehabilitation solution for the dry lake in Iran

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Abstract
The decline in Urmia Lake basin's water resources has resulted in a severe drought of the lake. The drought of this hyper-saline lake has put lives of 6.4 million inhabitants at risk. This study was conducted to assess the technical and economic employability of a payment for ecosystem services (PES) method as a policy tool to improve water resources management of Siminehroud river basin which is the most important tributary of Urmia Lake basin. For this purpose, the target areas were identified after the development of a land-use map for the basin. Then, by recruiting the integrated interview method and distributing 398 questionnaires, the required data were collected to assess the employability of the proposed PES method. Among various PES schemes, two methods including a) payment for shifting irrigation methods and b) payment to change cropping patterns in the frame of "Willingness to Accept" (WTA) were proposed to farmers. The results suggest that farmers highly welcomed both proposed methods. The benefit–cost ratio (BCR) for the change in irrigation system was 3.98, whereas the changes for the cropping pattern were 0.8 (for rapeseed), 0.72 (for soybean), and 1.09 (for safflower). As a result, shifting irrigation methods and changing cultivation patterns to safflower are both economically justifiable.

Keywords Urmia Lake · Payment for ecosystem services · Willingness to accept · Benefit–cost ratio · Irrigation system · Cropping pattern

1 Introduction

Water shortage has become the main concern in Iran and some regions in the world, which requires serious reconsiderations in the planning and management of potential and available water resources (Saeedi and Goodarzi 2018). In the present world, issues such as population growth and overexploitation of natural resources for economic development have particularly impacted water resources. It is no wonder that the United Nations has proposed

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water-related challenges as the main global issue after overpopulation (WWAP 2015). Therefore, in the year 2002 at the World Summit on Sustainable Development (WSSD), the first global agreement theory on water management was achieved. This was a considerable milestone in the history of human rights. According to this agreement, water was stated as a basic human right. One hundred and forty-five signatory states to this agreement committed to provide clean and safe potable water for people based on justice and non-discrimination (UNESCO 2006). On the other hand, in the dry Middle East, water and water management were and are of great influence on the socioeconomic interactions of inhabitants (Zarrineh and Azari 2014). Iran is located in a semidry region, and its uneven spatiotemporal precipitation and flow occurrence have created different regions with divergent water resources.

Urmia Lake is a shallow, hyper-saline water body located in northwestern Iran. This lake is among the largest saline lakes in the world (Saatsaz 2019). Along with climate change and prolonged droughts, as clear evidence of water resources mismanagement, this lake and its watershed are facing severe drought conditions (Hassanzadeh et al. 2012; Shadkam et al. 2016; Chaudhari et al. 2018). Urmia Lake receives the majority of the available water from its tributaries. These water flows have been dramatically decreasing during the last two decades due to severe drought conditions as well as the exploitation of rivers to expand agricultural activities in the basin. It has caused the lake's water level to drop from 1277.8 m in the year 1999 to 1273.35 m in the year 2012 (Tabari et al. 2012). According to the United States' Geological Survey, the continuation of this situation would result in complete abolishment of the lake (USGS 2012). Scientists have warned if the lake continues shrinking, it will be converted to a salt land. This will result in diminishing the food chain of the lake and its ecosystem, degradation of wetlands' habitat, emergence of salt storms, change in local microclimate, health problems, and adverse impacts on agriculture and livelihoods of 6.4 million inhabitants in the lake basin (Eimanifar and Mohebbi 2007; Golabian 2010; Hoseinpour and Safari 2010; Zarghami 2011).

If the challenges of the lake are not properly addressed, its situation will be comparable to the Aral Sea, where the salt storm from its dried surface caused an environmental disaster in the region, including loss of vegetation cover, reduction in agricultural yields, negative impacts on biodiversity, and numerous health symptoms (Micklin 2007). Considering the higher population density of the Urmia Lake basin in comparison with the Aral Sea, the health-related phenomena are also anticipated to rate higher. Yet according to the World Bank (2014), report improvements have been achieved regarding the situation of the Aral Sea. It has been mentioned that the volume of the Northern Aral Sea raised by 68% as early as 2008; the project has also brought other impressive results such as reducing the salinity by half, increasing fish production by more than 3 times, improving flora and fauna, and, most importantly, returning the local population who started to engage again in income generating activities, mainly fishing. Figure 1 shows a reduction trend in the water level of the Lake from 1976 to 2009.

In recent years, the Iranian government in collaboration with national and international environmental organizations has developed and implemented various projects to rehabilitate the Lake. Studies show that the agricultural sector consumes between 55 and 85% of the world's water resources (Zeinoddini et al. 2009). According to Kirnak et al. (2016), about 70% of the water resources available worldwide are allocated to agricultural activities, especially irrigation. With regard to the quantity of water consumed instead of discharging into the Urmia Lake, the main participant is agriculture, which accounts for 91% of water consumption, while industry and domestic consumption account for 6% and 3% of water consumption (Faramarzi 2012). Having this fact in mind, experts believe that the

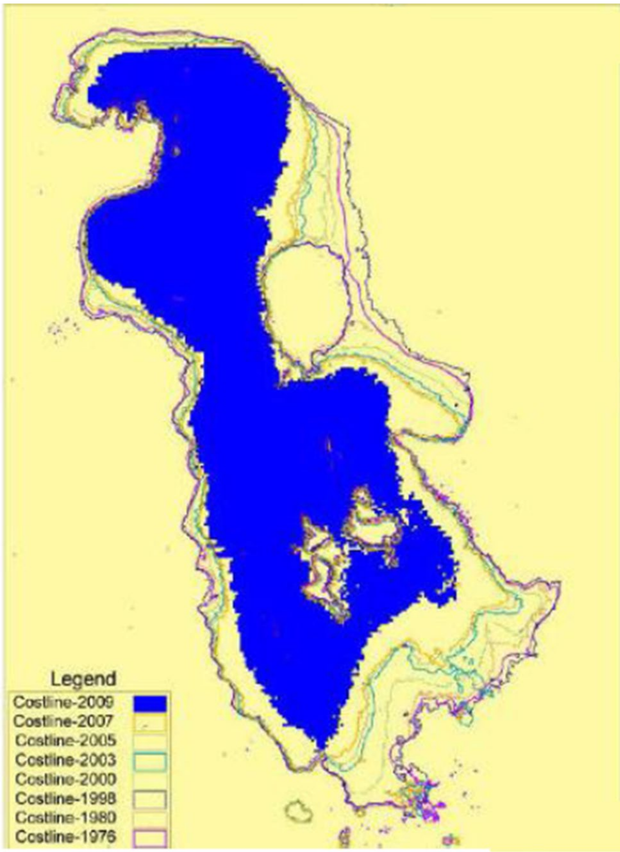

Fig. 1 Lake Urmia water level changes in period 1976–2009 (Zarrineh and Azari Najafabad 2014)

recent extensions in agricultural projects and over-extracting surface and underground water resources to supply agricultural production in the Lake basin are the main causes of drought in Urmia Lake. Therefore, the majority of rehabilitation efforts are concentrated on reducing water consumption by the agricultural sector, as well as enforcing an integrated water resources management in the basin. Water shortage and drought are the main factors that hinder agricultural crop production in the world's arid and semiarid areas. Water conservation in irrigated agriculture and the enhancement of water quality are of utmost importance in water scarce regions (Yazar et al. 2009).

