INVESTIGATING THE MECHANISMS OF THE LOCAL WATER MARKET FORMATION AND ITS ROLE IN URBAN AND REGIONAL PLANNING WITH EMPHASIS ON KASHAFROOD BASIN

INVESTIGANDO OS MECANISMOS DA FORMAÇÃO DO MERCADO LOCAL DE ÁGUA E SEU PAPEL NO PLANEJAMENTO URBANO E REGIONAL, COM ÊNFASE NA BACIA DE KASHAFROOD

Mohammad Hasan Habibi [1]
Mohammad Ali Ahmadian [2]

Abstract: *Today, the development of market-based allocation mechanisms is raised as a sustainable, flexible and efficient way in managing water resources and redistributing them among different uses. However, the market's ability to efficiently and optimally allocate water depends on the establishment of the specific conditions of the market and the commodity exchange (water).*

Water, in addition to being the source of life, is raised today as an economic commodity. One of the most important features of any economic commodity is its ability to be exchanged and traded in the market. According to the Law on Implementation of General Policies of Principle (44) of the Constitution, Article 142 of the Fifth Development Plan Act and also legal obligations, communicated strategies and policies and the need to employ appropriate economic tools to promote the economic value of water are better implemented through strengthening and developing local and regional water markets and providing a non-discriminatory, efficient and transparent environment for water exchange in the local market system. This study aims to explain the theoretical foundations of the local water market with emphasis on supply and demand management in the water sector (Kashafrood basin).

Keywords: *Water market governance. Monopoly. Water market agents. Water market formation requirements. Mashhad plain.*

Resumo: *Hoje, o desenvolvimento de mecanismos de alocação baseados no mercado é criado como uma maneira sustentável, flexível e eficiente de gerenciar os recursos hídricos e redistribuí-los entre diferentes usos. No entanto, a capacidade do mercado de alocar água de maneira eficiente e ideal depende do estabelecimento de condições específicas do mercado e da troca de mercadorias (água).*

A água, além de ser a fonte da vida, é criada hoje como uma mercadoria econômica. Uma das características mais importantes de qualquer mercadoria econômica é sua capacidade de ser trocada e comercializada no mercado. De acordo com a Lei de Implementação de Políticas Gerais do Princípio (44) da Constituição, o Artigo 142 da Quinta Lei do Plano de Desenvolvimento e também obrigações legais, estratégias e políticas comunicadas e a necessidade de empregar ferramentas econômicas apropriadas para promover o valor econômico da água é melhor implementada através do fortalecimento e desenvolvimento dos mercados locais e regionais da água e do fornecimento de um ambiente não discriminatório, eficiente e transparente para a troca de água no sistema de mercado local. Este estudo tem como objetivo explicar os fundamentos teóricos do mercado local de água, com ênfase no gerenciamento de oferta e demanda no setor de água (bacia de Kashafrood).

Palavras-chave: *Governança do mercado de água. Monopólio. Agentes do mercado de água. Requisitos de formação de mercado de água. Planície de Mashhad.*

[1] Razavi Khorasan Water and Wastewater Company, Mashhad, Iran. E-mail: inspector@abfakhorasan.ir

[2] Faculty member, Department of Geography, Ferdowsi University of Mashhad, Mashhad, Iran. E-mail: ahmadian@ferdowsi.um.ac.ir

Introduction

In terms of water resources, Iran is a dry country with few permanent rivers. The imbalance in the proportion of precipitation in the regions has increased water scarcity for some of the watersheds. By reducing precipitation over a period, we have witnessed a sharp decline in resources and flows in several famous lakes of the country and several large rivers, especially in eastern and southern regions of the country. This is evident in the central areas, including Salt Lake and Zayanderood basins. Therefore, groundwater harvesting has increased and subsequently, underground aquifers have declined sharply in many areas. Uncontrolled harvesting has caused salinization of the aquifers and, ultimately, soil degradation of agricultural lands.

The rapid population growth and the agricultural sector's growing need in Kashafrood basin have inevitably led us to the expansion of allocation systems and improvement of consumption patterns to save more water. Attention to this issue will be further felt in the near future as harvestable resources decrease. Thus, establishment of a central system that can solve many of these problems is essential. In this regard and in order to resolve challenges and implement corrective policies, water resources management planners have proposed the necessity of forming a local water market. In other words, consolidation of exchangeable water rights and formation and strengthening of water markets are among the requirements of this project. In this article, attempt is made that "strengthening water market system with a supply and demand management approach in Kashafrood basin of Mashhad plain" be raised as a central approach and its ability to solve some of the water resources management problems be mentioned. The success of this system, however, depends on the understanding and consensus required to form it, support from all institutions and water authorities, especially the government, and trust in it. In this article, the water market refers to the formal system, rules and regulations governing the selling, buying and water operation licenses that are ideally traded independent of land ownership right.

