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Assessing the learning capacity of water users – Adoption a social learning framework

Saman Moghimi Benhangi[a,b], Ali Bagheri[a,b,c,*], Leili Abolhassani[d], Hassan Hamidi Razi[a]

[a] Department of Water Engineering and Management, Tarbiat Modares University, Tehran, Iran
[b] Research Institute for Water Engineering and Management, Tarbiat Modares University, Tehran, Iran
[c] Department of Interdisciplinary Science and Technology, Tarbiat Modares University, Tehran, Iran
[d] Department of Agricultural Economics, Ferdowsi University of Mashhad, Iran

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ABSTRACT

Adaptive water governance systems are underpinned by enhanced social learning capacity of the society of actors to understand and adapt to changes properly. Thus, as a first step, it is crucial to assess the learning capacity of water actors in different levels, as human components of a socio-ecological system (SES), to know how to improve the water resources system adaptive capacity. Aiming at practicing assessment of learning capacity in a society of water actors, the present paper focuses on local water users, one the society of farmers using the groundwater resource in Rafsanjan Plain and the other one the society of farmers in Lakes Tashk-Bakhtegan Basin, both situated in the southern Iran. A methodological framework was developed and adopted to assess the learning capacity of water users corresponding to both the process of learning (represented by social justice, perception of interdependency, mutual trust, and interaction among all stakeholders) and the learning outcomes (including width, direction, depth and orientation of learning). The required data were collected using semi-structured interviews. The results showed how the responses of the local water users are affected by the mechanisms which are rooted in the social memory, technology, path dependency, and the degree of access to water. Although most of the researchers have addressed the social learning to have positive and constructive outcomes, the results of this research revealed the process of social learning resulted in neutral and destructive outcomes among water users in the study areas. Assessment of learning capacity in the water associated societies, using the methodological framework developed in this research, can help set off removing learning barriers and enhancing the socio-ecological system adaptive capacity.

1. Introduction

Social learning has been acknowledged and emphasized by researchers in recent decades as a fundamental feature of water governance, aiming at using past experiences to perceive changes and deal with future challenges (Blackmore, 2007; Coudel et al., 2011; Folke et al., 2005; Gupta et al., 2010; Muro and Jeffrey, 2008). Developing the social learning theory, Bandura (1977), Bandura (1986), Bandura (2001) believed that learning takes place as individuals interact with each other in an environment by direct observation of one another's actions. The process leads to new knowledge, shared understanding, trust, and finally collective actions (see *e.g.* Armitage et al., 2009; Craps et al., 2003; Daniels and Walker, 1996; Lebel et al., 2010; Maarleveld and Dabgbégnon, 1999; Mostert et al., 2007; Pahl-Wostl et al., 2008; Reed et al., 2010; Rist et al., 2006; Saarikoski, 2000; Schusler et al., 2003; Steyaert and Jiggins, 2007; Wenger, 1998; Wilner et al., 2012). This type of learning can enhance the performance and outcomes of the water governance regime through an innate shift, especially towards adapting to external stresses and destructive changes after disasters such as drought, flood and climate change (Folke et al., 2005; Gupta et al., 2010; Keen et al., 2005).

Many researchers have evaluated water associated systems from the lens of social learning for the purpose of enhancing the resilience and adaptive capacity of the societies to deal with social and environmental changes (Furman, 2010; Halbe et al., 2013; Pahl-Wostl et al., 2007; Pelling et al., 2008; Yeo, 2006). While social learning is known as a capacity of societies in terms of a form of learning which occurs through interaction within various social groups in different levels confronting changes (Lebel et al., 2010; Mostert et al., 2007; Pahl-Wostl et al., 2008; Schusler et al., 2003), it is, by all means, the accumulative result of a process of collective actions which usually lead to enhanced social and environmental outcomes (Armitage et al., 2009; Cheng and Mattor,

* Corresponding author at: Department of Water Engineering and Management, Tarbiat Modares University, Tehran, Iran..
E-mail addresses: ali.bagheri@modares.ac.ir (A. Bagheri), l.abolhasani@um.ac.ir (L. Abolhassani).

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2010; Craps et al., 2003; Cundill and Rodela, 2012; Dale, 1989; Daniels and Walker, 1996; Maarleveld and Dangbegnon, 1998; Reed et al., 2010; Rist et al., 2006; Saarikoski, 2000; Steyaert et al., 2007; Wenger, 1998; Wilner et al., 2012). The key features of a social learning process are learning from others through interactions, learning from past experiences to confront changes, and devising responses to adapt to changes, which is normally expected to bring improved outcomes.

Learning in social groups has been relied on social interactions as a core capability in order to facilitate and enhance the procedure of collective problem-solving (Craps et al., 2003; Cundill, 2010; Furman, 2010; Kumler and Lemos, 2008; Maarleveld and Dabgbégnon, 1999; McCarthy et al., 2011; Mostert et al., 2007; Nykvist, 2014; Rist et al., 2006; Scholz et al., 2014; Sol et al., 2013; Wallis et al., 2013). Researchers have assessed social learning in formal water organizations – which is mostly referred to as organizational learning – as well as in different informal groups of water actors. Assuming that social learning is more than just to be considered as a process or state, researchers in the field of water governance believe that it is a crucial attribute of adaptive capacity of the water governance system. Thus, frameworks, tools, and indicators have been developed for profound assessment of social learning as a crucial aspect of the problem-solving procedure (Bettini et al., 2015; Hayward et al., 2007; Huntjens et al., 2011; Johannessen and Hahn, 2013; Lee and Krasny, 2015; Medema et al., 2015; Mian, 2014; Mitchell, 2013; Pahl-Wostl, 2009; Peszko, 2014; Svennefjord, 2015; Vinke-de Kruijf et al., 2014). Mostert et al. (2007) argued that the social learning in the context of natural resource management field of study is founded upon three pivotal ideas: 1) in order to utilize all the resources and knowledge, all stakeholders must get involved in the natural resource management and therefore, proactively cooperate purposely and effectively; 2) natural resource management should obtain a form of organization allowing cooperation and facilitating decision-making which forges a strong long-term relationship between all stakeholders; 3) above all, natural resource management is a learning process which continuously develop stakeholders' knowledge and skills necessary to tackle and adapt to natural resources' problems in the world of uncertainties. Skoog (2005), Sokile et al. (2005), and Svennefjord (2015) have suggested to assess how changes are managed in a water governance regime as a means of assessing the social learning capacity of a water associated system.

While water resources are directly influenced by consumptive behaviors of water users, a large number of research projects in social learning have been devoted to the other water actors in the organizational and policy making levels. a few researchers analyzed social learning in the local societies (such as farmers or citizens) in terms of their interactions with formal water organizations (see *e.g.* Johannessen and Hahn, 2013; Maarleveld and Dabgbégnon, 1999; McCarthy et al., 2011; Mostert et al., 2007). In most research, the capability of learning has been known as a system capacity crucial to overcome and adapt to environmental changes such as drought, flood, climate change, etc. (Bettini et al., 2015; Huntjens et al., 2012, 2011; Johannessen and Hahn, 2013; Lee and Krasny, 2015; Mian, 2014; Mitchell, 2013; Pahl-Wostl, 2009; Reed et al., 2010). Therefore, the results of the social learning evaluation in the actual cases can be associated to their adaptive capacities to environmental changes (Folke et al., 2005; Gunderson and Light, 2006; Reed et al., 2010). Social learning is a means to analyze and enhance the current natural (hydrological and geographical conditions) and social (governance, cultural and economic systems) contexts affected by a pressure or change (Mostert et al., 2008). For this reason, identification and understanding of the changes that have affected the ecological system is the first step.