Among various nature conservation tools, payment for ecosystem services (PES) is considered as an effective method, which has demonstrated considerable positive results. PES is considered as an important method for the sound management of natural resources and public goods (Farley and Costanza 2010) and a tool to manage and revive degraded ecosystems and their economic and environmental services (Mombo et al. 2014). PES method provides a progressive provision toward the conservation of natural resources and environment, aiming at improving the well-being of humankind in a global scale (Wunder and Alaban 2008; Muradian et al. 2010; Costa 2011).

The literature on ecosystem services payments (ESPs) shows that ESPs were implemented in regions where indigenous peoples were main social actors (Chan et al. 2017; Chen et al. 2020; Redford & Adams 2009). People who have not given much light to their interests in terms of framing and design features will have to maintain their effectiveness. It is therefore important to find suitable approaches to elicit indigenous peoples' preferences when considering PES designs (Farley and Costanza 2010; Lliso et al. 2020). PES initiatives serve as a popular strategy for resolving the economic externalities of resource extraction and commodity growth, thereby enhancing social and environmental efficiency (Chan et al. 2017; Chen et al. 2020). Along with great enthusiasm, PES has faced a wide variety of serious criticisms (Chan et al. 2017). We have been lulled into complacency over the past two decades by the allure of "win–win" solutions, and we have concluded far too easily that basic policy instruments (whether ICDPs or PES) will solve complex policy problems (Mombo et al. 2014; Muradian et al. 2013).

The PES outcomes depend on the political, sociocultural, and institutional contexts they work within. Attention must be given to recognizing under what circumstances PES may make a major contribution to ecosystem conservation, rather than treating it as a policy panacea. The focus must also be placed on addressing the main causes of environmental degradation, profoundly rooted in power relations, and the way capital is collected and wealth is created through capitalist markets linked with in-equal structural power (Muradian et al. 2013). Although PES programs were originally met with considerable optimism, they also suffered controversy, which seems to have hampered their extension. A strong rejection is correlated with the commodification of nature and the concern with any market-based justification for protecting ecosystems when the same market-based reasons drive consumption that leads to environmental degradation. In the ongoing commodification debate, both proponents and detractors became more reactive and skeptical about the power, reach, and overall ambition of PES initiatives worldwide.

The concept of paying for ecosystem services as an efficient way of achieving conservation is posing particular risks. The claim is that people depend on ecosystem services and the step to secure their continued provision is to pay for them, thus ensuring that services are provided and the organisms and habitats that provide the services are preserved. Arguments for the value of ecosystem services protection and the significance of payment for ecosystem services as a protection resource are generally convincing and carefully designed. Yet we are concerned about the ecosystem services payment solution as a conservation strategy (Redford & Adams 2009). This is especially apparent in discussions about the ethical implications of implementing reward systems into a group setting and the social consequences. Despite these concerns, PES programs continue to attract significant attention worldwide, despite major institutional failures of specific market instruments. By definition, PES is a voluntary exchange scheme in which an ecosystem service is connected to a set of land use that can provide some conservation measures for that service. In this exchange, there should be at least one buyer of the ecosystem services (usually the government), and at least one service provider (the ecosystem), with an assumption that the ecosystem service provider will supply a specific service continuously (Wunder 2007). These solutions suggest a market-based mechanism in which the beneficiaries of environmental services are obliged to provide some services for environmental conservation practices (Pagiola 2002; Engel et al. 2008). In comparison with other natural resources management tools, PES has some advantages such as using direct financial incentives, identifying new financial resources for ecosystem conservation, regulating private land-use decisions, and supporting the livelihood of local communities (Ferraro 2001; Ferraro and Simpson 2001; Ferraro and Kiss 2002; Scherr et al. 2005; Pagiola et al. 2005; Matthies et al. 2015). PES

Table 1 Samples of PES programs in the world

PES method	Country	Researcher
Payment for carbon sequestration and watershed services	Ecuador	Wunder and Albán (2008)
Payment for mixed watershed and biodiversity services	Bolivia	Asquith et al. (2008)
Payment for conversion of sloping lands	China	Bennett (2008)
Payment for hydrological services of environment	Mexico	Munoz Pina et al. (2008)
Work for water	South Africa	Turpie et al. (2008)
Environmental Quality Incentives Program	USA	Claassen et al (2008)
Environmentally Sensitive Areas program and Countryside Stewardship Scheme	UK	Dobbs and Pretty (2008)
Fire Camp program	Zimbabwe	Frost and Bond (2008)
Payment for water-related environmental services	The Netherlands	Groot and Hermans (2009)
Payment for reducing carbon emission	Madagascar	Wendland et al. (2010)
Payment for biodiversity conservation	Cambodia	Clements et al. (2010)
Payment for protection of water quality in the South-to-North Water Diversion project	China	Dong et al. (2011)
Payments for conservation of water quality	Colombia and Germany	Munzo Escobar et al. (2013)
Promoting ecosystem service payments and associated sustainable funding mechanisms in the Danube Basin	Romania and Bulgaria	WWF Danube-Carpathian Programme (2013)
Payment for ecosystem services in Ecuadorian páramo grasslands	Ecuador	Bremer et al. (2014)
Payment for water flow conservation and security assurance in Nima catchment	Colombia	Francisco and Budds (2015)
Payment for conservation of forest ecosystem services	Vietnam	Phan et al. (2017)
Payment for ecosystem services	China	Pan et al. (2017)

will help greater social welfare and boost investment decisions in new technologies and land management practices (Woodbury et al. 2018). At present, countries recruit a wide spectrum of PES methods. Table 1 shows some of these programs.

The primary goal of payments for ecosystem services schemes cannot combat poverty. They provide economic incentives to increase efficiency and sustainability of utilizing ecosystem services (Chen et al. 2020). In planning a PES scheme, there are different mechanisms that can provide a chance for the poor to generate an income from ecosystem conservation. This is important as a part of rural livelihood which is derived from activities linked with natural resources (Matthies et al. 2015). Unsustainable income generation methods are usually considered as short term, but at the same time, they are known to provide limited options for future development. In comparison, PES would provide more sustainable management solutions in the shape of regular payment for ecosystem services. Consequently, we can expect the PES-based long-term solutions to provide income and employment for rural people. The amount of investment is always important, though we can expect a considerable increase in income while witnessing sustainability in land management, even with a low investment during a long period if certain measures are taken into account (Farley and Costanza 2010; Lliso et al. 2020). No matter who will directly benefit from PES, its positive effects such as enhanced economic situation and increased production of natural resources will reach other stakeholders as well. Having said that, as communities regulate and support PES mechanisms, they will receive more benefits from services such as flood control, hazard control, and improved water quality as indirect benefits of PES. These schemes have the capacity to be used for designation and identification of property rights and ownership of resources. As PES solutions clearly acknowledge the involvement of environmental advocates, such agreements can be considerable support to rural communities in their environmental debates. To do so, those ecosystem services that provide benefits to rural people and vendors (an individual or a group) should be outlined while planning for a PES scheme (Wunder and Alaban, 2008; Costa, 2011). The first and main solution for the rehabilitation of Urmia Lake is the reduction in agricultural water consumption (Sobhani et al. 2019). This study will try to technically and economically examine the role of PES in managing agricultural water demand in Siminehroud basin (Urmia Lake tributary) which supplies a major share of water to the Lake. This is to provide the water users in the basin with a better understanding about PES scheme to improve agricultural water allocation decision-making procedures, which would ultimately increase water flow to Urmia Lake. In the given context, this study aims to address the following questions:

1. What is the effectiveness of the PES scheme in the form of non-monetary facilities in improving the management measurements of Siminehroud's water resources?
2. How can the effectiveness of the PES scheme in the form of non-monetary facilities help the rehabilitation of Urmia Lake?
3. Among the proposed methods in this study, what is the most appropriate PES scheme to be recruited in the management of Siminehroud's water resources?
4. What is the water cost implication of change in irrigation and cropping patterns in Siminehroud basin in comparison with the values of Urmia Lake's ecosystem services?
5. What is the projection of annual water saving by the implementation of the PES scheme which will flow to the lake?

