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Irrigation water management in Iran: Implications for water use efficiency improvement

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ABSTRACT

Water is the most essential resource for the production of agricultural goods and services. However, high levels of water stress and increased frequency and intensity of droughts, which are mainly driven by climate change dynamics, have reduced the stock of freshwater resources in arid and semi-arid regions, such as Iran. Despite the major reduction of freshwater resources, the efficiency of irrigation water use has remained very low in the country and performance of water management schemes is far from satisfactory. Using the strengths, weaknesses, opportunities and threats/political, economic, social, technological, legal and environmental (SWOT/PESTLE) analysis, this paper explores 40 internal and external factors that influence irrigation water management in Iran and recognizes legal, social, technological and political dynamics as the major reasons for failure of irrigation water management in the country. A combination of the threats, opportunities, weaknesses and strengths (TOWS) matrix and bottleneck analysis was used to suggest irrigation water management strategies that rehabilitate the failed schemes and enhance water security in the agriculture sector. Rethinking the role of intensified agriculture in development along with raising the awareness and attitude of decision makers towards the risk of shortsighted water resource development plans, in addition to promoting agro-based industries and developing integrated plans to improve water efficiency are the strategies that can contribute to a more effective management of irrigation water in Iran.

1. Introduction

Water is considered as one of the most critical resources for human beings. It is vital not only for economic development, as water resources are important to the production of agricultural and industrial goods and services, but also it is the most essential component of the natural environment (Chartzoulakis and Bertaki, 2015). Also, it has a significant influence on health and nature conservation. However, only 2.7% of global water is available as freshwater with an appropriate quality, out of which only 30% can be applied to answer human and livestock demands (Ertek and Yilmaz, 2014).

Over the past 60 years, global demand for freshwater has increased for many reasons including rapid population and economic growth (Kaur et al., 2010), urbanization and industrialization (Biswas, 2010), land use change (Sophocleous, 2004), intensive agricultural practices (Tilman et al., 2002) and environmental degradation (Vörösmarty et al., 2000). Furthermore, changes in the frequency, duration and intensity of drought events have dramatically reduced the stocks of freshwater resources in several regions (Ronco et al., 2017), especially in the arid and semi-arid areas of Iran. For instance, the 2007–2014 drought in Iran led to the complete dry up of many internationally renowned wetlands and lakes, significant reduction of river flows and depletion of groundwater resources (Keshavarz and Karami, 2016).

On the other hand, by 2050, the world's population is projected to rise to 9.8 billion people and more than half of this population will reside in urban areas (UN, 2017). As population and economic growth will continue, more food will be needed to be produced in the future.[1] It means that water demand will grow more than 40% by 2050 (UN, 2015). Therefore, water scarcity will turn out to be a great issue in the near future (Doungmanee, 2016). In parallel, climate change is expected to deteriorate the situation through significant reduction of freshwater supplies and increase of frequency, intensity and duration of drought events (IPCC, 2014). While climate change has already affected the temporal and spatial variability of surface and ground water

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[1] Approximately 50% more food compared to the data for 1998 (FAO, 2010).

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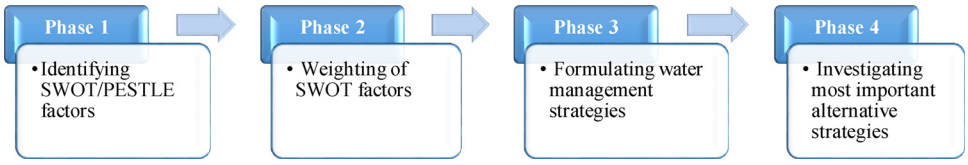

Fig. 1. Research framework.

availability (IPCC, 2014), it is predicted that approximately two-third of the world's population will encounter water stress conditions in 2025 (UN Water, 2010). As the available freshwater supply will become scarce, the demand for irrigation water will increase in the regions that their agricultural systems heavily depend on irrigation, such as Iran.

Irrigated agriculture is currently the major user of water resources worldwide by consuming approximately 70% of the total withdrawn water (FAO, 2013). In developing countries, like Iran, whose rural economies mainly depend on agricultural products, intensive irrigated agriculture is responsible for over 90% of freshwater consumption (Samian et al., 2015) and will continue to be the main user of renewable water resources (Rosegrant et al., 2009).

Since water scarcity is a harsh reality of the agricultural sector in arid and semi-arid regions, proper management and efficient use of agricultural water are imperative to ensure global water safety. However, water use efficiency of agriculture in Iran is very low. The average efficiency of irrigation systems in this country is about 35% (Madani, 2014), which is far lower than 70–90% irrigation system efficiency of the most developed countries (FAO, 2016).