In addition to those researchers who have evaluated social learning as a general concept (*e.g.* Wallis et al. (2013)), other researchers have addressed various aspects of social learning applying different approaches. Overall, we categorize those different approaches into two categories. In the first approach, the frameworks are adopted which underline processes and features underpinning social learning (Bouwen and Taillieu, 2004; Brummel et al., 2010; Cheng and Mattor, 2010; Davidson-Hunt, 2006; Kendrick and Manseau, 2008; Maarleveld and Dangbegnon, 1998; Schusler et al., 2003; Standa-Gunda et al., 2003). Such frameworks correspond social learning to the processes which affect the results; in this way, social learning can be known as a precondition to shape conditions/changes in the future. *Such processes shape or transform social entities' (such as actors, institutions, organizations, etc.) identity from various aspects such as knowledge and awareness, trust, inter-dependency, etc., in the social environment* (Mostert et al., 2008; Pahl-Wostl et al., 2007). Flow variables corresponding to change in the actors' collective actions and their interaction with the environment, are used to represent the process nature of social learning. Accumulation of the flow variables will form the state of learning capacity in the society (Cundill and Rodela, 2012; Vinke-de Kruijf, 2015). There is a variety of flow variables in the literature to assess social learning as a process, among which *mutual trust*, *perception of interdependency*, *social justice*, and *stakeholders' interactions* are the most frequent variables cited in the literature (see *e.g.* Cundill, 2010; Johannessen and Hahn, 2013; Kumler and Lemos, 2008; Mostert et al., 2008, 2007; Nykvist, 2014; O'Donoghue, 2007; Wals, 2007).

The other approach embraces the frameworks which address social learning as the system outcomes or performance (Collins et al., 2007; Dedeurwaerdere, 2009; Kroma, 2006; Lebel et al., 2010; Leys and Vanclay, 2011; Maurel et al., 2007; Nerbonne and Lentz, 2003; Pahl-Wostl and Hare, 2004; Pollard and Du Toit, 2007). Assuming that social learning ultimately ends with behavioral and state changes, the second group of frameworks defines social learning outcomes as *achieved results such as changes in the system performance, structural changes in institutions, improving socio-ecological systems, coming to a shared vision by the stakeholders as a basis for collective actions, or generally changing the features and variables characterizing the system performance* (de Kraker et al., 2011; Diduck, 2010; Keen et al., 2005; van der Wal et al., 2014). The variables which represent social learning outcomes correspond to the changes that have been consolidated in the system (Craps et al., 2003; Furman, 2010; Hayward et al., 2007; Lee and Krasny, 2015; McCarthy et al., 2011; Medema et al., 2015; Rist et al., 2006; Sol et al., 2013; Svennefjord, 2015; Vinke-de Kruijf et al., 2014). To assess the level and quality of social learning outcomes, most research has applied the concept of learning loops representing the depth of institutional changes (Bettini et al., 2015; Brown, 2000; Craps et al., 2003; Furman, 2010; Göransson, 2010; Hayward et al., 2007; Huntjens et al., 2011; Johannessen and Hahn, 2013; Lee and Krasny, 2015; Maarleveld and Dabgbégnon, 1999; Mian, 2014; Mitchell, 2013; Pahl-Wostl, 2009; Peszko, 2014; Svennefjord, 2015). In addition to the learning loops, few studies have suggested other variables in order to examine further characteristics of social learning outcomes (McCarthy et al., 2011; Nykvist, 2014; Scholz et al., 2014; Vinke-de Kruijf et al., 2014) such as the *width* of learning, which associates to the learning in an individual or a collective level (van der Wal et al., 2014; Vinke-de Kruijf et al., 2014), *direction* of learning, representing the impact of learning processes on interactions among actors (Scholz et al., 2014; Schusler et al., 2003; Vinke-de Kruijf et al., 2014), and *orientation* of learning, indicating whether the social learning outcome has been constructive, neutral or destructive.

Under the context of socio-ecological systems, social learning is considered as an innate, repetitive and trial-and-error process influencing the system performance and defining the variables whose outcomes would appear as enhancing the flexibility and adaptability of societies to changes (Armitage et al., 2008; Plummer and FitzGibbon, 2007; Wenger, 2000; Wilner et al., 2012).

Nevertheless, the dynamics of social learning within a water user society still needs further methodological evaluations. Aiming at developing a methodological framework to assess social learning in the level of water users, the present paper searches to determine the components of social learning framework such as attributes, aspects, variables and indicators. Adopting an ex-post assessment approach, the

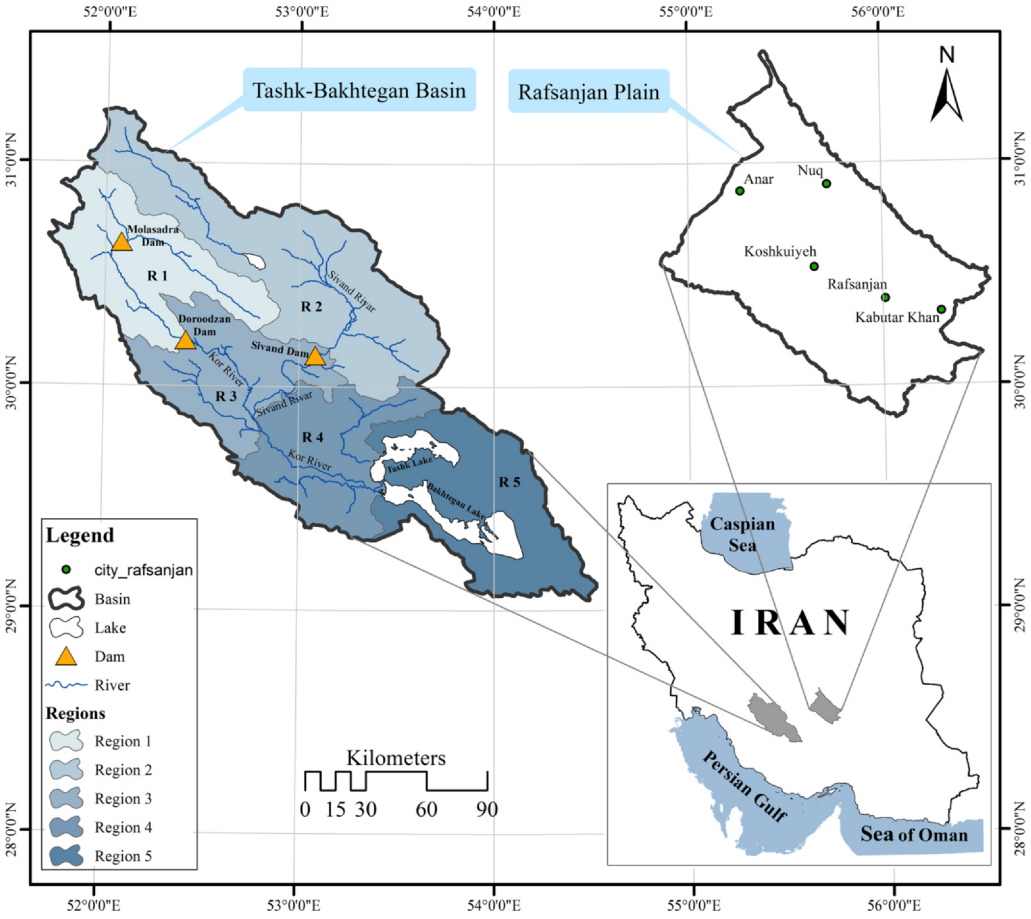

Fig. 1. The locations of study areas.

paper will illustrate the learning capacity of water users' societies in two case studies – one the society of farmers using the groundwater resource in Rafsanjan Plain and the other one the society of farmers in Lakes Tashk-Bakhtegan Basin, both situated in the southern Iran – in terms of assessing the responses of the local water actors to historical changes in the water availability. The methodology developed in this paper could be useful in assessment of social learning capacity among the societies of water actors in a local level.