2 Materials and methods

2.1 Introducing the study site

2.1.1 Urmia Lake basin

The basin of Urmia Lake with a surface area of 52,331 square kilometers is located in the northwest of Iran, between the longitude of 44° 33′ and 47° 52′ and latitude of 35° 39′ and 38° 30′. This is a closed watershed, and all surface and underground waters from the surrounding areas flow into the Lake. Rivers of Zarinehroud, Siminehroud, Mahabad Chay, Gadar Chay, Barandouz Chay, Zola Chay, Shahar Chay, Rozeh Chay, Nazli Chay, Daryan Chay, Adji Chay, Qala Chay, and Soufi Chay are discharged to the Lake. However, their flows are partially extracted for different usages (Jabbarlouye Shabestari 1999). The basin's altitude varies from 1,280 to 3,600 m AMSL, and it is one of Iran's six major basins. Urmia Lake, which is located in the middle of the basin, is the twentieth largest and second most hyper-saline lake in the world and is surrounded by a number of satellite freshwater wetlands. This situation generates a very dynamic and productive ecosystem in the region. Due to its unique characteristics, the Lake is recognized as a Biosphere Reserve by UNESCO (Mokhtarnejad et al. 2016).

2.1.2 Siminehroud river's basin

There are several rivers flowing to the Lake; however, this study was narrowed down to focus on Siminehroud, one of the largest and most important tributaries of Urmia Lake basin.

Siminehroud is located in the southern part of West Azerbaijan Province, in the west of Zarrinehroud river basin. 35% of the total water flowing to the Lake is supplied by Siminehroud and Gadar Chay. The length of the river is 200 km, flowing in a basin of 3500 km^2 including eleven sub-basins (Rezaei Zaman et al. 2014). Figure 2 demonstrates the position of Siminehroud basin in Iran and in Urmia Lake basin.

2.2 Methodology

Without a good understanding of the characteristics of cultivated areas, it will be difficult to utilize its land resources properly. Considering the goal of this study to propose some improvements in the management of agricultural water resources in the basin of Siminehroud, it is necessary to generate a general picture of land uses of the basin and identify surface areas allocated for both irrigated lands and orchards. For this purpose, a land-use map for the basin was generated by analyzing the areal image of Siminehroud basin from Landsat 8 OLI (Operational Land Imager) satellite dated April 8, 2014. To process the areal images and extract the land-use map, we utilized Envi 4.7 and ArcGIS 9.3 software. Because the purpose of areal image processing is to generate practical thematic maps, it is important to select an appropriate classification algorithm. In this context, maximum probability algorithm and support vector machine (SVM) with four different types of kernel including linear, polynomial, radial basis function, and sigmoid are known as extensively reliable methods in classifying remotely sensed imagery (Mountrakis et al. 2011).

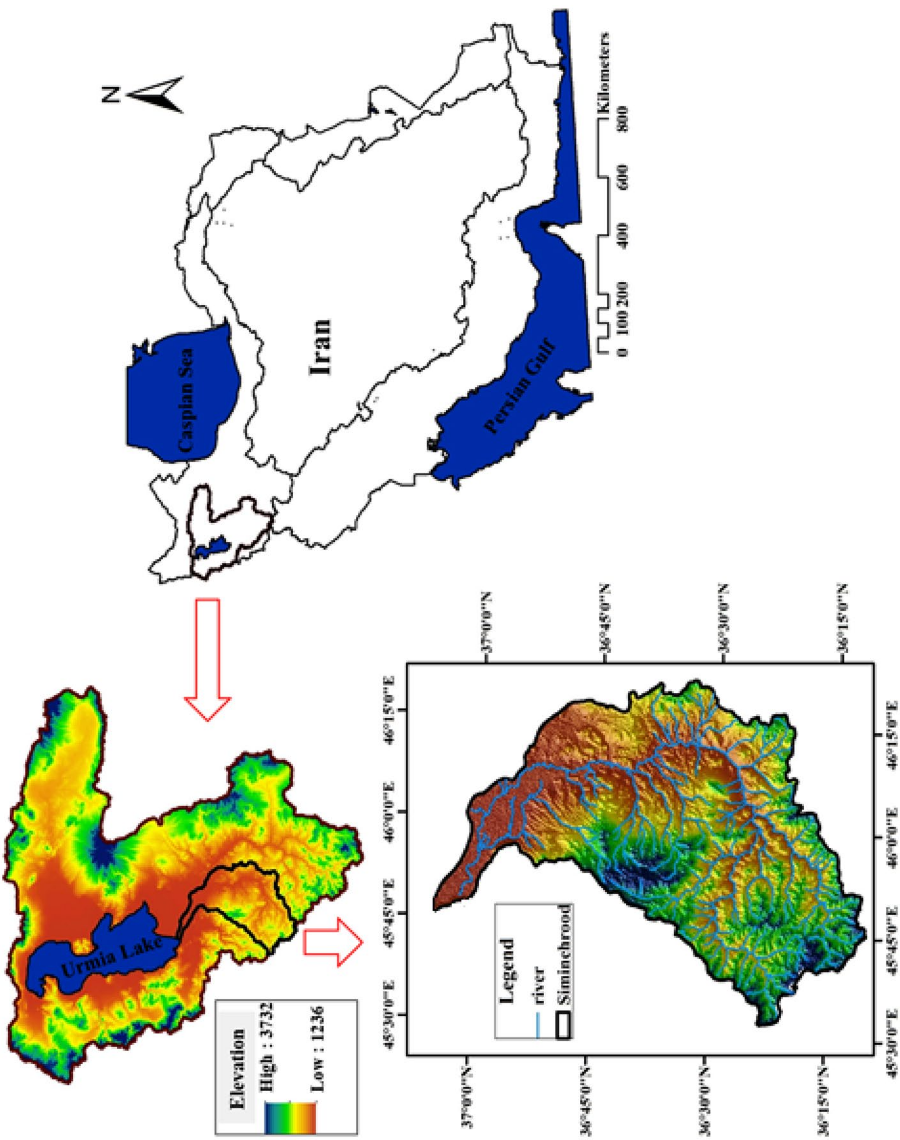

Fig. 2 Location of Siminehroud basin in Iran and Lake Urmia basin

Table 2 The results of image classification by RBF kernel of SVMs

Subject	Maximum likelihood	Support vector machines			
		Linear	Polynomial	Radial basis function	Sigmoid
Kappa coefficient	81	80	89	90	80
Overall accuracy	90	87	93	94	88

Therefore, in this study, by recruiting maximum probability algorithms and support vector machines kernels, we produced the land-use map of Siminehroud basin. Afterward, the most accurate result was determined by comparing different accuracies.

