Identifying Factors Affecting the Interactive and Information Systems of Water Governance in Iran Using Meta-synthesis

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ABSTRACT

Water is an essential natural resource being currently under considerable pressure and leading to a crisis in various sectors at the present and future. Water governance is one of the factors which can increase the ability of a country to deal with its crises and challenges. Water governance requires the processes encouraging people to actively participate in management planning and water management activities. In this study, the factors affecting the interactive and information system in water governance were identified using the meta-synthesis method and reviewing articles. Such a system was categorized into seven criteria and 36 sub-criteria. All the criteria and indicators were ranked in a fuzzy atmosphere using a questionnaire by referring to 20 senior managers, water resource professors, and the NGOs engaged in water management. In the interactive system (socio-cultural), the criteria of participation and decentralization were mostly frequent in the field of meta-synthesis while the criteria of awareness and availability-transparency had the fuzziest weight in classification in the information system.

Keywords: Water governance, interactive system, information system, fuzzy hierarchy, meta-synthesis

INTRODUCTION

The world faced an unprecedented environmental crisis at the beginning of the 21st century. The concerns about the destruction and shortage of water are increasing because food security is threatened due to a close relationship between the global water cycle, land management, and food production. Water crisis is one of the three major global crises (water, food and energy crises) (Steduto 2017; UN-Water, 2009). Regarding of the effects and consequences of droughts, the environmental pollution and climate change in recent years were highly regarded indicating an unpleasant global water situation. Thus, there is no need to explain more about such problems while it is important to eliminate the effects of these problems at the international and local levels. Sustainable development means using the sources of life like water in such a way that future generation can use them fairly

like the modern generations. A lot of efforts were made to respond this necessity and the achievement of such efforts raised the issue of education, training, and information as the most significant factors of sustainable development (water resources). A universal consensus exists on this crisis while the three categories can be distinguished. Most people consider crisis as a result of technology, so that the extraction and overuse of water and land are possible by using the advanced technologies like large dams, deep wells, strong pumps, machineries, and chemical fertilizers. Thus, this group regards solving the crisis through technology by promoting the technology as well as achieving appropriate technologies such as water desalination devices, drip irrigation, rainwater storage, appropriate fertilizers, and so on. The second group believes that the current crisis is due to inappropriate soil and water management. The factors such as partial fulfillment, poverty, corruption, mismanagement, lack of investment, insufficient development in this sector, the lack of adequacy in related institutions and organizations, and the lack of stakeholder participation or involvement in this sector are among the barriers to sustainable land and water management. The third group including many environmentalists considers the radical and unsustainable consumerism as the reason for this crisis. For example, the consumption pattern on a global scale tends to the products requiring large quantities of water. In addition, water consumption has increased due to the public perception of "the abundance and availability of water everywhere" (Askary bozayeh, 2016). Thus, the first group considers land destruction, water shortage, and water resources due to technology and the second group considers wrong management and governance as the crisis factor. The third group focuses on public awareness and perception towards the interests (Balali et al., 2009).

Governance

The term "governance" which is rooted in Greek was used by Plato for designing a government system (Beige Nia et al., 2012). This Greek word was converted into the Latin word "gubenare" in the Middle Ages implying the driving, ruling, or leading. According to Oxford Dictionary, this term means the government but is an old term which has been recently revived and is typically used as a new concept in relation to government and government management. However, two main concepts of governance have grown rapidly on the academic and political theoretical basis. A well-known definition was used by the World Bank and some United Nations agencies and governance was defined as a method of applying power in economic and social development management of countries (UNDP, 2013). The second approach in the definition of governance focuses on

the sharing of public administration authority between the government and NGOs, so that both governmental and non-governmental actors work together to solve social problems together (Beige Nia et al., 2012). According to Alberow, governance means the management of society by people (Askary bozayeh, 2016). Governance refers to a complex system of interactions between structures, traditions, responsibilities, and functions which are specified by three key values of accountability, transparency, and participation (Memarzade et al., 2010). However, the fact is that the concept of governance is still ambiguous despite the various debates and much emphases considered by various societies (Teisman et al., 2013). Some researchers consider it in form of a political style versus the governmental approach (Yazdanpanah et al, 2013).

Water governance

Governance can be generalized to various areas including the water sector (due to its features) and here are some definitions of water governance. Water is a natural resource forming regional prospects and is critical to the function of ecosystems and desirable human life. This vital resource is currently under increasing pressure. The changes of hydrological systems due to climatic, demographic and economic changes led to serious consequences for the people and the environment. The recent international congresses of water and published references emphasized the significance of water governance in determining the ability of a country to cope with water challenges. Some declared that the current water crisis in the world is not water shortage crisis, but a water governance crisis (Rogers & Hall, 2003; Solanes & Jouravlev, 2006; Hill et al., 2008; Pahl-Wostl et al., 2008; OECD, 2011, 2015; UNEP, 2012). Understanding the effective factors of water cycle and management is a highly critical issue at the international level. The studies indicated that the social systems and mechanisms affecting water cycle are beyond water management. Water crisis should be considered in the framework of social institutions and systems called water governance (UN-Water, 2009).

Water governance focuses on the way of formulating water management policies and appropriate management practices requiring the processes which enable people to actively participating, designing, managing, and implementing water management activities and empower the societies to accept changes (Currie-Alder et al., 2006). Based on the definition of global Water Partnership (GWP), water governance is a political, social, economic and administrative system for developing and managing water resources and providing water services at various levels of society (Kashyap, 2004).