2. The study areas

Two case studies have been investigated in this research. The first study area is the Rafsanjan plain (Fig. 1) located in Kerman Province in the South-eastern Iran. The only source of water in that area is groundwater resource over 90% of which is abstracted for agricultural purposes. Suffering from a chronic problem of groundwater table drawdown since 1970s, the area relies solely on pistachio agriculture as its dominant economy. The problem has been intensified during the recent decades by periodic droughts. The problem is not limited to merely dramatic depletion of the local groundwater resource, but it has also resulted in other serious environmental consequences such as water and soil salinity and land subsidence.

The other study area is the Lakes Tashk-Bakhtegan basin (Fig. 1) which lies in the north of Fars Province in the Southern Iran. It consists of two lakes of Tashk and Bakhtegan fed from both surface and ground water resources. About 95% of the basin water resource is consumed in the agricultural sector, with wheat as the main crop, and rice and pistachio as well. The persisting droughts (2000–2011), especially the extreme drought in 2008, along with exploitive pressure of agricultural sector, have led Tashk and Bakhtegan Lakes to dry up for the past decade.

There are similarities between those two areas including high share of water consumption by the agricultural sector with often single-crop farmlands, almost identical climatic conditions, and being affected by an overarching formal water institution and organizations. However, the two areas are different in terms of distinctive water withdrawal practices, types of agricultural products, and types and natures of the environmental changes imposed on the local water resources systems.

Having a common aquifer, the Rafsanjan plain was assessed within the administrative boundaries which include the cities of Rafsanjan (central), Nuq, Koshkuiyeh, Anar and Kaboutar Khan. Based on the hydrological and hydrogeological boundaries in accordance with local developmental mechanisms, the Lakes Tashk-Bakhtegan basin was divided into five sub-basins or assessment Regions (Fig. 1). Region 1 covers the sub-basin ending to Droodzan dam (including Mollasadra dam) in the upstream. Region 2 covers the sub-basin of Sivand River which makes a confluence with Kor River forming the major river which discharges into Tashk and Bakhtegan Lakes. Region 3 (Marvdasht Plain located downstream of Region1) links to Region 4 (Kharameh Plain) from Pol-e-Khan Hydrometric Station. The latter two regions share one common aquifer and have similar hydrological characteristics, but due to their different agricultural development mechanisms, they have been determined as two separate assessment regions. Region 5 covers the areas surrounding Tashk and Bakhtegan Lakes in the most downstream. Those two case studies can be regarded as representatives of the major water resources systems in the central Iran.

3. Assessment framework of social learning capacity

3.1. Conceptual framework of social learning assessment

The most possible and more efficient way to assess the learning capacity of water associated societies is to examine their responses to environmental events (see *e.g.* Bettini et al., 2015; Gupta et al., 2010; Huntjens et al., 2011; Pahl-Wostl, 2009). Therefore, we will assess the learning capacity in the water users level in the societies under investigation by examining the responses of local water actors to the historical water scarcity in the study areas. The water scarcity in Rafsanjan Plain is path-dependent over decades of groundwater over-exploitation for pistachios cultivation. Therefore, the study area suffers from a chronic sharp decline in groundwater level which has led to soil and water salinity as well as land subsidence. The Lakes Tashk-Bakhtegan basin is also confronting water scarcity as a consequence of both natural effects of a long-term (2000–2011) drought with the peak in 2008 and anthropogenic effects of over-exploitation of surface and ground water resources. The consequences of such a water scarcity in the study area have appeared in terms of groundwater table drawdown and drying up the lakes Tashk and Bakhtegan at the most downstream.

In this paper, we consider social learning as *learning occurring due to its corresponding processes which accumulate to make the learning capacity. The learning capacity leads to outcomes in terms of changes in rules, regulations, norms, values, etc. and ultimately, affects the actions and consequently the performances of stakeholders and results in an outcome (learning-based) that makes feedbacks to alter the learning capacity of the whole system (individually such as water users and collectively such as societies or organizations) through social learning processes (marked as the learning feedback loop). The outcomes, in a long-term, are expected to be effective on sustaining the water resources system (marked as the learning sustainability loop)*. That definition of social learning is conceptualized in Fig. 2.

3.2. Practical framework of social learning assessment

Social learning occurs through the process of interactions and communications among water actors that may come up with observable and perceived changes contributing (or not) to adapting to external stresses. Therefore, to assess social learning, it is important to address determinants of social learning process including social justice, perception of interdependency, mutual trust, and level of interaction among all stakeholders as well as type of outcomes represented by width, direction, depth and orientation of learning.

The scope of this paper embraces only the *Learning Feedback Loop* (Fig. 2), *i.e.* the process and outcome aspects of social learning. The *Learning Sustainability Loop* appears in a long-term period and is not addressed in this paper. Each of the process and outcome variables targets different aspects of social learning. Table 1 demonstrates a list of variables specified in this paper to assess the processes and outcomes of social learning, which we call *components*. The components have been combined in terms of the conceptual framework depicted in Fig. 3. The research was conducted during 2015–2019 based on field investigations and interviews with local water users.

3.3. Data collection, analysis, and validation

Data on the components associated with the processes and outcomes of social learning were collected using a combination of semi-structured interviews, documents review and field visits. The method of semi-structured interviews associated with driving forces, existing conditions, environmental events, influential components and changes to water resources in the studied areas were adopted as the main source of collecting data (Table 2). The interviews were used to recognize the responsive behaviors of the societies of water users – represented by the local farmers – in the two study areas versus water scarcity. Farmers' individual and collective actions, as well as their associated drivers and incentives to interact with formal organizations such as the local water authorities, were examined through interviews. The interviewees were selected among the key actors and major water exploiters consisting of smallholders and major landowners using the snowball sampling method (Neuman, 2002; Speziale et al., 2011). Those farmers were known as the influential farmers and representatives of the local communities possessing a great deal of knowledge about the historical backgrounds of the studied areas and the farmers' networks. Semi-structured interviews were conducted in the midst of 2016 using open-ended questions corresponding to the components considered in the methodology. Documents, including projects' reports, news articles, field notes and photos, and books related to the history of the study areas, were also reviewed. Therefore, all collected data and information were compiled and assessed.

The questions posed to the interviewees are listed as below:

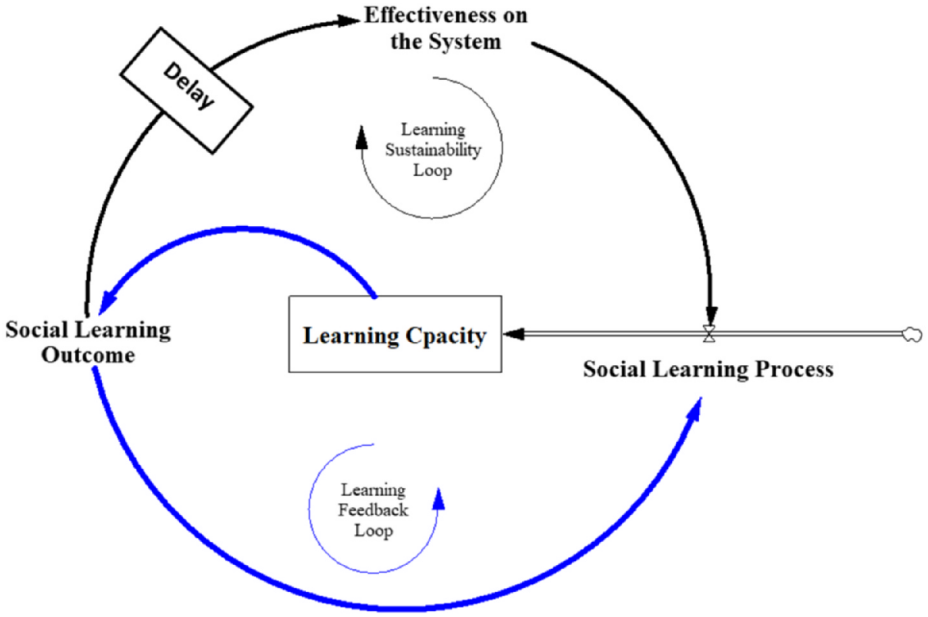

Fig. 2. Understanding the concept of social learning.