Given that voluntary participation is one of the most important criteria in the PES programs, the level of acceptance by indigenous peoples to use this type of program shows the non-monetary effectiveness of these programs. In addition, to measure the effectiveness of PES programs, their impact on solving the existing problems and their economic justification must be identified (Pagiola et al. 2005). Therefore, this study investigated the level of voluntary participation of indigenous people and the amount of annual water savings through implantation of the PES programs and measuring the economic justification. To justify the economic employability of PES mechanisms in improving irrigation water management, the costs of implementing PES mechanisms should be lower than the value of Lake's water. Therefore, firstly, it was necessary to calculate the economic value of Urmia Lake. For this, we recruited the "Benefit Transfer Method" as well as the results of Brander's study (Brander et al. 2013). In addition, to examine the feasibility of implementing the PES mechanism, a mixed method of interview and questionnaire was conducted (Groot and Hermans 2009; Munoz Escobar et al. 2013). Based on the current study findings from the literature review, a questionnaire was developed including 38 questions in 2 sections: a) general inquiries related to water users and b) inquiries related to the utilization of the PES mechanism. The rural settlers around Siminehroud River were our target group who are the traditional water right holders.[1] At the first stage, we listed all villages with water rights[2] to the River and then identified farmers in these villages. There are twelve thousand one hundred and ten farming households in sixty-six villages who extract water from the River, directly or indirectly. To identify the total sample size, the Cochran formula was used (Eq. 1).

$$n_0 = \frac{Z^2 \mathrm{pq}}{e^2} \tag{1}$$

where n_o is the sample size, z is the selected critical value of desired confidence level, p is the estimated proportion of an attribute that is present in the population, q p = − 1, and e is the desired level of precision. Based on the formula, three hundred seventy-three questionnaires were generated. Considering the distribution and locality of villages in the area, 40 target villages were selected by using the accidental sampling method. After data

[1] The rights to exploit river water in many parts of Iran follow customary laws among local communities. According to this, the villagers divide the water based on their share of land.

[2] The water exploitation of the river is carried out by the water pump, which requires the license of water departments.

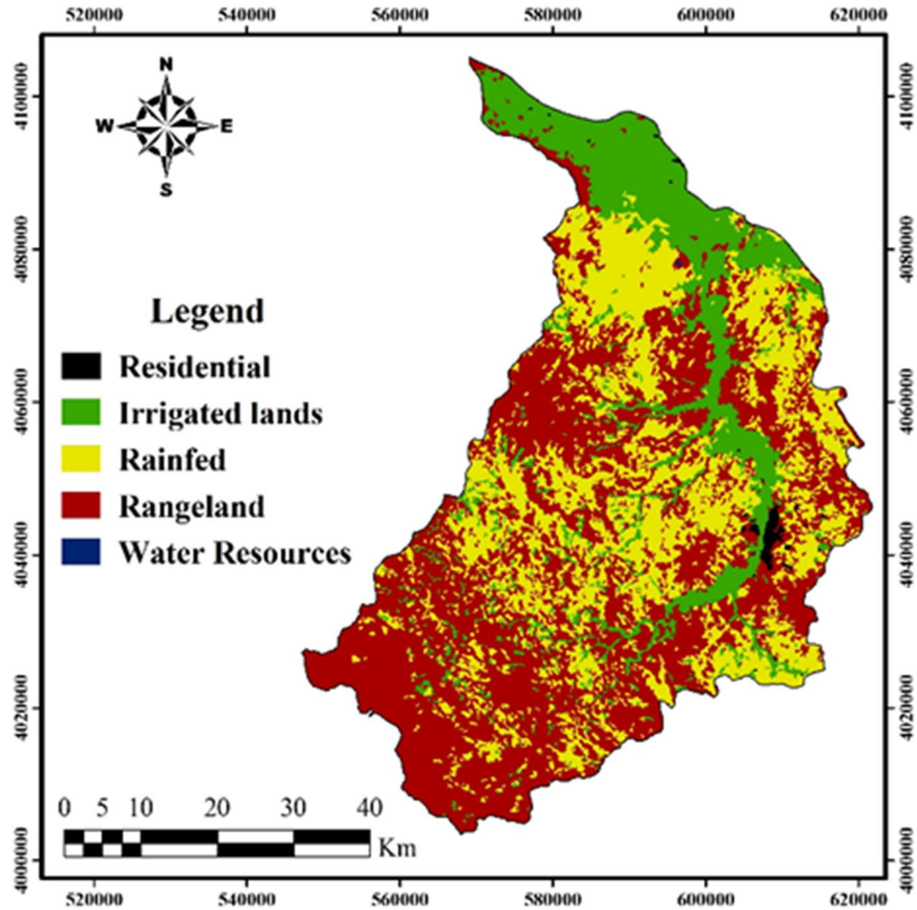

Fig. 3 The land-use map produced by classification method—RBF kernel of SVMs

gathering, the questionnaires were encoded, and then the data were analyzed using SPSS. In this regard, in addition to the descriptive analysis, in order to study the correlation of nominal data with interval data, Pearson chi-square was used. Eta coefficient was used in order to study their correlation intensity. In addition, for assessing the correlation of nominal data and ordinal data, Pearson chi-square was used, and contingency coefficient was used to identify the intensity of their correlation (Thakkar 2020).

3 Results and discussion

3.1 Producing land-use map of Siminehroud basin

In this study, SVM algorithms were utilized to produce the land-use map of the basin maximum likelihood, and considering the share of each level, an adequate number of training samples in the target area were selected after conducting field studies. Overall,

Table 3 The results of the economic valuation of the world's wetlands (Brander et al. 2013)

Variable	Flood control (USD/ha/year)	Water supply (USD/ha/year)	Nutrient recycling (USD/ha/year)	Total value (USD/ha/year)
Mean value	6923	3389	5788	16,100

in Siminehroud basin, five levels of land-use, including residential areas, irrigated croplands, rainfed lands, rangelands, and water bodies, are observed. Therefore, the map was extracted using the ENVI 4.7 software. To compare the classified images and identify an accurate method, the overall accuracy and kappa coefficient were used. The kappa coefficient as a gauge in accuracy assessment of maps for each matrix by calculating diametric and marginal elements disseminates how much the classification method is in line with the real data. In addition, the overall accuracy presents the ratio of accurately classified pixels to the total pixels classified (Mokhtarnejad et al. 2016). The best classification occurs when both overall accuracy and the kappa coefficient are high (Rezaei Zaman et al. 2014). The results showed that among algorithms recruited, the radial basis function (RBF) kernel has the highest kappa coefficient and total accuracy (Table 2). It shows that the surface area calculated by this method for the land uses is of the highest accuracy. Therefore, these results were used to calculate the surface areas for the existing land uses. Figure 3 illustrates the results of image classification with RBF kernel of SVMs.

After classification, the images were imported into the GIS software to calculate different land uses covered in the basin. Figure 2 shows the surface area of identified land uses from the classified image. The areas of different land uses obtained from classified images are as follows: residential area with 1934 hectares, irrigated lands area with 67,210 hectares, rainfed area with 123,387 hectares, rangeland area with 178,397 hectares, and water resources area with 41 hectares.