On the other hand, Tropp (2007) stated that water governance is expressed in terms of formal and informal networks development, partnerships, joint decision-making processes, and the outputs of negotiations. Therefore, water governance is introduced in form of a complicated context playing a regulating role in development, management and water services development (Mirnezami & Bagheri, 2017).

By reviewing the conducted references on water resources management in Iran, it can be argued that the concept of government in general and water governance in particular is a negotiable issue with many unknown aspects and indicators. The gap of many of these issues in this area is felt in Iran.

The challenges of water governance in Iran

The average annual precipitation in Iran is about 251 mm which is about one-third of the global average and half of the rainfall in Asia. Thus, topographic conditions, climatic conditions, precipitation distribution system, physiographic structure, and the direction of gradient of the earth, and finally geographic location classified Iran as an arid and semi-arid area where major parts of it are semi-arid (Fallah-Alipour et al., 2018). Due to the mountainous conditions of Iran, the distribution of atmospheric precipitation in Iran is very heterogeneous in the world and its distribution is in a way to place Iran in the ranks of countries with severe water restrictions (Research Center of the Islamic Consultative Assembly (2017).

The spatial distribution of water in Iran is very heterogeneous due to natural conditions. Due to the total lands of Iran, i.e. 1.623 million square kilometers, and the average rainfall in Iran, the total volume of received water is about 405 billion cubic meters based on an average of 48 years (Iran Statistical Yearbook, 2016). In addition to the uneven distribution of atmospheric precipitation in Iran, the uneven temporal distribution of Iran is also very uncoordinated leading to many economic and social problems in various sectors. especially agriculture and the supply of water to cities in Iran is very evident in the central regions of Iran in some cases. Despite the decline in renewable water resources, water consumption not only reduced in Iran, but also increased. While the average water potential of Iran is declining, this increase in water demand reduced the average per capita from 5500 cubic meters in 1978 to about 145 cubic meters in 2016. The water resources of Iran including the groundwater were heavily exploited with the advancement of technology and availability to new technologies of water pumping over the past decades, disrupting the governance of water resources, and increasing water demand in Iran. This phenomenon led to a huge water deficit in Iran, which was invisible for

a long time. Since most of this water created due to excessive water pumping, it provided long-term false capacity of the resources for agricultural development (PourAsghar-Sangachin et al., 2017). Thus, the unprecedented withdrawal of water resources in Iran, especially groundwater resources, is one of the main challenges in the water sector which has already caused serious problems in Iran. Such a withdrawal led to declines in groundwater aquifers in many parts of the country. This phenomenon, in line with the recent droughts in Iran, increased the utilization of groundwater and caused irreparable damages to groundwater resources in Iran.

The amount of withdrawal reached from 9 billion cubic meters in 1972 to more than 47 billion cubic meters in 2016. Thus, the number of wells was 16 times higher and the number of harvested was more than 5 times during this period. Despite the increase in the number of wells over the last few decades, it was expected that the discharge rate from these water sources would increase, but their discharge has decreased since 2008 despite a significant increase in wells. The amount of groundwater consumption for more than 85% is spent on the agricultural sector and the rest is consumed in industry and services (Water resources management -water management company of Iran (2017). In addition, low productivity of water in the agricultural sector and farmers' unawareness on government plans and non- participation of stakeholders in the water decision making system, as well as the lack of transparency and unavailability of information create a deep gap between renewable resources and water consumption in Iran. The presence of Iran in the water crisis is regarded as the most obvious indicator of the failed resource and water resources management system in Iran despite the huge economic, social and political costs over the last six decades. Further, the lack of attention to the water issue in Iran as a complex, interdisciplinary and malignant issue is one of the most important reasons for the failure of this management system apart from the problems which can be imposed on the concept of water governance. As a result, the evaluations of projects and plans derived from this management system are limited to economic and technical dimensions. Due to ignoring other dimensions, especially interactive social dimensions, awareness, and participation, even the economic goals of them cannot be sometimes realized in the short and long term (Fazeli & Fattahi, 2018). The policies and laws defined in the water governance system in Iran led to the low participation of the stakeholder in water management. Thus, no participatory decision was made on the management of water resources for plains, and the delegation of authorities to the main beneficiaries of surface water and underground waters

(Ahmadi et al., 2017). Iran has a diverse ecosystem and modest to warm and dry ecosystems which unfortunately provides a series of similar versions for water management and governance. Water resources in Iran are governmental which prevents the private sector involvement and stakeholder participation in decision making. The lack of sufficient information on water resources and its policies reduced the sense of participation and accountability of the stakeholders. Ghaemi (2016) indicated that the most problems in the field of water are related to the lack of awareness and appropriate public education since one of the most important principles of governance is how to interact with stakeholders and people, depending on their location. First, it is related to the perspective of a consumer who needs to understand how to supply water and the effects of excessive consumption and inappropriate consumption. Water on the environment and pollution of aquifers play an important role in integrated water resources management. Second, educating people and authorities in restoring the native management of productive societies on water resources and eliminating top-down decision making, and establishing institutional frameworks and social networks which can lead to the democratic process (Pedregal et al., 2015; Sternlieb & Laituri, 2015). The people-centered water management is considered as one of the things which can make a big contribution to supply management and demand from uncertainties in the water sector (Browne, 2015), which is rarely done in water governance structure in Iran. In addition, the general government of water distribution is one of the main feature of the water system is Iran (Yazdanpanah et al., 2013; Balali et al., 2009), which requires the definition of two interactive systems in the cultural, social and informational field within the structure of Iranian water governance which can create coordination, decentralization and participation leading to the effectiveness of public and local communities and stakeholders in the management of human resources. Further, it can directly increase the level of awareness and participatory processes of the community and interfaces in resource management and management. Second, the reliability, types and manner of availability and sharing the information between official actors, and between formal and informal actors of water governance indirectly lead to clarity and accountability in the studied basin (Cookey et al., 2016). This study attempted to outline these criteria and indicators of these two systems and their importance in Iranian water governance.