Table 1
The social learning outcomes and processes variables applied in this paper.

Aspect	Component	Remarks
Social learning as a process	Mutual trust	Lack of mutual trust and commitment among the actors in a learning process will tackle social learning to achieve suitable and significant outcomes and even prevent further practices.
	Perception of inter-dependency	Social learning requires all stakeholders to perceive their inter-dependency and believe that the problem will be resolved through full participation embracing a diversity of views, approaches and information resources.
	Social justice	Mutual trust will not be established and there will be no motivation for interaction unless actors, especially the exploiters, believe in social justice.
	Stakeholders' interaction	Social learning will give rise to desirable outcomes when interaction among the actors has taken place.
Social learning as a system outcome	Depth	*Single-loop learning*: re-defining actions to improve performance without any changes in underlying assumptions, values, objectives, and frameworks. *Double-loop learning*: questioning underlying assumptions and values, changing the objectives and frameworks, re-shaping actors' attitudes and decision rules. *Triple-loop learning*: Transformation of institutional contexts according to new values, beliefs and views.
	Width	*Individual*: learning often occurs only in individuals as a change in their understanding, values, and worldviews, or decisions and actions. *Collective*: learning occurs in an organizational form in the shape of changes in common views, actors' relationships and collective understanding and actions.
	Direction	*Convergent*: Convergent learning occurs when social learning contributes to converging the stakeholders' views, interests, and opinions which can ultimately result in improvement in their interaction. *Divergent*: Divergent learning occurs when social learning leads to inconsistent views and interests, increased conflicts and eventually decreased level of interaction.
	Orientation	*Constructive*: Constructive social learning occurs when it can end up with an improvement in the system status. *Neutral*: Neutral social learning occurs when it has nothing to initiate any change in the social system for the system improvement. *Destructive*: Destructive social learning occurs when it results in destructive outcomes which will deteriorate the system despite the fact that it has caused changes in the system.

(1) Can you think of any event which has affected your life and profession concerning the water resource? (If no, what are your reasons to indicate that there is not a single water-related problem in your surrounding environment?)
(2) If yes, what challenge or change has had ever the major effect on the local water resources?
(3) How did you come to realize the existence of this/ these problem (s)? (By yourself or self-awareness, others or any other information resources?)
(4) What did you do for the noticed problem(s)?
(5) Did you conclude to take this/these measures as a response all by yourself or through the collective recognition and decision-making process?
(6) In addition to what you mentioned, what other actions could you have taken to tackle the mentioned problem(s)? (If nothing particular, was there any specific reason behind not taking an action?)
(7) What other farmers have done in this regard?
(8) Do you think it is necessary to include every farmer in the process of decision making and taking actions? (Yes or no, why do you think this is the case?)
(9) Is it convenient and correct to take actions individually or collectively? (Why do you think so?)
(10) What reasons do you think exist behind other farmers' behaviors?
(11) Do you think that farmers would do anything they can to assist you in order to deal with the problem(s)?
(12) In your opinion, who is responsible for the current situation of water resources according to the emergent problem(s)?
(13) Regarding the current condition and circumstances, what sort of responses do you plan to take currently or shortly in order to overcome the problem(s)?

All the interviews were evaluated by repetitive coding process with the use of qualitative content analysis method (Elo and Kyngäs, 2008). The coding process helped identify the functions and responses of water users to dynamic changes and pressures on the water resources systems under study according to the social learning framework adopted in this research.

The interview questions, coding process, and interpretation of interviews using codes and qualitative content analysis methods were finalized and validated by the experts. The validity of research was satisfied by using multiple sources of evidences (such as interviews, documented evidences and review of historical and relevant statistical data, field visits and direct observations), peer-reviewing the draft of analyses and research results by three experts including one social scientist and two academic professors, and investigation of multiple cases as a theoretical replication method. To increase the reliability of the study, the same case study protocol and evaluation procedure were used in the two cases (Seale, 1999; Shields and King, 2001; Willis et al., 2007).

4. Results

4.1. Social learning process components

The components of a social learning process affect the learning capacity and its outcomes and indicate how the process will be likely to occur in the future. As mentioned in the previous sections, in order to avoid any confusion regarding variables and components, in this article, those variables or indicators presented in Table 1 are called components from now on. In the analysis stage, the components were examined corresponding to the within farmers' inter-relations. Table 3 represents the assessment results for process components of social learning according to the content analysis of semi-structured interviews.

4.1.1. The process components in the Rafsanjan plain

The results of social learning assessment regarding process components in the Rafsanjan plain showed low degree of learning capacity in the most parts of the study area. Situated in an economically competitive environment, the Rafsanjan area is relying solely on single-crop farming of pistachio, which is economically attractive owing particularly to its premium variety in that area. While the farmers behave according to the local rules governing their relationships, they are more affected by the policies and actions taken by the formal organizations. The results showed destructive reactions by the farmers such as groundwater overexploitation, unlicensed well drilling, and lack of

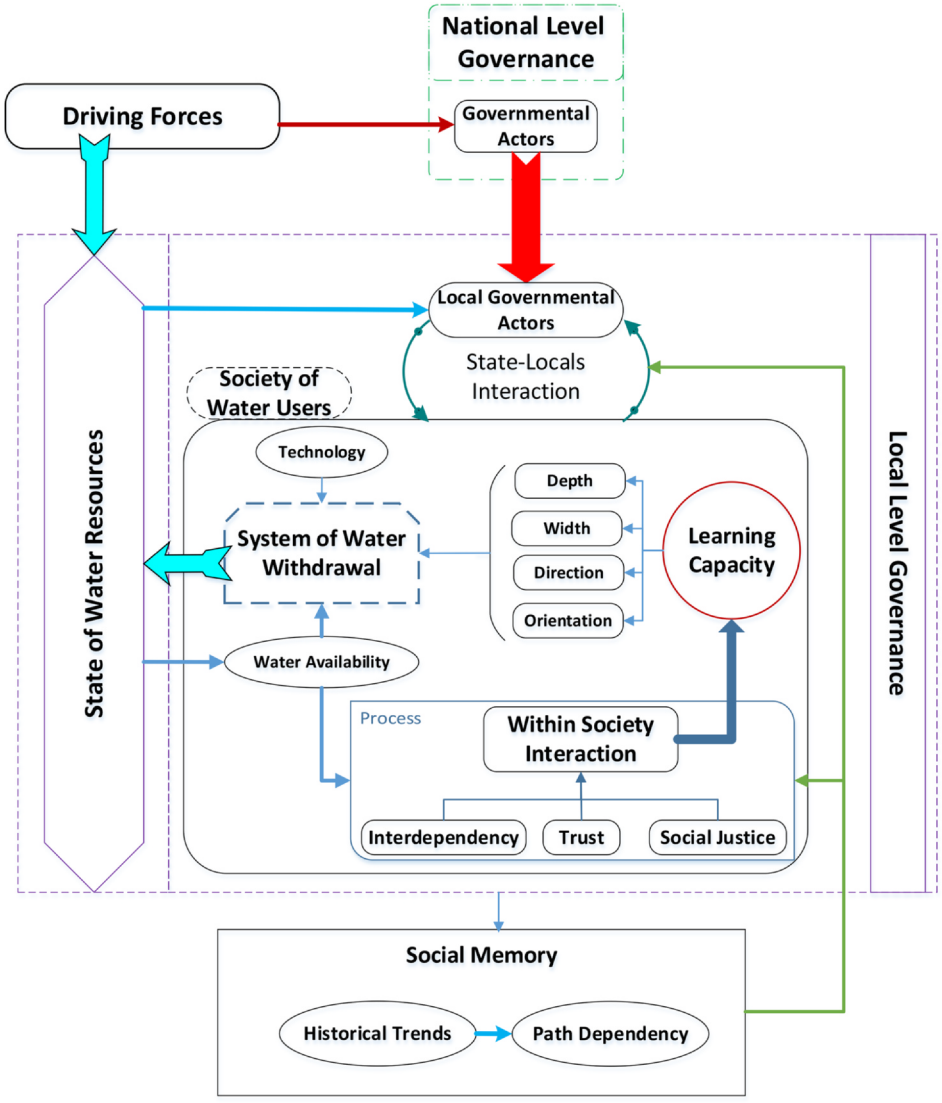

Fig. 3. The conceptual framework of social learning in a water associated society.