Some researchers have made a comprehensive comparison of water markets in the United States, Australia, Chile, South Africa and China and have shown how markets function within very different legal and institutional frameworks and what implications they have for efficiency, justice and sustainability (Peter Debaere et al., 2014).

Water markets emerge in different ways. Some are gradually formed, such as in South East Australia, and some other may emerge as a result of an event such as litigation in the discussion of decentralizing the operation of water utilities in Mali. What is common in most water markets is the existence of water scarcity; that is, markets emerge as water demand approaches the existential water ceiling. Nevertheless, what is most important for water consumption control and the proper functioning of markets is that water consumption be within the limits specified in the issued licenses. When water supplies are limited, water markets help to facilitate the non-compulsory exchange of water right between buyers and sellers. In this way, water markets can be seen as an example of the application of the exchange system within the designated ceiling. Water exchange usually changes the distribution of water among consumers or competing sectors. In addition, setting a ceiling can provide a significant incentive to save water.

In matching the theoretical foundations of economics with the unique characteristics of water, it is explained why the market entity is unable to fully consider the economic, social, cultural and environmental impacts in meeting the needs, creating balances and resolving problems. Water fluidity and mobility and reusability, consideration of non-market and environmental quality, the issue of the natural monopoly of service delivery because of economies of scale and joint, vital and non-replaceable features and the need for government intervention in collective actions are among the components of interest in this discussion. On the other hand, if it is not possible to receive the actual price of water and related services from their user based on the economic logic, a gap is created between the harvesting value and water and the paid cost, which is called "rent". There are different systems from the perspective of involvement of water exchange system and operation:

1- Autonomous system: The consumer directly harvests the water himself and fully finances the cost of water harvesting. But given the difference between his cost and that of those referring to the local water market, it is seen that the rate of rent is high and the rent-seeking phenomenon is quite visible. In this field, the issue of market and water pricing are not considered since water harvesting is done only for the consumption of the person harvesting it and the end consumer pays

the harvesting costs that are far less than the water value.

2- Local water market: Part or all of consumer needs are provided through the purchase of surplus water from other water right holders and water resource exploiters. In this environment, investment and initial costs are provided by the private sector and local water markets are considered and the pricing is done based on some sort of agreement between the water supplier and water applicant. This method of pricing is usually called rent and does not have much political burden and does not face social protests in case of being competitive and fair. Protests are handled by local trustees or Justice Department and the judiciary.

3- Government agents: Consumers meet their needs from government-dependent companies. In the government environment, a system of selling and pricing water is considered. Investment is made and initial costs are provided by the government. In this state, in order to repay and finance, pricing is considered which is set and obtained based on state laws and regulations. Water pricing in this managerial environment usually has a high rent and political burden and for this reason, the companies in charge cannot use all legal capacities to obtain tariffs.

The basis of the water market is exchange. That is, someone who has water and does not need all the volume of his water transfers it to anyone who needs water at that time and in this way, an exchange is formed. Exchange development creates market. This requirement is not only limited to irrigation systems and is found in almost all types of systems. Across our country, markets have been shaped “unofficially” based on the need for exchange despite the existing preventive laws.

There is another serious incentive to exchange water. If an exploiter can obtain more economic value than other water exploiters, he himself can use a share of others’ water by paying an amount. The result of these exchanges is that water becomes more valuable, and planning and development become possible in areas where it is not possible to supply new water. As previously stated, water markets usually have low depth and consistency and a limited geographic range. Moreover, uncompetitive and monopolistic conditions prevailing the market may lead to market inefficiency and malfunctioning. Therefore, an appropriate set of policies or executive plans is needed to optimally utilize this economic entity to resolve water resources management problems.

A perfect market is the market in which:

- Ownership rights are defined.
- These rights are safe and non-violable.
- These rights are transferable and applicable under various conditions.

Effective government presence to monitor the performance of this market and guide it toward optimal conditions is recommended by economists (Esfandiyari, 2010).