METHODOLOGY

This study was a descriptive survey aiming to explain and calculate the coefficients and weight of each component of the interactive, social, cultural systems and water governance. First, the studies in the

field of water governance were reviewed and the factors being frequently used in valid scientific studies were specified by content analysis method and were sent to the related experts. Then, the experts introduced the indicators affecting water governance in interactive and informational fields based on knowledge and ideas using their experience in accordance with the conditions of Iran. Then, the indexes and selective criteria in the fuzzy space were ranked by applying the relevant software due to the existence of various indeterminable or conflicting indicators as well as the existence of numerous organizations and individuals in water governance (Despic & Simonovic, 2000).

Meta-synthesis studies the information and findings from other qualitative studies to related and similar topics (Dekker & Bekkers, 2015). As a result, the desired sample for meta- synthesis was formed from selected qualitative studies and based on their relevance to the research question. Meta-synthesis is not the integrated review of the quality literature of the subject matter and the analysis of secondary and original data from selected studies, but is considered as the analysis of the findings of these studies. In other words, meta-synthesis is a combination of the interpretation of the interpretations of the main data of selected studies (Zimmer, 2006).

Meta-synthesis involves the researcher combining the findings of relevant qualitative research by a thorough and in-depth review. By reviewing the findings of the main articles of the research, the researchers reveal and create the terms which represent a more comprehensive representation of the phenomenon under study. Similar to the systematic attitude, the outcome of meta-synthesis is larger than its total segments. Major patterns of meta-synthesis include 1) the three- step model (Noblit & Hare, 1998) the six-step model (Walsh & Downe, 2005), and 3) the seven-step model (Sandelowski & Barros, 2006).

The most complete method in the field of meta-synthesis is the Sandelowski and Barroso (2006) method, which introduces the following seven steps:

1-Raising the research question, 2-Reviewing the literature systematically, 3-Searching and selecting the right texts, 4-Extracting the text information, 5-Analyzing and synthesizing the qualitative findings, 6-Controlling the quality, and 7-Presenting the findings (Yahyapour et al., 2015).

Data collection method

The present study aimed to identify the socio-cultural and information indicators of water governance in Iran in the library service department. Thus, the meta-synthesis method was used. Meta-synthesis begins with a research question.

Raising the research question

What: The first step in meta-synthesis is determining "what" in the study. In this research, the question "what are the indicators affecting the interactive and information systems of water governance?" was studied and included the question "what?".

Who: It refers to the introduction of the studied population. In this study, the databases Wiley, Springer, Elsevier, Noormags, Magiran, Civilica, and Ensani were used.

When: The timeframe determines the articles to be examined. In this research, the timeframe was considered from 2000 to 2018.

How: The purpose of this section is to investigate the methods for collecting research data. In this research, secondary data, called past records, are also used. These documents include all research papers and reviews, as well as the books related to the research question. In meta-synthesis, the text of these articles is considered to be data.

Review of literature

During the first phase, the keywords of water governance, water governance indicators, water governance in riverside, urban water governance, agricultural water governance were searched and all articles were categorized based on title, abstracts of articles with search keywords.

Controlling the quality of retrieved references

The retrieved references were evaluated in terms of content quality. To this aim, the critical evaluation method was used (Kondori et al., 2018; Glynn, 2006), which helps the researcher determine the accuracy, validity, and significance of qualitative studies (Catalano, 2013). For this purpose, a checklist including five questions was designed to investigate the accuracy, validity, and significance of the articles. In this regard, the questions included reviewing the research objectives of the research method, the accuracy of the analysis, the expression of the findings and the result. Based on the scale of 50 points, the articles were ranked qualitatively being very good (41-50), good (40-31), moderate (30-21), weak (11-20), and very weak (0-10). Eventually, the articles with at least 20 points remained in the research, with 39 papers accepted. After completing the process of evaluating the retrieved resources, the sources were studied. In this research, components and indicators of interactive (cultural and social) and information systems of water governance were identified by focusing on resources. At this stage, the scholar searches for concepts which appear among the existing study codes in the foreground (Sandlowski & Barroso, 2006). It refers to this as a subject study when the

concepts are identified, the researcher creates a classification, and places the same classes in a group. The categorization of codes in similar groups like the concepts of horizontal and vertical coordination, participation, non-concentration, awareness, transparency, availability and sharing were organized higher in the two levels of the interactive system (cultural and social) and information formed in Table 2. In this way, 36 codes, seven concepts, and finally three categories were identified.

The definition of variables

Interactive system (social and cultural)

Coordination: It is a process in which different parts of water governance are combined to achieve a single goal and includes a kind of interaction among the stakeholders who believe that a desirable water governance is not possible without interaction. In fact, it achieves its sophisticated, intertwined, interpersonal goals and collective responsibility (O'Leary and Bingham, 2009).