Table 2
The classification of interviewees in the study areas.

Study area	Region/County	Number of Interviewees		
		Major Landowners	Smallholders	Total
Lakes Tashk-Bakhtegan Basin	1	2	7	**9**
	2	1	5	**6**
	3	5	10	**15**
	4	4	7	**11**
	5	1	5	**6**
Total Number of Interviewees		**47**		
Rafsanjan Plain	Nuq	2	7	**9**
	Koshkuiyeh	10	1	**11**
	Anar	2	7	**9**
	Kabutar Khan	1	5	**6**
	Rafsanjan	6	10	**16**
Total Number of Interviewees		**51**		

cooperation with others to conserve water resources. According to the adopted social learning framework, it was found that the feeling of injustice imposed by the formal organizations was a reason to those reactions. In fact, high level of the social injustice, especially due to contradictory behaviors of governmental actors, has made farmers unwilling to interact with governmental stakeholders, even for the conservation of their water resources. "*While not controlling unlicensed wells, they push me, as a 30-year experienced farmer, to reduce my license allowance and dry up my trees*" (A smallholder). Along with the poor status of social justice, the perception of interdependency was not well-suited either. Since the Rafsanjani farmers use a common-pool aquifer for agricultural water supply, it should be logical to perceive a high degree of dependency among all actors; nevertheless, the results showed lack of interdependency perception among the farmers and governmental actors in the plain. "*As I am seeing my neighbor is over-exploiting the aquifer, I would say why I shouldn't do so? … Why should I relinquish my right?… this is my right…*" (A smallholder).

The lack of interdependency perception has led the farmers to enter a reinforcing loop of descending level of perceived interdependency, and consequently, imposing more pressure on the local water resource. "*All those present here are only looking for their own personal interests … I only seek to provide water for my own orchard, and have nothing to do with my neighbor's…*" (A smallholder). Since farming in this area is often done solitarily, there has not existed opportunities for establishing trust among farmers; thus, the level of trust has been remaining to be poor. "*The point is that if we do not use it, this water will be used by another one so that we continue to extract water from the well more than the permitted amount*" (A smallholder). On the other hand, due to failure of the

Table 3
The results of evaluation of the social learning process.

Study area	Region/County	Processes Components			
		Mutual Trust	Perception of interdependency	Social Justice	Interaction among all Stakeholders
Lakes Tashk-Bakhtegan Basin	1	High	None	Low	None
	2	Low	N*	Low	Low
	3	Low	None	Low	None
	4	High	High	None	High
	5	Low	Low	Low	High
Rafsanjan Plain	Nuq	Low	Low	None	Low
	Koshkuiyeh	None	Low	None	Low
	Anar	Low	None	Low	Low
	Kabutar Khan	Low	Low	None	Low
	Rafsanjan	None	None	Low	Low

* N = Neutral.

governmental bodies to meet farmers' needs and demands over the past years, which led to the belief in injustice by the local water users, the low level of perception and attitude to interdependency ultimately prompted weaker trust between water users and governmental actors (the locals and the state). "*The government has abandoned agriculture in the region … not caring so much about the farmers …*" (A smallholder). The process components of social justice, perception of interdependency and mutual trust are among the most fundamental ones that enable the social context for interaction and participation among actors aimed at improving socio-ecological conditions (Mostert et al., 2008; Vinke-de Kruijf et al., 2014). Because of low levels of the aforementioned factors, the interaction component did not provide favorable conditions either. Since the farmers, without changing their attitudes and behaviors, have retained significant economic benefits from their products, they have no longer perceived to need to interact with each other and with the governmental bodies, and even insisted on their former behaviors against solutions to conserve the water resources such as installing meters to control the water extraction. "*If they want to install the meter, people will not resist, but they would go and learn the way how to bypass it …*" (A smallholder). Therefore, the interaction was assessed at the very low level in overall.

4.1.2. The process components in the Lakes Tashk-Bakhtegan basin

The results of social learning assessment regarding process components in the Lakes Tashk-Bakhtegan basin showed a significant variation in the levels of learning capacity. As mentioned, the more the farmers believe in injustice, the more they will avoid to interact with the government, because they do not see a guarantee of fulfilling their requests from the other side. In most parts of the basin, a low level of perceived justice was judged, while in region 4 most of the farmers significantly believed in social injustice by the government. "*What happened this year was that they did not allocate the water for wheat-farming, instead they did so to cultivate the rice crop in Kamfirouz area [in Region 1]…*" (A farmer from Region 4). This non-committed behavior has had a huge impact on the perceived justice, resulting consequently in making the farmers pessimistic to the governmental stakeholders, deepening the gap between them.

One of the basic principles of better management and preservation of water resources is the participation of all stakeholders in the problem-solving process. It is interesting to note that, unlike the other regions, the results in Region 4 showed higher level of perception of interdependency. "*Now, as we have all got into trouble, and had six ponds dried, we have gathered together to look for solutions like changing the cropping pattern.*" (A farmer from Region 4). In contrast to Region 4, the farmers in Regions 1 and 3 declared independency on the other farmers. That led to the failure of each and every activity to improve the state of water resources. Nevertheless, having believed in interdependency on governmental bodies, such as the local water authority, the farmers in Region 4 have moved further to seek for solutions through interaction with the governmental bodies. A low level of trust in the governmental actors was overall observed through the whole basin; nonetheless, contrary to the expectations, the results unveiled significant and profound trust-lacking levels to the governmental stakeholders in Region 4. "*The main factor that hurts us was our representative in the Parliament … the local water authority did not commit to its promises at all… The Agricultural Organization has not done anything for us …* "(A farmer from Region 4). Except from Regions 1 and 4, where an acceptable level of trust was observed among farmers, it was found in the other regions that farmers would not trust each other undoubtedly where it was the matter of water resources. The low level of trust is a major obstacle ahead of further engagement and participation. "*The problem that has caused the current crisis is rooted in the farmers with neighboring lands; a farmer would feel escalated if his neighbor extracts water but he does not, and so on …*" (A farmer from Region 3). The higher the learning capacity formed by the actors, the more the ability to interact, and accordingly the higher the potential learning capacity (Mostert et al., 2007). In terms of interactions, the results showed that the farmers in Regions 4 and 5 have not only reached to a level of interaction, but geared up for interacting with the governmental bodies to find a solution to the status quo problem; nevertheless, in the other regions, there is a slight desire (or even not at all) to interact among farmers themselves. "*We have integrated some of our lands together … Almost 80% of the farmers attended and integrated their lands …*" (A farmer from Region 4).

4.2. Social learning outcomes

The social learning outcomes were assessed based on the responses of the farmers as water users in facing with changes and/or problems associated with the water resources in the studied areas. The results are summarized in Table 4.