Research method

The purpose of this article is to explain the theoretical foundations of the local water market with emphasis on supply and demand management in the water sector (Kashafrood basin). This research is a case study and, as the case may be, a task from the Ministry of Energy to fully implement the local water market. Statistical population is related to the agricultural sector and existing cropping patterns with regional efficiencies. Besides, in the statistical population, the amount of water harvesting through the groundwater resources or water rights in this section is indicated.

Research Background

Landry (2001) conducted a study entitled “How can the water market respond to the challenges?”, in which he has referred to the feature of water allocation in the market and has laid stress on the removal of restrictions on water use. He, while emphasizing the necessity of the dynamics of water laws and elimination of the direct government interventions, argued that the establishment of a set of rules and guidelines that are enforced by water right holders is required to create a market in water supply and even monitoring and protection of water resources, and transparency of water laws and rights and determination of water exchange prices in each region with the strengthening of market forces are a key factor in encouraging public and private participation in water management.

Bohlulvand and Sadr (2006), by estimating water demand function in Mojen of Shahrood,

revealed that in total, 30% of the water consumed by farmers is supplied from the water market exchanges. Kiyani (2008) also estimated water supply and demand functions and stated that on average, 22% to 28% of the water consumed is supplied through the water market. Garrido (2000) evaluated different scenarios of water transfer among farmers within a region at the equilibrium price resulting from different water markets in the agricultural sector of Spain. Calatrava and Garrido (2005) assessed the decisions on farmers' participation in water markets in southern Spain. Weister (2005) simulated the water market between farmers and water supply companies in Tunisia using mathematical programming method while considering four different scenarios of water level. Gomez Limon and Martinez (2006) decided to analyze the economic and social impacts of water market creation using multi-criteria decision-making (MCDM) method. To this end, they simulated cash irrigation water market in Spain and maintained that the water market causes that water input shifts from low-productivity consumption to high-productivity consumption.

Within the country, Kiyani (2000) performed a study on the formation of water market and its effects on agricultural sub-sector and water resources management. The results demonstrated that exchange of irrigation water among farmers in Saveh plain increases their gross profit in times of water scarcity and conditions for water stress. Increased labor demand and reduced negative effects of water shortage on employment are also other consequences of water market formation in Saveh plain. Nikouei and Najafi (2001) simulated a water market to analyze the economic and welfare aspects of its use in Isfahan. According to the results, after establishing the water market and reducing water restrictions, farmers increase their program efficiency by allocating the land between different crops and sell the surplus water and buy their required water. In these circumstances, the welfare of farmers will increase significantly. Parhizkar (2013) simulated the establishment of a water market and analyzed the impacts of irrigation water sharing policy on the planting pattern of selected crops in Shahrood basin. The results disclosed that by forming local water markets and making irrigation exchanges between the studied areas, the economic profit of farmers in Alamut Region in the lands of tail water of Shahrood basin has increased compared to the base year conditions and the total area under cultivation of aquatic products has also increased from 9% to 13% in the studied area. Yousefi (2014) investigated the welfare effects of market allocation of water resources in the Iranian economy. For this purpose, they applied the general equilibrium model. The results of the water market creation in dehydration conditions showed that with the establishment of water markets, welfare rates for urban and rural households decrease and increase respectively. Furthermore, the welfare rate for the upper deciles in rural areas has significantly increased compared to the lower deciles. Ahmadi (2013) made an economic evaluation of the implementation of agricultural water market technical platform in Mahyar irrigation network in Zayanderood basin. The results displayed that after establishing the market, farmers' program efficiency has increased by 19% relative to the base state. Moreover, the volume of water exchanged in the market is 41% of the volume of water consumed, suggesting the high participation of farmers in the market for optimal water allocation. Studies show that the establishment of irrigation water markets, especially at the local and regional levels, increases the farmers' program efficiency and prevents the waste of extra water across the lands in addition to balancing the supply and demand of irrigation water. To this end, the present research aims to investigate the effects of the local water market formation on balancing the supply and demand of irrigation water and agricultural production in Kashafrood region (Mashhad plain studied area). The innovation of the current study in assessing the potential impacts of the structural entity of water market compared to previous studies conducted in this field is the use of a complex hydrological-economic integrated modeling system, which is calibrated in five successive stages and has the capability to incorporate water stress in the crop production process in addition to including a set of system and calibration constraints. Hence, in the field under investigation, the present research is among the studies that benefit from a set of hydrological and economic models.