Horizontal coordination (internal and external)

It refers to a kind of coordination within the general government sector (in the field of institutions and water management) among different sectors of an organization which is organically interdependent (Christensen & Lægreid, 2008), or happens among the various organizations of the public sector including the Ministry of Energy, Ministry of Agricultural Jihad, the Organizing Committee of the Organization of Natural Resources and Environment, etc. External coordination – horizontal coordination is the coordination occurring between organizations, NGOs, and private sector organizations.

Vertical coordination (internal and external)

This type of coordination such as internal horizontal coordination refers to the kind of coordination occurring within the public sector except the organizations and institutions related to water governance which are not the same as the Ministry of Energy, the water resources management authority, regional water companies, as well as rural and urban water and wastewater companies. The external-vertical coordination involves a kind of coordination outside of the general public with the difference that the parties to the interaction fail at sharing the same hierarchy of viewpoints such as interacting water management with international organizations or the Ministry of Energy with provincial water companies, and the rural and urban water and sewage company in the provinces.

Decentralization

In the administrative system, the administrative focus of affairs is under a command and the administration of water from a center is governed by

ministers being high-level decision-makers in the state organization. In this type of administrative system, Ministry of Energy approves laws and regulations, and communicates them to water departments in the provinces, and other departments and agencies in all Iranian cities in accordance with the written and official administrative regulations. In a centralized system, adopting new and arbitrary administrative procedures in the cities is impossible, but the community is managed by granting the administrative autonomy and the competence of decision-making in a region and place in a decentralized system. Unlike the centralized system, this administrative system aims to participate people in NGOs in administrating local affairs to plan for their own destinies, along with a careful monitoring. In this system the government assigns administering some parts or counties to NGOs organizations in the related area.

Participation

Wandersman & Florin (2000) considers participation as a process in which members participate in decision-making on the institution, plans, and implications of these decisions. Participation is the voluntary partnership of people in public programs, which are expected to play a role in national development. In water governance, people, local and state institutions, and organizations become sensitive which is considered as the first step in partnership. Being informed is regarded as the next step is. People and NGOs have the right to know what is happening in the area of water management and governance.

Information system

Awareness: It means understanding the state or subject at the moment based on the information or experience being aware of the knowledge of water resource management systems and the way water is managed through media or popular organizations.

Transparency and availability: According to the International Organization for Transparency, transparency is the key to ensure that individuals are informed of the number of issues and their decision-making methods, but the duty of government executives is that their behavior should be obvious, predictable, and understandable (Christopher & Transparency, 2006). In this study, the concept of availability to information and transparency is related to the sources of spending and decisions and how to decide on managing water in Iran.

Sharing: Sharing means the transfer of official and informal information on water resource information and making the decision between formal actors and informal actors. When the information is shared, duplication in production and data collection is

prevented, costs are reduced and data sources are efficiently used for planning and decision making.

As shown in Table 2, 36 codes were divided into seven indicators and two systems. Extracted measures in Table 2 were made available for evaluation and rating by experts based on the international experts and upstream documentation acceptable to Iran water management, including macro-water policies. Measurement tool was a questionnaire. Validity and reliability of the indices were calculated by using the Cronbach's alpha (r=87%). The statistical population included 25 managers, faculty members, water experts in local and indigenous communities, and NGOs. Then, the fuzzy hierarchy method was used to determine the coefficient of importance and priority of each concept. In order to determine the inter-rater reliability between the two coders, in addition to the researcher who attempted to initialize the code, another researcher encoded the same code that the researcher encoded without knowing its codes separately. When the codes of these two researchers are close together, a high agreement is observed between the two coders representing a high degree of reliability. The Kappa coefficient was used to calculate the coefficient of agreement between two encoders. In this study, two articles coded by the researcher were given to one of the experts for evaluation and then the Kappa coefficient was calculated by SPSS software.

A fairly good reliability was observed because the Kappa coefficient is 0.693 being higher than the acceptable value (0.6). In the next step, in order to rank and weigh the indicators, the hierarchical analysis process (AHP) technique, developed by Saaty (1980-1990), was extensively used as a complex decision tool. Despite the popularity of AHP method, it is not possible to fully reflect the style of human thinking due to its inability to combine inherent ambiguity and lack of clarity (Amir Hasani & Ghobadi, 2016). In order to avoid these flaws, the AHP method was developed to solve ambiguous hierarchical issues. Larhorn and Patrick (1983) proposed a method for the fuzzy hierarchy process analysis based on the Logarithmic Least Squares Method. The complexity of the steps in this method prevented from its use frequently. Due to the first flaws in the Fuzzy AHP method, Buckley (1985) developed a new method called Geometric Mean Method in order to use the AHP technique. Buckley made two basic mistakes in Larhorne and Patrick's technique. First, they used linear equations, and this method may not always have the same responses. Second, trapezoidal numbers are more suitable for fuzzy numbers than fuzzy numbers (Habibi et al., 2014).