3.2 Economic valuation of Urmia Lake's ecosystem functions

In this study, the "Benefit Transfer" method was used for the valuation of Urmia Lake. To recruit this method, it is necessary to use valuation results of a similar case study; therefore, some similar results were borrowed from Brander's work (Brander et al. 2013), who calculated the average economic value of fifty-two thousand five hundred and ninety-four wetlands in the world. Among the evaluated functions in this study, three functions, including flood control, water saving, and nutrient recycling, are more highlighted; therefore, to produce the results for this study, these three functions were selected. The results of the valuation for these three functions are shown in Table 3.

To use the results of this study for the valuation of Urmia Lake and to calculate the value for each cubic meter of Lake's water, it is necessary to calculate the total surface area and water volume of the Lake when it is in its highest water level. According to Hosseini and Solatifar (2009) and Mahsafar et al. (2011), in its total surface area of 582,200 hectares, the Lake's total water volume will be 31 billion cubic meters. Therefore, by dividing water volume by surface area, the average water volume of the Lake in each hectare was calculated, which was equal to 0.187 cubic meters. Knowing that the economic value for each hectare of wetland in the world is 16,100 USD, the economic value of water in the lake will be equal to 0.302 USD per year.

Table 4 Impacts of drought in Urmia Lake on life condition of water consumers

The occurrence of the impact	Type of impact	Frequency	Relative frequency (%)
Yes	Saline aerosols	233	58.54
	Underground water depletion	68	17.09
	Salinized soils	80	20.1
	Diseases	4	1
No	–	13	3.27
Total		398	100

3.3 Feasibility of recruiting PES schemes in the form of non-monetary facilities

Two PES mechanisms proposed in this research (changing the irrigation system and changing the crop patterns) are voluntary schemes; therefore, full cooperation of local communities is considered as a key for assuring their successes. In addition, a governmental or non-governmental entity needs to bear the implementation expenses of the project. According to the domestic laws of Iran, the government is the main owner of natural resources and is the owner of all matters relating to the protection and maintenance of it. Also considering the vital role of Urmia Lake in the region, the Iranian government has announced that it welcomes all the plans for restoring Urmia Lake, which have economic justification and can solve the problem of drying the lake. Therefore, the first step is to consider a plan for providing non-monetary facilities in the form of payments to change the irrigation system and change the crop pattern in terms of acceptance by local people. Then, their economic justification will be examined and, finally, the effectiveness of these programs will be examined and compared to reduce agricultural water consumption.

The influence of human activities on local and national ecosystem services is most perceptible. Historically, natural, seminatural, or controlled ecosystems were able to provide ecosystem services to meet the needs of social growth. Nevertheless, the differences between the ability of ecosystems to provide services and human needs are increasingly growing, due to the rapid growth of population. In the past 50 years, 60% of the world's ecological resources have declined due to global population rises and economic growth. Such relationships between the human and ecosystems were generally regulated by resource use and environmental protection policies (Lu et al. 2012). Eventually, spatial–temporal variations in the Urmia Lake networks can decide the exact type of ecosystem service provision from a single restoration step. Considering rehabilitation priorities for Urmia Lake, there is a need for encouraging policy, planning, and practical implementation on conservation programs. In addition, the recovery programs will provide benefits across a variety of environmental services and restore stability and sediment transportation. The restoration processes should restore longitudinal, lateral, and vertical connectivity concerning physical and biological fluxes and highlight the role of upstream catchment and intervention projects. In addition, the rehabilitation programs should identify the key ecosystem services provided by intact and adjusted river ecosystems at catchment scale and the need to involve local communities and other stakeholders in policy development. Socioeconomic facets of social preference need to be matched with incentives for biophysical recovery. In the next step, ecosystem service hot spots should be protected/restored in

Table 5 Frequency distribution of interviewees regarding their tendencies to change the irrigation system

Interested in changing irrigation system	Reason for not being interested	Frequency	Relative frequency (%)
Yes	–	321	91.45
No	Unfamiliarity with the new system	17	4.84
	Low water quality	5	1.42
	Working on rented lands (not having ownership)	4	1.14
	Limitation in the size of the lands	4	1.14
Total	–	351	100

Table 6 Frequency distribution of interviewees regarding their tendencies to change crop pattern

Interested in changing crop pattern	Reason for not being interested	Frequency	Relative frequency (%)
Yes	–	200	50.25
No	Lesser productivity in comparison with current crops	77	19.35
	Unfamiliarity with the new crops and their cultivation	66	16.58
	Unsuccessful previous experiences	37	9.3
	The current crop system is perennial or horticulture	18	4.52
Total	–	398	100

catchments with carefully planned environmental economic and social monitoring to enable mapping and evaluation of ecosystem services.

3.3.1 Effects of Urmia Lake's drought on life condition of water consumers

About 96.73% of interviewees, who were asked about the impacts of drought on their lives, believe that they will be negatively impacted by drought-related factors such as saline aerosols, underground water depletion, salinized soils, and diseases. Among them, the majority (58.54%) named saline aerosols as the most important anticipated phenomena of the Lake's drought (Table 4).

The second question was to examine interviewees' interests in cooperating with the government to stop drought of the Lake. 80.9% of them were interested in cooperation, while 19.1% did not show any interest.

Table 7 The area under cultivation for each crop in Siminehroud basin

Land-use type	Crop type	% cultivated to both total farmland and garden	Cultivated areas in total basin (ha)
Farmland	Wheat	38.19	25,667.50
	Sugar beet	21.15	14,214.92
	Alfalfa	16.76	11,264.40
	Barley	9.34	6,277.41
	Corn	2.47	1,660.09
	Tomato	2.20	1,478.62
	Beans	1.65	1,108.97
	Vegetables	1.10	739.31
Garden	Apple	5.22	3,508.36
	Grape	1.37	920.78
	Peach	0.55	369.65
Total		100	67,210

Table 8 Annual costs for the installation of piped irrigation systems

System type	Annual running cost (USD per ha)	Annual maintenance and repair cost (USD per ha)	Total annual costs (USD per ha)
Sprinkler system	320.51	192.31	128.20
Drip system	416.67	250	166.67

3.3.2 Studying irrigation methods utilized by water users in the study area

The result of the question about irrigation methods used in the target area shows that the majority (83.42%) continue practicing traditional methods (i.e., flooding method, without using piped irrigation system), while only 11.81% completely and 4.77% partially use piped irrigation system in their croplands. In addition, the results indicated that only 13.86% of croplands in the study area are equipped with the piped irrigation system. However, productive use of water by irrigation is becoming increasingly necessary, and alternative methods of application of water such as drip irrigation can contribute substantially to the best use of water for agriculture, increase the yield, and improve benefits of the farmer and the conservation of the environment (Papadopoulos 1996; Tekinel et al. 2002; Sagheb and Hobbi 2002; Sezen et al. 2006; Ou Yang et al. 2013; Fan et al. 2014; Tanaskovik et al. 2016).