4.2.1. The social learning outcomes in the Rafsanjan plain

The worse the social learning process works, the lower would be the social learning outcomes. According to the results, the imposed change on water resources has been perceived in Koshkuiyeh; nonetheless, the farmers have responded to the change in the same way that they used to do so, only with slight improvement. "*At the time being, my well does not have more than three meters of water, which will last, at most, for four more years … then I'll go, and dig another new well …*" (A major landowner). The economic utility of pistachio has motivated the farmers in the area to prefer short-term benefits over the long run ones. "*What they want is to take my lunch today so that I would have breakfast tomorrow, it does not work … if I am supposed not to live tomorrow, how would it heal to catch my lunch?*" (A smallholder). Therefore, at the level of water users in the area, single-loop learning was dominant. Although the farmers have adopted measures and actions, their approach has not incorporated in water resources conservation. That stems from not understanding the root causes of the issue accurately which has tackled convergence of farmers for working collectively.

However, the farmers in Kaboutar Khan showed somewhat different reactions due to different perceptions of the existing problem. In fact,

Table 4
The summarized results of assessment of the social learning outcomes.

Case Study	Region/County	Outcome Components			
		Depth	Width	Direction	Orientation
Lakes Tashk-Bakhtegan Basin	1	Single-Loop Learning*	Individual	Divergent	Neutral
	2	Single-Loop Learning*	Individual	Divergent	Neutral
	3	Single-Loop Learning*	Individual	Divergent	Neutral
	4	Triple-Loop Learning	Collective	Convergent	Constructive
	5	Double-Loop Learning*	Collective	Convergent	Constructive
Rafsanjan Plain	Nuq	Double-Loop Learning	Individual	Divergent	Destructive
	Koshkuiyeh	Single-Loop Learning*	Individual	Divergent	Neutral
	Anar	Double-Loop Learning*	Individual	Divergent	Destructive
	Kabutar Khan	Single-Loop Learning	Individual	Divergent	Neutral
	Rafsanjan	Double-Loop Learning	Individual	Divergent	Destructive

* With signs of existence of higher loops of learning.

the water users have not fully understood the changes to the water resources; that has engendered persisting of previous practices irrespective to the problem. In other words, the farmers' lack of awareness inspired them with an idea that the existing problems have quite exogenous reasons (*e.g.* drought). "*Since many years ago, the water level in the wells has dropped down… there is not water … no precipitation and now the drought has been persisting for 16 years*" (A major landowner). Similar to the farmers in Koshkuiyeh, the observed responses in the other counties represented single-loop learning along with neutral, individual and divergent attitudes without any perception of interdependency.

Inspired by a different mental model, the farmers in Nuq have behaved in a way with destructive effects on the local aquifer. The change in norms and beliefs that underpin the abusive or even offensive behaviors is rooted in the conflicting confrontation and economic pressures on the farmers by the governmental actors. "*When there is a pump next to mine with no difference, but has a permission to discharge 40 L, while mine is 10 L, if you attempt to lessen mine, my least reaction would be that I will rob his crops*" (A smallholder). That is why the farmers do not assume the excessive discharge of a common pool water resource illegal and abusive. That abominable reaction has been transformed into a social norm. Due to lucratively economic profits of pistachios the farmers are not convinced to abandon farming or change their behaviors even in the current circumstances of water crisis and illegal actions. Like Nuq, since Anar is also located in the downstream, the farmers in that area are quickly affected by any change in the upstream which makes them to respond quickly. Unfortunately, this quick awareness of change has stimulated the farmers in Anar to react under destructive mechanisms. "*The reason that people are indifferent to excessive water abstraction while everyone knows who is overexploiting, is that they are all associating in a collective crime … they say he discharges, so do I*" (A smallholder). Even the measures such as emigration from the local villages can be categorized as a change in beliefs and attitudes but with no effects on conserving water resources. "*The earlier the places were destroyed, the sooner their inhabitants emigrated … now their orchards are drying up, and they are selling their homes and lands and leaving one by one*" (A smallholder). According to the results, dominating of a double-loop divergent learning in an individual scale with a destructive orientation is more likely among the farmers.

In Rafsanjan County, the views and behaviors among different groups differentiated much more than in the other areas. What was in common among all the stakeholders in this county is that agriculture, *i.e.* pistachio cultivation, is not just a means of livelihood, rather it is seen as a profitable business. That is why the farmers are not willing to change their practices. "*Agriculture in Rafsanjan County is by no means a practice to make living…*" (A major landowner). Similar to the other areas, in Rafsanjan County, the conflicting interaction of governmental stakeholders with farmers has caused to emerge wrong mindsets among the farmers. That mindset stimulated the farmers for their abusive behaviors. "*If there is a way to commit bad things, be sure the farmers will do it … if the water authority wishes to install the meters, people will not resist, but they will find out how to bypass them*" (A smallholder). On the other hand, since the governmental bodies have always played the role of owner and manager of water resources, it has led the farmers to expect that the government itself is responsible for solving any problem associated to the water resources. Hence, the government is solely assumed responsible for all water resources issues and devising the solutions. Therefore, the farmers believe in persisting their current practices, and whenever a problem arises, there exists the government to resolve it. "*The water authority allowed the people to dig wells without doing any technical investigations… if they had done, Rafsanjan would not have faced such a severe condition… if they had supervised wells, agricultural practices and the cropping pattern, the plain would not have dried up*"(A smallholder). "*As I witness my neighbor is depleting the water, I would say, why I should not do!?… Why do I overlook my right?… This is my right… The water is allotted to the farmers, if I do not use today, it is likely not to exist tomorrow… If you say we will be facing a water crisis over 10 years upcoming, then we can harvest our orchards in any possible way so that we will be satisfied financially after that duration*" (A smallholder). Emergence of such attitudes and beliefs which underpin the behavioral pattern of water users in withdrawing local groundwater resource, indicates dominance of a double-loop learning oriented to destruct water resources. Furthermore, it was found out that water as a value is no more respected by the farmers. That is also a sign of divergent double-loop learning with an individual scale oriented towards water resources destruction.

4.2.2. The social learning outcomes in the Tashk-Bakhtegan basin

According to the results, the major responses of farmers in Regions 1, 2, and 3 were in terms of transformation of agricultural fields to orchards, shifting from surface to underground water resources, shifting from rain fed farming to irrigated agriculture, shifting from traditional to modern irrigation systems, and change in cropping patterns. All of those mentioned responses are repetition of their former responses without questioning the basic values and decision rules.

The analyses revealed significant results about farmers' behaviors in those regions. Firstly, underpinned by a simple understanding of the changes in the local water resource conditions, the farmers persisted in their traditional attitudes and practices corresponding to water resources management, *i.e.* instead of turning to conservation of the water resource, they pursued the same strategy of increasing water productivity and efficiency. "*During the recent drought, the farmers persisted in the same behavior, having only faced with little troubles…*" (A smallholder). This gap, along with the improper and contradictory responses of officials, such as damming the river and transference of national lands, aggravated the existing problem which led to the persistence and even increase in the crop areas, *i.e.* the farmers entered a reinforcing loop of unsupervised exploitation. "*After the droughts, farmers severely turned to dig wells and extract underground water…*" (A major

landowner). The farmers' reliance on individual practices and former routines not only did not help to restore water resources, but also caused the bad conditions to persist. That represents a single-loop of learning in the region.