Buckley's geometric mean method

In this method, Buckley's geometric mean technique is used to calculate relative weights in fuzzy

pairwise comparisons (Hsieh, et al., 2004). The steps of this method are described below. Assume that $\tilde{P}_{ij}$ is a set of decision-maker preferences for an index relative to other indicators. The matrix of pairwise comparison is as follows:

$$\tilde{A} = \begin{bmatrix} 1 & \tilde{P}_{12} & \tilde{P}_{1n} \\ \tilde{P}_{21} & 1 & \tilde{P}_{2n} \\ \tilde{P}_{n1} & \tilde{P}_{n2} & 1 \end{bmatrix}$$

Where n is the number of related elements in each row. The fuzzy weights of each pairwise comparison matrix are obtained by the Buckley geometric mean method (Hesia et al., 2004). The geometric mean of the fuzzy comparisons of index i is obtained for each index from equation (1).

$$\tilde{r}_i = \left(\prod_{j=1}^{n} \tilde{P}_{ij} \right)^{1/n} \quad i = 1,2,3,\dots,n \qquad (1)$$

Then, the fuzzy weight of the i-th index is represented by a triangular fuzzy number (Habibi et al., 2014) .

$$w_i = r_i \otimes (r_1 \oplus r_2 \oplus \dots \oplus r_m)^{-1} \qquad (2)$$

After calculating the fuzzy weight factors, the weights are defuzzified and then normalized by the following formula.

$$w_{crisp} = \frac{l + 2m + u}{4} \qquad (3)$$

In this study, verbal expressions and triangular fuzzy numbers included in Table 3 were used to calculate the weights in pairwise comparisons.

RESULTS

During this step, the pairwise comparison of criteria was first formed and assigned to 60 respondents. After answering the pairwise comparison, the incompatibility rates of the tables were calculated, which were smaller than 0.1, indicating that an acceptable reliability of the pairwise comparison. Then, the responses were merged into pairwise comparisons using the geometric mean method and the pairwise comparison weights were calculated using the Buckley's geometric mean method as presented below.

As shown in Table 4, participation (C9) with a weight of 0.302 was at the first place. Decentralization (C8) and horizontal coordination (C7), with the weights of 0.292 and 0.239 were respectively ranked as the second and third ranks. As indicated in Table 4, awareness (C10) with a weight of 0.395 was at the first place. availability (C11) and sharing (C12) with the weights of 0.353 and 0.252 were respectively ranked as the second and third place.

Based on Table 5, horizontal coordination in the central government system (C7-2) with a weight of 0.197 was at the first place. Coordination and synchronization in implementing water storage and supply projects (C7-5) and coordination of local administrative organizations (C7-4) with the weights of 0.191 and 0.170, were ranked as the second and third. Based on the results in Table 5, the use of local knowledge to increase participation (C9-8) with a weight of 0.181 was ranked first. Empowering the stakeholders and local users (C9-5) and strengthening the status of social studies in design, implementation, and operation (C9-7) with the weights of 0.152 and 0.146 were ranked as the second and third.

As shown in Table 6, the coordination between the central and regional offices (C8-1) with a weight of 0.367 was at the first rank. Coordination with other countries in common resources (C8-2) and coordination between international and domestic organizations (C8-3), with the weights of 0.339 and 0.294, were respectively ranked as the second and third.

As shown in Table 6, the authority for decentralization (C8-3) with the weight of 0.334 was at the first rank. Decentralization policy (C8-2) and community coordination and decision-making (C8-2) with the weights of 0.307 and 0.196 were respectively ranked as the second and third.

Based on the results, public awareness about water management system (C10-4) with the weight of 0.288 was ranked first (Table 7). Public awareness on increasing participation (C10-5) and environmental awareness in interactive media (C10-3) with the weights of 0.272 and 0.187 were respectively ranked as the second and third.

Based on the results in Table 7, the establishment of the National Water Data Center (C11-2) with the weight of 0.294 was at the first rank. The compilation of information system (C11-5) and availability to information by stakeholders (C11-4) with the weights of 0.278 and 0.175 were ranked as the second and third.

As shown, information sharing between government and stakeholders (C12-3) with a weight of 3.15 was at the first place (Table 8). The promotion of negotiation for decision-making management between stakeholders and users (C12-2) and information sharing among government agencies (C12-1) with the weights of 0.330 and 0.155 were ranked as the second and third, respectively.

CONCLUSIONS

As indicated by the results of the process, participation is the most effective indicator among the

other indicators of regional water governance due to the low participation of people, stakeholders, and NGOs in the province. For this indicator, participation plays a role of local knowledge as a sub-criterion in the participatory index and is of great significance due to the long-standing compatibility of Iran with dehydration and local knowledge including the sedimentation of rocks and sandy on flood rivers, use of jug irrigation, seeding of some smooth products adjacent to or in the roots of deep-rooted plants, etc. (Ghazizadeh Ehsaee, 2014). Local knowledge has various conceptual, technical, and philosophical aspects (Ebrahimi & Salimi Kochi, 2015). The knowledge of local and indigenous peoples, in contrast to official knowledge, is welcomed by local people. Using local people's experiences and knowledge increases their participation in better water resources management. In addition, the status of social studies in the field of water management in Iran water projects was considered to be largely overlooked or more focused on solving the problem of economic and technical aspects.

Among the effective indicators of water governance, the decentralization is the second most influential criterion for water governance indicating that all decisions and laws governing water governance are aligned from top to bottom regardless of local communities. As shown in Table 9 under the criteria of centralization, the authority of a system for decentralization is regarded as the main influence on water governance, which can be legitimized and accepted with the participation of stakeholders, which results in less problematic rules and regulations. Governance is a look at the society in a large stratum, a set of government actions (inside and outside the water sector), while the private sector and social forces and public institutions have found their place and roles within that framework. The lack of a macro-presence program and inadequate decision-making in the provincial planning of the state made the centralization difficult. A centralized water management in Iran and the lack of diversification in the active presence of the private sector and civil society result in reducing the authority of the water governance system, being a kind of unauthorized well extraction in Iran. No other influential criteria are available for water governance while there is a comprehensive policy for focusing on this area which is highly associated with the principles of massive decision-making in society (Esfandiari, 2018). Further, multiple social capitals should be able to link the three pillars of governance including the civil society, private and public sector, and establish an interconnected relationship to transform the process from top to bottom. Coordination is considered as another significant measure of water governance so that the horizontal coordination from the point of view