Therefore, conservation of water resources and affordable and sustainable use of irrigation water is required to mitigate the problem of water shortage, in Iran. As the reduction of irrigation water supply and demand will pose a great risk to national food security (Kang et al., 2016) and will increase rural poverty and forced migration without diligent planning, a consistent policy of rational irrigation development is necessary. In this respect, improving the productivity of irrigated agriculture has been a priority for the government of Iran since 1960 (Forouzani and Karami, 2010). Despite increasing institutional investments in dam construction, provision of low-interest loans and implementation of various policy measures such as subsidized agricultural water and energy use, the performance of many water management schemes is far from satisfactory (Keshavarz et al., 2013; Madani, 2014; Moazedi et al., 2011). The efforts of Iran for managing irrigation water have been criticized due to the decades of disintegrated planning and management myopia (Madani, 2014). Also, the rapid investment and growth in the economy and infrastructure sectors without considering the dynamic relationships between these sectors and the water, environment and ecosystem components have been discussed (Mirchi et al., 2010). Moreover, the absence of an integrated view about the human-natural system relationship is evident in Iran, which means that the context, local realities or legitimacy are ignored during the implementation of water management practices (Hjorth and Madani, 2014). Since continuation of the current irrigation water management trends will amplify the water crisis of Iran, it is imperative to assess site-specific irrigation water management challenges and ensure sustainable management of irrigation water.

Numerous studies have applied SWOT (Strengths, Weaknesses, Opportunities and Challenges) and/or PESTLE (political, economic, social, technological, legal and environmental) analysis to different fields of water management in both developed and developing countries, e.g. Abdullaev et al., 2009; Bastiaanssen et al., 2007; Burt et al., 2006; de Souza and Costa da Silva, 2014; Gallego-Ayala and Juízo, 2011; Grigg, 2005; Jang et al., 2014; Martins et al., 2013; Michailidis et al., 2015; Molden and Oweis, 2007; Mugabi et al., 2007; Mylopoulos et al., 2008; Panigrahi and Mohanty, 2012; Srdjevic et al., 2012; Tekken and Kropp, 2015; Yavuz and Baycan, 2013. However, the factual status of irrigation water management is not well documented in Iran. Meanwhile, there is strong evidence that each country involves its unique internal, i.e. strengths and weaknesses, and external, i.e. opportunities and threats, factors that reinforce or depreciate water management. As an outcome, conducting a research related to improving irrigation water management in the Iranian context can raise awareness of water sustainability challenges and help decision makers to rehabilitate the failed schemes of irrigation water security. Therefore, this study attempts to i) identify the strengths, weaknesses, opportunities and threats of the Iranian water management practices and policies, ii) determine the most critical factors associated with sustainable management of irrigation water and iii) propose some water management strategies to ensure effective use of the limited water and alleviate irrigation water shortages, in the arid and semi-arid regions of Iran.

2. Research method

A four-phase decision making framework was designed to identify the critical internal and external factors that are associated with sustainable management of irrigation water resources in Iran and rank the water management strategies according to their importance (Fig. 1). The study framework is described with more details, in the subsequent sections.

2.1. SWOT/PESTLE analysis

SWOT/PESTLE was used to investigate the current status of irrigation water management in Iran. Generally, SWOT is a list of factors that can be used to describe present and future trends of both internal and external environments (Yavuz and Baycan, 2013). SWOT is a convenient way of conducting a situational evaluation (Wickramasinghe and Takano, 2009) and categorizing the key internal and external factors that are important for achieving sustainable water management.

In order to identify the preliminary strengths, weaknesses, opportunities and threats (SWOT) of sustainable management of Iran's irrigation water systems, the literature about irrigation water management in Iran was reviewed. In addition, three primary sources were used as a starting point including i) an expert group meeting, ii) a focus group discussion by policy makers, and iii) semi-structured interviews with the main irrigation water users i.e. farmers of the Moghan plain who hold the positions of opinion leadership (Table 1). The Moghan plain, northwest Iran, is one of the leading agricultural regions in Iran.

The farmers, who participated in this study, were selected based on

Table 1
General characteristics of the participants.

Characteristics	Number	Percentage of the total sample
Participants		
Farmers	16	53.3
Policy makers	5	16.7
Experts	9	30.0
Gender		
Male	28	93.3
Female	2	6.7
Education		
Ph.D.	9	30.0
M.Sc.	4	13.3
B.Sc.	5	16.7
Diploma	12	40.0