Compared to the regions studied in the previous section, water users of Region 5 in Lakes Tashk-Bakhtegan Basin, including Tashk and Bakhtegan dried up lakes, exhibited a higher learning capacity in terms of appropriate performance and responses corresponding to the 2008 drought. In that region there exist both rain fed and irrigated agricultural lands. Therefore, some parts of the farms continued to be treated in the same manner despite the drought, but the rest shifted to irrigated farming. The responses devised towards the change in the water resources conditions in this region included change in cropping patterns, switch from agriculture to horticulture -especially pistachios- and limited change in the irrigation systems. But the nature of measures adopted by the farmers in that region is interesting. "*For each landowner in Neiriz and Istahban, a financial aid was granted for agriculture … What happened in Istahban was that they dogged three new wells, and thus handed over the water exploitation and transferring management to the farmers*" (A gardener). Apart from the type of action taken by the governmental actors, engaging the farmers in the management of water resource initiated a new mode of participatory water resources management with building capacities in that area. The outcome of such a change was, consequently, forming a suitable level of bottom-up approach as well as engaging the farmers -who used to act individually on their own lands with no interaction with each other- in collective actions which can be manifested as a paradigm shift in terms of acknowledging local governance and participatory management. Another interesting mechanism which was initiated in that area was emergence of a local water market where the farmers could trade their water rights. The importance of emergence of those mentioned mechanisms from the social learning perspective is that new institutional arrangement and setting have been initiated which represents an outcome of double-loop learning with constructive and convergent type of learning and collective actions.

Region 4 in the Tashk-Bakhtegan basin has shown the highest level of learning and adaptive capacity among the all regions. That might be because that region has received the most severe impacts of the drought. The impacts of the drought were revealed in this area more quickly than in the other areas, so the farmers in that region reacted beyond the farmers in the other areas. A wide range of responses were devised including from change in cropping patterns, irrigation systems, and introducing pistachios as a new crop, to lands integration, and even, at some limited degrees, change in occupations and emigration. While those responses embrace all levels of social learning, what is attractive is establishing new unions and associations to initiate collective actions and institutional responses for water resources restoration. That new institutional arrangement and setting succeeded to enhance the level of perception of interdependency and trust which led to close interactions with the local authorities to approve a ban on rice cultivation in the upstream. Furthermore, the farmers volunteered for a no-cultivation plan which was proposed to the Agricultural Organization by themselves. Although the new settings bear weaknesses, the responses such as change in the farmers' attitudes and a new viewpoint at the water crisis, convergence of opinions, resolving the conflicts and disagreements, creation of new mechanisms and settings for achieving the goals, are all signs of innovations and emergence of new mental models in terms of double and/or triple-loop of learning within the water users, which supports higher and more flexible capacity of learning and adaptation to change.

4.3. The effects of social learning on the water users' behaviors

Despite the institutional and ecological differences between Rafsanjan and Tashk-Bakhtegan case studies, there are similarities in the behaviors and performances of the local governmental actors. This similarity is because of a centralized and top-down water governance regime. Through the centralized water governance regime decisions are planned and made for different regions at a national level regardless of their biophysical and contextual differences. For example, one of the national policies that affected Lakes Tashk-Bakhtegan Basin substantially, was the policy on guaranteed purchasing of agricultural products specifically wheat. "*After the revolution [in 1979], wheat cultivation expanded as it was a strategic product and guaranteed to be bought by the government…*" (A major landowner). "*If there is a guaranteed buying strategy, which is regarded importantly, farmers will plant everything…*" (A smallholder). The formal policies emphasis on cultivating certain products because of political motives, regardless of the regional ecological potential, caused remarkably increased cropping areas as well as an excessive pressure on the local water resources.

The same trend can be seen in the Rafsanjan plain, where inappropriate and ineffective rules to manage unlicensed wells and excessive water withdrawal, not only did not prohibit those actions, but also resulted in increase in the number of illegally-drilled wells and encouraged farmers to abstract from the underground water resource excessively (Moghimi Benhangi et al., 2019). Confronting biased and inappropriate reactions by the governmental actors against unauthorized drilling of wells, the Rafsanjani water users learned that lawbreakers are not only not punished, but also are encouraged in terms of future supportive laws which make their unauthorized wells authorized. With an intention of making livelihoods, the farmers believed in such an action of law violation as a social norm. The governmental stakeholders' reaction to conserve the groundwater resources as well as transformation of the values and norms of the water users has impacted the regional groundwater resources and caused their severe deterioration, as half of the wells in the country are unauthorized (Moghimi Benhangi et al., 2019).

Without learning from past mistakes, the governmental actors have directly impacted water users' learning capacity by repeating their previous practices and responses. At the next step, not only did the low and destructive learning capacity of water users lead to the local water resources deterioration, but also that phenomenon was diffused to the other areas. According to the research results, one of the farmers' responses in the Rafsanjan plain was to emigrate and repeat the same cropping and water use behaviors in other areas as the issue appeared. In the Tashk-Bakhtegan basin one of the adaptive strategies was the change of cropping patterns to pistachio orchards. It was observed that the pistachio cultivating was initiated by the emigrant farmers from Rafsanjan who resided in the Tashk-Bakhtegan basin, particularly in Region 5, and pursued their old-styled pistachio horticulture. "*Here, they have come from Rafsanjan and are buying lands for planting pistachios …*" (A gardener in Region 5). What is important is that the Rafsanjani farmers did not think of any new innovative reaction in their new habitat other than repeating the same behavior they had done in terms of pistachio cultivation. Hence, they are fueling overexploitation of local water resources in Lakes Tashk-Bakhtegan Basin. It seems that the consequences of governmental stakeholders' misconduct are being transmitted as a disease to other regions over time. The low learning capacity resulted from the failed past experiences will entangle other regions' institutional contexts indirectly in a similar fate.

The results showed that the social memory which is affected by technology and path dependency throughout the historical trends, has had the greatest impact on the levels of learning loops which have a significant effect on the formation and enhancement of learning capacity. According to the results, the society of water users in the Tashk-Bakhtegan basin demonstrated a higher learning capacity than that of the Rafsanjan plain. That might be because of the experiences from at least the two severe droughts occurred in the past (almost in the late 1940s and 1960s) in that area. In response to the first drought in 1940s, the farmers had to tolerate the circumstances due to technological limitations. Hence, instead of forcing the nature to serve the human in any condition, they used to cope with the conditions of the nature. But

in the second drought in 1960s, as the technology had improved, the farmers got able to expand their water withdrawal capacity thanks to new technologies such as drilling deep wells and damming the river (single-loop learning). During the recent drought in the Tashk-Bakhtegan basin, the farmers quickly understood the environmental change and its intensity and also realized the inefficiency of old measures and approaches, because the technology failed to completely fix the problems. On the contrary, the historical trend in the Rafsanjan plain, with entire reliance on technology (as an external factor) as a solution for fixing the water resources problems, caused the farmers to follow the same former actions as digging new wells or excessive water withdrawal (single-loop learning) facing with a change. Since they stuck to their traditional business of pistachios cultivation, one can say they have got in a path dependency trap. Hence, the more they become dependent on bygone solutions, the more vulnerable they have been and lost their learning capacity. As a result, part of today's problems is due to the attitudes that have emerged over the past few decades; their change would be a fundamental step in adapting to the new conditions. On the other hand, the engineering responses devised during the past years made it feasible to record these responses in the institutional memory and return to them today while encountering problems. The same reaction is expected to occur facing complex newly emerged problems in the future if institutional capacity is not improved by indigenous innovative responses.