of the provincial experts is of a higher degree of importance than vertical coordination, because the water bodies and ministries involved in water affairs have an effective coordination in the field of water and can manage water as it deserves in horizontal coordination. Therefore, it is suggested to create an over-organizing committee beyond organizations and administrations which should interact in the water coordination process at the presence of delegates from each interactive organization to explore the opportunities and structural threats. In the vertical coordination, there should be more coordination between regional local water companies or rural and urban water and sanitation, as well as the provincial agriculture and water departments. The entire border of Iran is about 8755 kilometers of which 2700 kilometers are the sea and 4137 kilometers are arid lands (Fani Hagh ,2013). Given the current trends, the water requirements of the world are in great demand. As a result, many rivers in the joint areas between several countries were heavily influenced by the struggle to restrict limited water resources which could intensify the water crisis and cause the conflict between neighboring countries (UNEP-DHI, 2016). Iran was no exception to this crisis. Over the past five decades, the rising average temperature, the average decline in rainfall, the reduction of renewable water sources, and the untapped exploitation of water resources led to the emergence and intensification of water crisis in Iran. Such an issue is vital in joint border zones due to the dependence on the water resources of the frontier. Therefore, the coordination of Iran with other countries in the optimal allocation of joint border water resources is necessary. In the information system in the field of water governance in Iran, awareness is at the first rank indicating the significance of public awareness about water and the risks of water shortage as well as the familiarity with water management. Despite all the ongoing efforts such as educational measures, the true face of water management in Iran is far from ideal requiring the creation of a new strategy with a participatory awareness approach using the media and NGOs, so that people's participation and cooperation with water plans and policies can be achieved by increasing awareness about water and governance and water governance. In addition, people should have accurate and comprehensive information and statistics in the water area so that they can play a role in the field. After changing the attitudes of the officials, the most significant factor for entering people into decision-making and management is transparency and their contribution to statistics and information. Transparency is the fastest, cheapest, simplest, and most reliable mechanism for active and effective public participation. Further, transparency has a

tremendous impact on accountability. As the first step in availability and transparency, with due regard to security considerations and information classification, it is suggested to create a "comprehensive water information system of the country" with information available to stakeholders and other related groups. Further, sharing information is considered as another critical criterion in the information system of Iranian water governance. In sharing information, creating social value including justice through the provision of opportunity equal to the stakeholders to availability information is the most important thing in interacting between state officials and stakeholders in the water sector. Furthermore, the role of the government in cooperation and stakeholder participation in this field are highly significant and information should be presented among the organizations involved in this field in a coded and structured way, so that it can be in the field of decision making with public institutions and stakeholders which play a critical role.

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Table 1. The system classification of indicators affecting the water governance in interactive and information area

Classification	Criterion	Codes	Reference	Frequency
Interactive system (cultural-social)	Horizontal Coordination (C7)	Effective coordination (C7-1)	Cookey et al. (2016), Askary bozayeh (2016)	2
		Horizontal coordination in the central government system (C7-2)	Cookey et al. (2016), Akhmouch & Clavreul (2017), Askary bozayeh (2016)	3
		Coordination of NGOs and stakeholders (C7-3)	Meissner & Jacobs (2014), Davidson & Loe (2016), Cookey et al. (2016), Mir Nezami & Bagheri (2017)	4
		Coordination of local administrative organizations (C7-4)	Askary bozayeh (2016), Cookey et al. (2016)	2
		Coordination in implementing water storage and supply plans (C7-5)	Ghaemi et al. (2017), Esfandiari (2018)	2
		Coordination between the field of science (universities and research institutes), and institutional and executive spheres (C7-6)	Kolahi (2017), Iranian Water Policy Research Institute (2015)	2
	Vertical coordination (C8)	Coordination between Central and Regional Offices (C8-1)	Cookey et al. (2016), Meissner & Jacobs (2014), Neef (2009) Askary bozayeh (2016), Kamasi & Goodarzi (2014),	6
		Coordination with other countries in shared resources (C8-2)	Nikitina et al. (2010), Meissner & Jacobs(2014), Fanhani Hagh (2013), Pourasghar-Sangachin, et al. (2017)	5
		Coordination between international and domestic organizations (C8-3)	Pourasghar-Sangachin & Ebrahimi-Khosfi (2018), Hoekstra (2006) Iranian Water Policy Research Institute (2015)	3
	Decentral	Decentralization plan (C9-1)	Cookey et al. (2016), Pahl-Wostl & Knieper (2014), Claudia Pahl-Wostl (2017), Yusefi et al. (2016)	4