3.3.3 Assessing farmers' willingness to utilize piped irrigation systems in case of financial coverage by the government

Among 398 interviewed water users, 351 of them practiced traditional irrigation methods in their croplands, totally or partially. In response to the question about their interests in using the piped system, 91.45% were interested in the proposal if the government

Table 9 The volume of saved water by utilizing piped irrigation systems

Land-use type	Crop type	Annual water demand (m^3/ ha)	Water consumption in traditional irrigation method (m^3/ ha)	Water consumption in piped irrigation method (m^3/ ha)	Reduced amount of water consumption in piped irrigation method (m^3/ ha)
Farmland	Wheat	2730	6825	3640	3185
	Sugar beet	6500	16,250	66/8666	34/7583
	Alfalfa	6850	17,125	33/9133	67/7991
	Barley	1990	4975	33/2653	67/2321
	Corn	4380	10,950	5840	5110
	Tomato	6660	16,650	8880	7770
	Beans	2910	7275	3880	3395
	Vegetables	2740	6850	33/3653	67/3196
Garden	Apple	5910	14,775	67/6566	33/8208
	Grape	5260	13,150	44/5844	56/7305
	Peach	6410	16,025	22/7122	78/8902

supports the replacement financially and technically. Table 5 demonstrates the interest frequency of water users for the change in irrigation system and its reasons.

3.3.4 Studying the interests of farmers to change crop patterns

According to local expert opinions, soybean, rapeseed, and safflower are three crops that farmers are willing to replace their current cropping patterns with. 50.25% of respondents indicated if the government provides inputs (e.g., seeds), they can allocate 70.53% of their lands to new crops. This is equal to 23.81% of total croplands in the study area. Furthermore, 49.75% of respondents did not show any interest to change their cultivated plants. In Table 6, the frequency of answers, as well as reasons for not changing cultivation patterns, is demonstrated.

3.3.5 Economic analyses of utilizing non-monetary facilities

3.3.5.1 Economic analyses of changes in irrigation methods from traditional to the piped irrigation system to manage water resources of Siminehroud basin According to the results of questionnaires, there are 11 agricultural and horticultural species cultivated in the study area. By extending the cultivation ratio of each crop to the total irrigated land-use area of Siminehroud (Table 2), we calculated the area under cultivation for each of the agricultural and horticultural species (Table 7).

To calculate financial aspects of the "payment for change in irrigation system," first, the cost for installing piped irrigation systems should be calculated. According to the information collected from piped irrigation companies, in 2014, the cost of installing a sprinkler irrigation system in farmlands was 3,846.15 USD per hectare, while it was 5,000 USD for installing the dripping system in horticultural lands. The service life of these projects is 30 years. The costs associated with maintenance and repair in these projects are considered about 5% of the initial value of the investment. Therefore, the annual cost of these projects was calculated as demonstrated in Table 8.

In addition, according to the official statistics of Ministry of Agriculture for irrigation efficiency (40% for traditional, 75% for sprinkler, and 90% for drip irrigation systems), the reduction in water usage can be calculated for each crop by utilizing piped irrigation systems (Table 9).

By knowing the annual cost for the installation of piped irrigation systems as well as the volume of saved water by utilizing these systems, we can calculate the costs of reducing one cubic meter of water usage in piped systems (Table 10).

According to Table 3, the cost of installing piped irrigation systems to reduce water consumption per cubic meter for all crops studied in this research is lower than the value of each cubic meter of Lake's water (0.302 USD). However, to calculate the arithmetic average cost of installation, it is necessary to calculate the percentage of lands allocated to cultivate each crop in the total area of irrigated and horticultural lands in the basin (Table 7).

Therefore, having considered the percentage of cultivation area for each crop, the average cost of installing piped irrigation systems to reduce 1 cubic meter of water usage is 0.076 USD. Assuming that the crop production is the same for both traditional and piped irrigation systems, and considering the value of each cubic meter of Urmia Lake's water, the benefit–cost ratio of this project is 3.98, which is financially justifiable. This is despite the fact that the residual value of these systems had to be ignored due to the lack of

Table 10 The utilization cost of piped irrigation systems for reducing 1 m^3 of irrigation water

Land-use type	Crop type	Cost for the installation of piped irrigation system (USD/ha)	Implementation cost of piped irrigation system per cubic meter of water (USD)	Volume reduced in water consumption by using piped irrigation systems (m^3/ha/year)
Farmland	Wheat	320.51	0.101	3185
	Sugar beet	320.51	0.042	7583.34
	Alfalfa	320.51	0.040	7991.67
	Barley	320.51	0.138	2321.67
	Corn	320.51	0.063	5110
	Tomato	320.51	0.041	7770
	Beans	320.51	0.094	3395
	Vegetables	320.51	0.100	3196.67
Garden	Apple	416.67	0.051	8208.33
	Grape	416.67	0.057	7305.56
	Peach	416.67	0.047	8902.78

Table 11 Total reduction in water consumption for different crops in Siminehroud basin

Land-use type	Crop type	Area under cultivation in the basin (ha)	Volume reduced in water consumption by using piped irrigation systems (m^3/ha)	Total reduction in water consumption for each crop in the basin (m^3)
Farmland	Wheat	25,667.50	3185	81,750,987.5
	Sugar beet	14,214.92	7583.34	10,779,671.43
	Alfalfa	11,264.4	7991.67	90,021,367.55
	Barley	6277.41	2321.67	14,574,074.47
	Corn	1660.09	5110	8,483,059.9
	Tomato	1478.62	7770	11,488,877.4
	Beans	1108.97	3395	37,649,531.15
	Vegetables	739.31	3196.67	2,363,330.10
Garden	Apple	8208.33	8208.33	2,897,776.64
	Grape	7305.56	7305.56	6,726,813.54
	Peach	8902.78	8902.78	3,290,912.63
Total	–	67,210		359.58724.31

Table 12 The cost of seed for oil crops per hectare

Crop	Price per 1 kg (USD)	Amount used per hectare (kg)	Cost of supplying seed per hectare (USD)
Rapeseed	1.54	8	12.32
Soybean	1.54	115	177.1
Safflower	1.38	25	34.5

Table 13 Net annual profit for oil crops per hectare

Crop type	Mean of crop yield (ton/ha)	Price per kilogram (USD)	Total cost (USD)	Total profit (USD)	Net profit (USD)
Rapeseed	2.2	0.73	642.4	1606	963.6
Soybean	2.5	0.67	670	1675	1005
Safflower	0.9	0.65	234	585	351

Table 14 Net annual profit from the cultivation of regular crops in the basin

Crop type	Mean of crop yield (ton/ha)	Price per kilogram (USD)	Total profit (USD)	Total cost (USD)	Net profit (USD)
Sugar beet	64.45	0.081	5,205.577	2,082.231	3,123.346
Alfalfa	8.92	0.135	1,200.769	480.308	720.461
Corn	14.42	0.3	4,326	1,730.4	2,595.6
Tomato	43.46	0.097	4,178.846	1,671.538	2,507.308

accurate data. If we could use the data to calculate the residual value, the ratio would have been much bigger. In Table 11, the total reduced volume of water consumption across the croplands of Siminehroud basin by utilizing piped irrigation systems is demonstrated.