The results also showed a relationship between water availability and learning capacity. As observed in the Tashk-Bakhtegan basin, despite the occurrence of a basin-wide drought, only the farmers in Regions 4 and 5, situated in the downstream, were stimulated to take collective actions to adapt to the new conditions. That can be interpreted as enhancing the learning capacity. Although the whole system was exposed to a severe lasting drought, since the farmers in Regions 1, 2, and 3, situated in the upstream, have had still full and adequate access to water resources to meet their needs, they have not realized the necessity of inter-dependency. Thus, they have not been motivated to interact towards changing their mindsets and behaviors. As we move from the upstream to the downstream in Lakes Tashk-Bakhtegan Basin, we can observe that the less water is available for the exploiters, the higher is the water users' learning capacity. In the Rafsanjan plain, on the other side, the farmers in the downstream including, Nuq and Anar Counties, lie in double-loop of learning from the perspective of overall learning capacity due to insufficient access to water resource, destructive responses in the upstream, and physical changes in the water resource system; nevertheless, the learning orientation has been towards water resources deterioration. That could be because of the following four main reasons: 1) the style of agriculture in Rafsanjan (pistachios horticulture) which is completely solitary. That style has eroded any relationships among farmers and weakened social capacities such as interaction, perception of interdependency and mutual trust. Therefore, unlike in Lakes Tashk-Bakhtegan Basin, no effective institutional context has formed in Rafsanjan; 2) the governmental contradictory responses, including conflicting laws and policies (*e.g.* the regulations associated to well-drilling), have lowered the level of risk of laws violation in favor of individual gains; 3) the high economic profits associated to pistachios in the domestic market, regardless of its global market, would compensate any costs/penalties corresponding to law-breaking risks; and 4) The change in surface water flows is perceived more quickly than in groundwater resources. That will cause a delay in responses to the changes associated to groundwater resources as was the case in Rafsanjan. That is why, in spite of the higher depth of learning in the Rafsanjan plain, the farmers, particularly in the downstream, went through a destructive learning orientation.

5. Conclusions

This research attempted to develop a social learning assessment framework to be adopted in water users' societies. Adopting an ex-post assessment approach, we practiced the framework in two case studies – one the society of farmers using the groundwater resource in Rafsanjan Plain and the other one the society of farmers in Lakes Tashk-Bakhtegan Basin, both situated in the southern Iran – in terms of assessing the responses of the water actors to historical changes in the water availability. We originally assumed social learning as the learning occurring due to its corresponding processes which accumulate to make the learning capacity. The learning capacity leads to outcomes in terms of changes in rules, regulations, norms, values, etc. and ultimately, affects the actions and consequently the performances of stakeholders and results in an output (learning-based) that makes feedbacks to alter the learning capacity of the whole system (individually such as water users and collectively such as societies and organizations) through social learning processes.

The results indicated that the process of social learning and its outcomes in the Rafsanjan plain were significantly weak. The attitudes and practices in that area have progressed not in the direction of groundwater restoration, but to intensifying its deteriorating trend. According to the results in the Tashk-Bakhtegan basin, the process components of social learning were evaluated in different levels. The learning capacity in the downstream of the basin was higher in terms of process and outcome components than those in the upstream.

The adopted framework of social learning embraces both process and outcome components. The former includes attributes such as mutual trust, perception of interdependency, social justice, and interaction among all stakeholders that affect the outcomes of social learning. The outcome components are perceived as the results of the social learning process including depth, width, direction and orientation of learning. However, what the proposed framework lacks is its weakness to explain the transition phases between different loops of learning. The transition phase comprises the period from when the actors realize inefficiency and inadequacy of the former settings (including practices, assumptions, beliefs, attitudes, etc.) till they initiate to establish new institutions and structures. Unless the evidences of emerging new institutional settings and arrangements has not come to existence, the capability of triple loop learning cannot be tracked explicitly. However, it does not necessarily mean as a low learning capacity and flexibility.

The nature, duration and consequences of the change would determine the necessity for higher learning loops. Hence, higher learning levels are not necessarily required in all systems when facing with changes.

Traditionally, most of the research on social learning assumes positive outcomes for the process of learning, *i.e.* social learning is basically assumed to always lead to positive social changes in institutional mental models in a way so it will result in new practices and organizations and consequently a better outcome on the ecological system. Unlike to the findings of the previous research, in the cases studied in this research, it was observed that learning led to deteriorating the socio-ecological system in terms of creating defensive and passive mechanisms for problems within the water users' mental models. In other words, the learning outcomes do not always improve the condition of water resources under the change, but they may also exert destructive institutional changes. Hence, in those cases the learning capacity could no longer be considered as an improving process in adaptive capacity. Learning orientation, thus, was presented in this research as an essential component which is lacked in the former frameworks. Furthermore, the authors differentiated between neutral and destructive learning orientations. While neutral learning means no change, the destructive learning will lead in double- and triple-loop of learning but with *cobra effects*. In addition, due to large delays in the ecological systems, there exists still a question on the sustainability of the adaptive responses of the social system – known usually as positive outcomes – to a historic change.

It was also shown that technology improvement and historical trends can make path dependency which dominates social learning capacity. It seems in the water associated societies the social memory

which is shaped by social learning is correlated with water availability.

It was revealed that in Rafsanjan plain the overall level of learning capacity of the local water actors was low as that of in Regions 1, 2 and 3 in Lakes Tashk-Bakhtegan Basin. In contrast to those passive societies, the water users in Region 4 and, to some extent, in Region 5 in the Tashk-Bakhtegan basin showed higher levels of learning capacity in terms of forming a new institutional setting and having become more adaptive and resilient to changes. Unless nothing is changed in the learning capacity of those passive water associated societies, it can be expected that the actors' responses to changes in the future, *e.g.* climate change, would be similar in nature to their historical experiences. That is why they need to first unlearn what they have learned and then re-learn how to adapt to changes pro-actively. In this manner, ex-post approach adopted in this research can be used for ex-ante projections and planning.

The societies of water users, as the target stakeholders of the policies, are more likely to change – particularly in times of severe crises such as droughts and water scarcity in Regions 4 and 5 in Lakes Tashk-Bakhtegan Basin – through entering double and triple-loops of learning than the governmental organizations. To make the changes effective in terms of a social change towards sustainability there should be a link between informal and formal institutional bodies. The key message of this paper is that apart from the intentions expressed in policies, the dynamics embedded in the policies and the way they are implemented affect social learning in the target stakeholders. Despite the aim of each policy, the system might confront the *cobra effect* as the learning outcome in target actors might be oriented towards divergence and destructiveness. As an *unintended consequence* then wrong and destructive norms might be replaced as the new social values. It is important what is meant in the policies and rules, but, what is more important is what the target groups learn as the final outcome. Therefore, first of all, the rules and policies should be designed and implemented respecting the position of learning concepts as one of the key pillars for social and even political contexts. Secondly, it will obviously be necessary to acknowledge not only the learning capacity of actors, but also it is essential to address the learning capacity underlying the social context when devising and adopting new policies and rules.

For example, change in the cropping pattern is usually suggested as the first and the shortest process-starting policy homogenously to adapt to climate change effects. According to the results of social learning assessment in a basin like Tashk-Bakhtegan it was discovered that the adaptive capacity is not homogenous throughout the whole basin. The farmers in the downstream are more likely to accept more thorough, radical and flexible changes, while in the upstream, even the same basic solution of change in the cropping pattern cannot be recommended or put into effect. The methodology adopted in this paper shows how social learning capacity as an important institutional context of the target community can be acknowledged to underpin planning and implementing policies and measures to initiate an effective change.

Looking at the social learning capacities in communities, one can understand why different systems vary in terms of social responses and ecological states despite somewhat similar environmental conditions. It was also observed in areas such as Tashk-Bakhtegan, that the existence of a multi-source water system constituted a part of the delay in learning and activating its capacity. In a way, farmers did not need to change their behaviors as long as they persisted on deterioration of the resource, but had an alternative source such as groundwater. On the other hand, severe water crisis can act as a tipping point for emerging collective actions and to stimulate the water actors to go through double and triple-loop of learning to transform their water institution (*e.g.* as in Regions 4 and 5 in Lakes Tashk-Bakhtegan Basin). Therefore, further research is needed to identify the tipping points as well as the reasons which cause delays in reaching to the tipping points. In water stressed countries like Iran, the existing institutional context needs improvement to build the system capacity to confront future changes. A society is adaptive when it can firstly understand – or even foresee – the historical trend of changes in the ecological system quickly, and secondly, fully innately respond to the changes. In some circumstances, the responses may need to be in a form of social transformation.

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.

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