		Comprehensive decision making (C9-2)	Pahl-Wostl & Knieper (2014), Akhmouch & Clavreul (2017), Esfandiari & Arshadi (2017), Cookey et al. (2016),	4
		Authority for decentralization (C9-3)	Cookey et al. (2016), Iranian Water Policy Research Institute (2015), Afrakhteh et al. (2016)	3
		Decentralization policy (C9-4)	Esfandiari & Arshadi (2017), Cookey et al. (2016), Ghaemi et al. (2017)	3
	Participation)C10(	Private sector interference (C10-1)	Ross & Martinez-Santos (2010), Meissner & Jacobs (2014), Dimadama & Zikos (2010), Cookey et al. (2016),	5
		Participation of public participants and stakeholders (C10-2)	Nikitina et al. (2010), Araral & Wang (2013), Ross & Martinez-Santos (2010), Cookey et al. (2016), Meissner Jacobs (2014), Akhmouch & Clavreul (2017), Hill (2013), Clarvis & Engle (2015), Iranian Water Policy Research Institute (2015), Ghaemi et al. (2017), Askary bozayeh (2016), Kamasi & Goodarzi (2014)	13
		Local community participation (C10-3)	Roth et al. (2017), Dimadama & Zikos (2010), Akhmouch & Clavreul (2017), Akhmouch et al. (2016), Cookey et al. (2016), OECD (2015), Salari et al. (2015), Askary bozayeh (2016), Kamasi & Goodarzi (2014), Yousefi et al. (2016), Omranian (2015), Mirzaei et al. (2017)	11
		NGO Participation (C10-4)	Araral & Wang (2013), Dimadama & Zikos(2010), Akhmouch & Clavreul (2017) Cookey et al. (2016), Askary bozayeh (2016), Yousefi et al. (2016)	6
		Participation in Empowering Stakeholders and Local Users (C10-5)	Dimadama & Zikos (2010), Akhmouch & Clavreul (2017), Ghaemi et al. (2017), Yousefi et al. (2016,) Omranian & Davari (2017), Cookey et al. (2016)	7
		Interference of local communities in planning in the basin (C10-6)	Akhmouch et al. (2014), Ghaemi et al. (2017)	2
		Strengthening the place of social studies in design, implementation, exploitation (C10-7)	Ghaemi (2016), Iranian Water Policy Research Institute (2015)	2
		Using local knowledge to increase participation (C10-8)	Hill(2013), Kamisi & Goodarzi (2014), Nezami & Bagheri (2017)	3

Information system	awareness)C11(	Public awareness of the environment (C11-1)	Dimadama & Zikos (2010), Cookey et al. (2016), Balali et al. (2009)	3
		Ngo Participation in Informing (C11-2)	Cookey et al. (2016), Dimadama & Zikos (2010)	2
		Increasing media awareness in the media (C11-3)	Medema et al. (2014), Afsari et al(2017)	2
		Community awareness and knowledge about water management system (C11-4)	Dimadama & Zikos (2010), Cookey et al. (2016), Akhmouch & Clavreul (2017), Ghaemi et al. (2017)	4
		Awareness and raising public awareness in the areas of participation in water management (C11-5)	Ghaemi (2016), Afsari et al. (2017)	2
	Transparency and availability (C12)	Free flow of information from government agencies (C12-1)	Akhmouch et al. (2016), Hill (2013), Cookey et al. (2016)	3
		Establishing the National Water Data Center (C12-2)	Ghaemi et al. (2017), Yousefi et al. (2016)	2
		Mechanism for disclosure of information (C12-3)	Cookey et al. (2016), Akhmouch & Clavreul (2017)	2
		Availability to information by stakeholders (C12-4)	Akhmouch & Clavreul (2017), Akhmouch et al. (2014), Hill (2013), Cookey et al. (2016), Asgari Bazaye (2016), Mirzaei et al (2017)	5
		Compilation of a comprehensive information system for resources, costs and allocation of water resources (C12-5)	Ghaemi et al. (2017), Hill (2013)	5

		Compilation and implementation of a comprehensive information system and water monitoring hierarchy (C12-6)	Ghaemi. (2016), Iranian Water Policy Research Institute (2015),	2
	Sharing) C13(	Sharing information among government agencies (C13-1)	Akhmouch et al. (2016), Cookey et al. (2016), OECD (2015)	3
		Sharing information between government and stakeholders (C13-2)	Ross1 & Santos (2010), Akhmouch & Clavreul (2017), Cookey et al. (2016), Ghaemi et al. (2017)	4
		Promoting conversation and negotiation to share information between stakeholders and users (C13-3)	Salari et al. (2015), Iranian Water Policy Research Institute (2015), Omranian (2015), UNDP (2013)	3
		Sharing academic information categorized to address the cultural and social problems of water (C13-4)	Iranian Water Policy Research Institute (2015), Ghaemi (2016)	1

Table 2. Calculation of Kappa coefficient

Number of variable observations	Value	Estimated standard deviation	t-value	significance level
Kappa agreement	0.693	0.069	12.81	0.0001