The results of Table 11 show that by changing the irrigation pattern in Siminehroud's entire basin, there will be a 359,058,724.31 m3/year reduction in water consumption. Considering 13.86% of basin's cropland, which is already equipped with piped irrigation systems, the remaining 86.14% (equal to 57,894,69 ha) of the cropland can save 309,293,185,12 m3/year of water by installing the system. Furthermore, according to the results of our field interviews, the respondents are interested in changing irrigation patterns in 91.45% of remaining areas (equal to 52,944.69 ha) in which traditional irrigation methods are still being practiced. In this condition, it is possible to save 283 million m3 (equal to 282,848,617.79 m3), which could be allocated to the Urmia Lake. According to Table 9, about 92.86% of the irrigated lands in the basin are farmlands and 7.14% are horticultural lands. Therefore, in about 49,164.44 ha of farmlands and 3,780.25 ha of horticultural lands in total, the piped irrigation system can be installed. Considering that the sprinkler system is only used for farmlands with an initial installation cost of 3,846.15 USD and the drip system is used for horticulture with initial installation costs of 5,000 USD, the required initial budget for the installation of these systems across the basin is about 208 million USD (exactly 207,995,061.9 USD).

Table 15 Comparing the profit of oil crops with regular cultivations

Crop type	Difference with rapeseed profit per hectare	Difference with soybean profit per hectare	Difference with safflower profit per hectare
Sugar beet	2,159.746	2,118.346	2,772.346
Alfalfa	−243.139	−284.539	369.461
Corn	–	–	2,244.6
Tomato	1,543.708	1,502.308	2,156.308

Table 16 Average water consumption for different crops in Siminehroud basin

Land use	Crop type	Annual water demand (m^3/ha)	Water consumption in traditional system (m^3/ha)	Water consumption in piped system (m^3/ha)	Average water consumption (m^3/ha)
Farmland	Wheat	2,730	6,825	3,640	6,383.56
	Sugar beet	6,500	16,250	8,660.66	15,198.94
	Alfalfa	6,850	17,125	9,133.33	16,017.35
	Barley	1,990	4,975	2,653.33	4,653.21
	Corn	4,380	10,950	5,840	10,241.75
	Tomato	6,660	16,650	8,880	15,573.09
	Beans	2,910	7,275	3,880	6,804.45
	Vegetables	2,740	6,850	3,653.33	6,406.94
Garden	Apple	5,910	14,775	6,566.67	13,637.32
	Grape	5,260	13,150	5,844.44	12,137.45
	Peach	6,410	16,025	7,122.22	14,791.07

3.3.5.2 Economic analyses of changing crop patterns to manage water resources in Siminehroud basin In this study, based on consultations with agricultural experts, soybean, safflower, and rapeseed were selected as suitable replacements with current crops to be introduced to the interviewees. According to the responses, it is possible to change cropping patterns in 23.81% of the agricultural lands in the basin. According to the Ministry of Agriculture, the annual water demand for soybean and rapeseed is 5,000 m^3/ha and for safflower is 3,250 m^3/ha. As indicated in Table 9, there are only three crops (tomato, sugar beet, and alfalfa) that consume more water than soybean and rapeseed; therefore, these two latter plants can be replaced with three earlier crops. According to Table 7, about 40.11% of croplands in the basin are allocated to sugar beet, alfalfa, and tomato (26,957.93 ha), which can be replaced by soybean and rapeseed.

As for safflower, there are only four crops with higher water demand, including sugar beet, alfalfa, corn, and tomato. These four crops cover 42.58% of cultivated lands in the basin (equal to 28,618.02 ha). In proposing cropping pattern change as a PES scheme to the farmers, supplying seeds of newly proposed crops should be taken into account. Therefore, the cost of supplying seeds per hectare can be calculated (Table 12).

To successfully implement PES schemes, the government should bear the implementation costs; therefore, in addition to the cost of the seeds of new crops, any payment to the farmers to compensate any reduction in their income due to cultivation of these new crops

Table 17 Required budget to reduce water consumption (per cubic meter) for rapeseed

Crop type	Reduced volume of water consumption per hectare if replaced by rapeseed (m^3)	The cost of replacement by rapeseed per hectare (USD)	The cost of reduction in water consumption per each cubic meter if replaced by rapeseed (USD)
Sugar beet	2698.94	1134.23	0.420
Alfalfa	3517.35	1134.23	0.322
Tomato	3073.09	1134.23	0.369

Table 18 Required budget to reduce water consumption (per cubic meter) for soybean

Crop type	Reduced volume of water consumption per hectare if replaced with soybean (m^3)	The cost of replacement with rapeseed per hectare (USD)	The cost of reduction in water consumption per each cubic meter if replaced with soybean (USD)
Sugar beet	2698.94	1257.61	0.466
Alfalfa	3517.35	1257.61	0.357
Tomato	3073.09	1257.61	0.409

Table 19 Required budget to reduce water consumption (per cubic meter) for safflower

Crop type	Reduced volume of water consumption per hectare if replaced with safflower (m^3)	The cost of replacement with rapeseed per hectare (USD)	The cost of reduction in water consumption per each cubic meter if replaced with safflower (USD)
Sugar beet	7073.94	1798.60	0.254
Alfalfa	7892.35	1798.60	0.228
Corn	2116.75	1798.60	0.850
Tomato	7448.09	1798.60	0.241

should also be taken into account. For this reason, the net profits from cultivating four regular species including sugar beet, alfalfa, corn, and tomato as well as oil plants were calculated. Afterward, by deducting 40% of the gross profit for any crop (in 2014), the net profit for each crop can be calculated (Tables 13 and 14). By comparing the net profit of three oil crops with four regular ones (Table 15), it is clear that the profit from the oil crops is considerably lower than that of the four regular crops. The profits of rapeseed and soybean are higher, and the profit of safflower is lower than that of alfalfa as well.

In total, based on the area coverage of each crop in the basin (Table 7), the average profit loss for replacing rapeseed with regular crops, soybean, and safflower is calculated to be 1,121.91 USD/ha, 1,080.51 USD/ha, and 1,764.1 USD/ha, respectively. By taking into account the costs of cultivation for new crops (Table 12) and the average profit loss by cultivating these crops, the total replacement cost of rapeseed, soybean, and safflower will be 1,134.23 USD/ha, 1,257.61 USD/ha, and 1,798.6 USD/ha, respectively.

Now the amount of saved water in case of cultivating new crops should be calculated. Considering the irrigation efficiency, which is 40% in traditional methods, the water consumption for rapeseed and soybean is 12,500 m^3 and for safflower is 8,125 m^3. According to the Ministry of Agriculture, the water efficiency of traditional irrigation methods, sprinkler irrigation, and dripping irrigation is 40%, 75%, and 90%, respectively. On the other side, based on the results of the questionnaire, only in 13.86% of currently cultivated lands, the piped irrigation systems are utilized, and in the entire 86.14%, traditional irrigation is practiced. Therefore, by calculating the arithmetic average between water consumption in traditional and piped systems, the average water consumption for each crop is calculated (Table 16).

The next step is to calculate the saved water volumes for oil cropping replacement based on the average water consumption for the regular crops (Table 16). Taking into account the total cost for the replacement of oil crops per hectare, the required budget to reduce one cubic meter of irrigated water for these three crops can be calculated (Tables 17, 18, and 19). These calculations are based on the assumption that after changing the cropping pattern, we still practice traditional irrigation systems.

Considering the area covered by sugar beet, alfalfa, corn, and tomato cultivation across the basin (Table 7), the average cost per cubic meter to reduce water consumption in case of replacing sugar beet, alfalfa, and tomato with rapeseed is 0.377 USD and with soybean is 0.417 USD. In addition, the cost of replacing safflower with sugar beet, alfalfa, corn, and tomato is 0.278 USD. Considering the value of Urmia Lake, the benefit–cost ratio for rapeseed is 0.8, for soybean is 0.72, and for safflower is 1.09. Therefore, the cropping pattern change for safflower is financially justifiable.