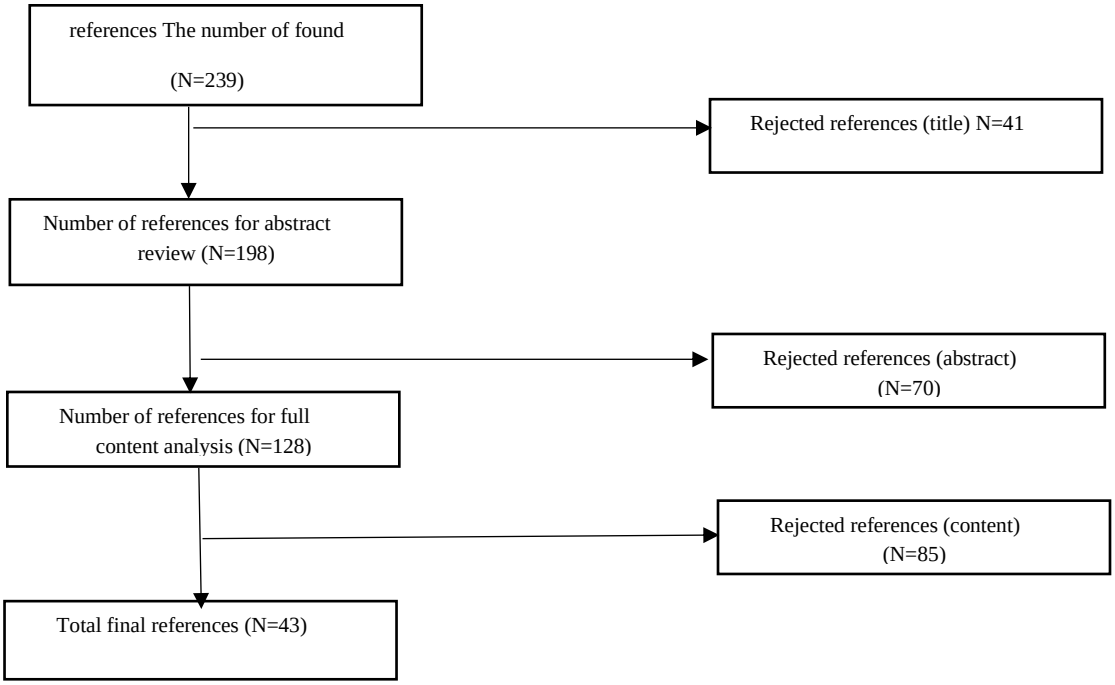

Figure 1. Algorithm for selecting final references

Table 3. Verbal expressions and fuzzy numbers for weighting the criteria

Code	Priorities	The fuzzy equivalence of priorities		
		Low limit	Average limit	High limit
1	Equally important	1	1	1
2	Equal to relatively more important	1	2	3
3	Relatively more important	2	3	4
4	Relatively more important to much important	3	4	5
5	Much important	4	5	6
6	Much to very much important	5	6	7
7	Very much important	6	7	8
8	Very much to completely more important	7	8	9
9	Completely more important	8	9	10

Table 4. The weight of interactive system criteria (socio-cultural) and information system

interactive system	Definitive weight	Normal weight	Rank	**information system**	Definitive weight	Normal weight	Rank
Horizontal coordination (C7)	0.245	0.239	3	Awareness (C10)	0.401	0.395	1
Vertical coordination (C8)	0.171	0.167	4	Availability and transparency (C11)	0.358	0.353	2
Decentralization (C8)	0.299	0.292	2	Sharing (C12)	0.256	0.252	3
Participation (C9)	0.309	0.302	1				

Table 5. The weight of horizontal coordination and participation sub-criteria

coordination sub-criteria	Definitive weight	Normal weight	rank	**participation sub-criteria**	Definitive weight	Normal weight	Rank
Effective coordination (C7-1)	0.141	0.137	6	Private sector interference (C9-1)	0.064	0.061	8
Horizontal coordination in the central government system (C7-2)	0.202	0.197	1	Participation of public participants and stakeholders (C9-2)	0.1	0.096	7
Coordination of NGOs and stakeholders (C7-3)	0.165	0.161	4	Local community participation (C9-3)	0.130	0.124	5
Coordination of local administrative organizations (C7-4)	0.174	0.170	3	NGO participation (C9-4)	0.119	0.114	6
Coordination in implementing water storage and supply plans (C7-5)	0.196	0.191	2	Empowering the stakeholders and local users (C9-5)	0.158	0.152	2
Coordination between the field of science (universities and research institutes) and institutional and executive institutions (C7-6)	0.148	0.144	5	Interference of local communities in planning in the field (C9-6)	0.131	0.126	4

Table 6. The weight of vertical coordination and Decentralization sub-criteria

Coordination sub-criteria	Definitive weight	Normal weight	Rank	**Decentralization sub-criteria**	Definitive weight	Normal weight	Rank
Coordination between central and regional offices (C8-1)	0.376	0.367	1	Decentralization plan (C8-1)	0.166	0.163	4
Coordination with other countries in shared resources (C8-2)	0.347	0.0339	2	Decision-making of societies (C8-2)	0.200	0.196	3
Coordination between international and domestic organizations (C8-3)	0.300	0.294	3	Authority for decentralization (C8-3)	0.341	0.334	1

Table 7. The weight of awareness and availability sub-criteria

awareness sub-criteria	Definitive weight	Normal weight	Rank	availability sub-criteria	Definitive weight	Normal weight	Rank
Public environmental Awareness (C10-1)	0.145	0.141	4	The free flow of information from government agencies (C11-1)	0.131	0.128	4
Knowledge of NGOs in awareness campaign (C10-2)	0.116	0.113	5	Establishing the National Water Data Center (C11-2)	0.301	0.294	1
Environmental awareness in interactive media (C10-3)	0.192	0.187	3	The mechanism for disclosure of information (C11-3)	0.128	0.125	5
Public awareness about water management system (C10-4)	0.296	0.288	1	availability to information by stakeholders (C11-4)	0.179	0.175	3
Public awareness on increasing participation (C10-5)	0.280	0.272	2	Compilation of information system (C11-5)	0.284	0.278	2

Table 8. The weight of sharing sub-criteria

	Definitive weight	Normal weight	Rank
Sharing information among government agencies (C12-1)	0.196	0.192	4
Sharing information between government and stakeholders (C12-2)	0.323	0.315	1
Promoting the discussion to share information between stakeholders and users (C12-3)	0.289	0.283	2
Sharing academic information to address the cultural and social problems of water (C12-4)	0.214	0.210	3