Knowing that out of 67,210 ha of cultivated lands in the basin, 42.58% (equal to 28,618.02% ha) are cultivated by sugar beet, alfalfa, and tomato, only in these areas we can expect a change in cropping pattern to safflower. On the other side, based on the analyzed data from the questionnaires, those farmers who cultivate sugar beet, alfalfa, corn, and tomato are willing to change their cropping pattern in only 33.22% (equal to 9,506.9 ha) of the farmlands. Given the required budget for replacing safflower in each hectare (Table 19), the overall cost of this replacement in the whole basin will be 17,099,120.37 USD. This change in cultivation pattern will help to save up to 67,763,746.29 m3 water per year (Table 20).

3.3.5.3 Correlation analysis of demographic characteristics of water users with their willingness to accept PES solutions In this section, the correlation of demographic character-

Table 20 Total reduction in water consumption by changing the cropping pattern to safflower in Siminehroud basin

Crop	Area under cultivation that can be replaced with safflower in the entire basin (ha)	Volume of reduction in water consumption per hectare by changing the cultivation to safflower (m^3)	Volume of reduction in water consumption in the entire basin by changing the cultivation to safflower (m^3)
Sugar beet	4,722.19	7,073.94	33,404,488.72
Alfalfa	3,742.03	7,892.35	29,533,410.47
Corn	551.48	2,116.75	1,167,345.29
Tomato	491.2	7,448.09	3,658,501.81
Total			67,763,746.29

Table 21 Correlation of demographic characteristics of water users with the willingness to change the irrigation system

Demographic characteristics of water users	Pearson chi-square amount	Level of significance
Age	226.1	0.000**
Education level	10.816	0.013*
Owned cultivation areas	218.6	0.000**
Total income	120	0.000**

Table 22 Correlation intensity between demographic characteristics of water users with willingness to change the irrigation system

Demographic characteristics of water users	Eta coefficient	Agreement coefficient
Age	0.025	–
Education level	–	0.173
Owned cultivation areas	0.332	–
Total income	0.146	–

Table 23 Correlation of demographic characteristics of water users with the willingness to change the cropping pattern

Demographic characteristics of water users	Pearson chi-square amount	Level of significance
Age	88.66	0.004**
Education level	6.01	0.111
Owned cultivation areas	110.10	0.000**
Total income	64.48	0.002**

Table 24 Correlation intensity of demographic characteristics of water users with the willingness to change the cropping pattern

Demographic characteristics of water users	Eta coefficient	Agreement coefficient
Age	0.061	–
Education level	–	0.122
Owned cultivation areas	0.062	–
Total income	0.084	–

istics of water users, including age, education, owned cultivated areas, and total income, with the willingness to accept non-monetary facilities was assessed. As demonstrated in Table 21, there is a 99% correlation between the willingness of accepting the change in irrigation systems and the variables of age, total cultivated lands, and total income. However, in total, the intensity of this correlation (according to Table 22) for the cultivated areas has a higher value. In addition, a 95% correlation between their willingness and educational level was found.

Additionally, there is a 99% correlation between willingness to change cropping patterns with age, cultivated land ownership, and total income variables (Table 23), but in total, the intensity of these correlations (according to Table 24) was considerably low. Moreover, there is no correlation between willingness to change the cropping pattern and the educational level.

4 Conclusion

This study tried to introduce PES as a modern and efficient tool to manage the water resources of Siminehroud River basin. Although the practical benefits and success stories of PES mechanism in reducing poverty are being advocated, it is important to acknowledge that such a scheme is not a solution for every problem. In recent years, PES has been at the center of attention for policymakers, and this solution has provided considerably positive results. It seems PES, more than other tools, provides economic incentives to better utilize ecosystem services. Therefore, PES is only able to portrait the financial resources required for a household whose life is dependent on resources. It is very important to announce that it is not possible to employ PES mechanisms everywhere. For example, in situations where corruption rate is high or there are debates on the ownership rights, it is quite difficult to implement any PES mechanisms. In such conditions, on the one hand, the buyers of ecosystem services would be reluctant to get fully engaged because of the uncertainty about the results of activities that they have paid for. On the other hand, if the contracts are not strong enough, the ecosystem services providers would feel that their rights on resources are not considered, or there are possibilities of conflict, or they will not receive enough benefits. These are only a few challenges and aspects of risks imposing PES deals in rural communities.

In this study, we suggested two PES mechanisms to the water users, including payment for changing irrigation systems and payment for changing crop patterns, to manage agricultural water in Siminehroud watershed. According to the results, the water users welcomed both schemes. Economic analyses showed that the change in irrigation systems has a high economic justification. Nevertheless, considering cultivation pattern change, the only justifiable crop is safflower. It should be kept in mind that the proposed change can only occur in a very limited area of the entire river basin and, therefore, the water volume saved by this change is very low. In the meanwhile, the implementation of the change in the irrigation system can cover more areas and results in more water saving. Overall, the best economically wise solution for water resources management in Siminehroud basin is to first change the irrigation system from traditional methods to piped irrigation and afterward, where possible in the croplands, change the cultivation pattern to safflower. It should be noted that both schemes need high financial support from governmental resources, but as the results of this study confirm, since the economic value of Urmia Lake is much higher than the costs of changing irrigation systems and cultivation patterns, such an investment is reasonable. This issue is relevant since the social benefits obtained by mitigating the environmental impacts are represented by the recovery of the volume of water in Lake Urmia. Particularly, it can be achieved in many ways, including new taxes, increasing tax rates, funds, financing of a tax change, tax-efficient way of financing, interest as higher withholding tax rates, etc. It should be mentioned that this study only assessed three main economic functions of Urmia Lake among many others. If there was a possibility to consider other unique functionalities of the Lake such as Artemia production, the economic value of it would have been much higher.

Another important point about this study is that despite some other solutions for the rehabilitation of the Urmia Lake such as direct payment to the farmers to suspend cultivating their lands, the proposed solutions in this paper create no barrier for the continuation of cropping activities and there will be no risk of unemployment. However, if these solutions are not utilized under a good management act, they will increase the extraction of water from ground resources to expand cultivation in non-irrigated lands. Moreover, in changing the cultivation pattern, we should not replace crops like wheat with the oil crops even though they have much less water demand than wheat. Experts believe that rapeseed oilseed cultivation is essential for sustainable wheat production because it helps strengthen the soil, reduce pests and diseases, improve water use, and ultimately increase wheat production. The continuous cultivation of wheat in arable lands reduces the growth potential of lands and significantly reduces wheat production. To prevent this process, another crop should be considered in the rotation of wheat for alternative cultivation. Scientific studies (Hassanzadeh et al. 2012; Huang et al. 2019; Neshati Rad et al. 2014) show that rapeseed oil is the best type of product in this area. Overall, it can be argued that the implementation of different PES mechanisms to manage water resources in Siminehroud basin results in higher efficiency, and they can be successfully implemented. These results are in accordance with the findings of Turpie et al. (2008), Farley and Costanza (2010), Bremer et al. (2014), and Francisco and Budds (2015).

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Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflict of interest.

Human and animals rights This research does not involve any human participants or animals.

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