Mathematical formulas and relations

Hydrological-economic modeling (HEM)

Hydrological-economic modeling (HEM) system is employed to jointly investigate the relationships between hydrological (water resources) and economic (gross profit, income, water value, production rate) variables. Today, this system is used to analyze the economic impacts of

policies of water resources and agriculture sectors (Mohammadi & Parhizkar, 2016). It is important to select an appropriate scale for hydro-economic models since the mechanism required for the dynamic space of each process or component in this model may be inappropriate for another process or component. For this reason, the relationship between two hydrological and economic components is essential for understanding the issues in this regard (Parhizkar, 2013).

Selection of the proposed model and its simulation in different water markets

SOWT model analysis

SWOT analysis is absolutely essential before entering any market and generally every time we want to enhance the feedback on our marketing and advertising activities. In this method, all situations and conditions in our environment are examined and by discovering weaknesses, strengths, opportunities and threats, we will be more prepared for future market events.

Once you have identified strengths, weaknesses, opportunities and threats, you can use the SOWt matrix to design an appropriate strategy for activities. In this method, you can develop strategies in four different ways:

SO strategies: Use your strengths to exploit your opportunities.

WO strategies: Take advantage of the opportunities that can be used to remove your weaknesses.

WT strategies: They are a kind of defensive strategy where you may be harmed by threats because of your weaknesses.

ST strategies: In this strategy, you neutralize your threats using your strengths.

Water market simulation in Mashhad plain using the SOWT model

To simulate the water market of Mashhad plain, different steps can be imagined, including:

- First step: Segmentation of regions and collection of base year data
- Second step: Solving linear programming model and determining shadow prices
- Third step: Estimation of regional production function and coefficient estimation
- Fourth step: Estimation of exponential cost function and its parameters
- Fifth step: Estimation of demand function of crops based on endogenous prices
- Sixth step: Creation of the final programming model and explanation of the calibrated PMP model

SOWT model results in Mashhad plain

Results of water market formation in Mashhad plain include the following:

- Cropping pattern: Noticeable changes in the cropping pattern (while removing some crops from the cropping pattern, increasing the area under cultivation of other crops)
- Farmers' profits: Replacing more profitable products with less profitable products and lower income fluctuations
- Production inputs: 22% and 6% decrease in capital and total labor force
- Water consumption in the plain: 20% reduction in water consumption

Developing the proposed structure for the water market formation in Mashhad plain

First phase: Law amendment (separation of water ownership rights from land ownership rights, liberalization of water exchange from land and recognition of water rights)

Second phase: Design of a mechanism for securing the exchanges (legislation for market activities and intra-sectoral and extra-sectoral transfers for the consistency of the water market)

Third phase: Creation of physical infrastructure (inclusion of laws related to the settlement of disputes arising from water market exchanges)

A guideline for water transfer in Mashhad plain water market structure

This guideline contains 12 articles, some of the most important of which are as follows:

Article 5_ Study of the main issues related to water transfer (including size, cost, time, distance, etc.)

Article 6_ Definition of the transfer process in the water market structure including the following steps:

1- Completing and signing the application form by the transferor (seller) and transferee (buyer) and providing the required documents

2- Reviewing the application by the regional water company

3- Returning the application to the applicant in case of disagreement and entering the stage of issuance of operating license in case of agreement (depending on the type of permanent or temporary transfer)

Article 7_ Companies can only issue operating licenses for the applicants under the ceiling of the issued allocations.

Article 8_ Continuous monitoring of the implementation of operating licenses in the water market by the regional water company

Article 9_ Considering the side effects of water transfers and any conditions that affect water market transfers

Article 10_ In any type of water exchange, the type of water consumption should be changed with the permission of the regional water company.

Article 11_ In water transfer to greater distances, all of the above should be pursued with greater sensitivity.

Article 12_ Definition of the transferor's and transferee's tasks in the market structure

Introduction of the area under study

Mashhad plain is part of Kashafrood basin located in north of Razavi Khorasan province. Kashafrood as the main drainage of this basin is drawn from northwest to southeast and passes through Mashhad plain (Figure 1). The second largest metropolis of the country, Mashhad, and the counties of Chenaran, Torqabeh, Shandiz and Razaviyyeh are located in this plain. A population of 3.5 million people lives in this plain (Khorasan Razavi Regional Water Authority, 2015).

The problem of water crisis in Mashhad plain is not only related to agricultural use, but service and industrial consumptions are also involved so that the rate of water consumption in the service and industrial sector has increased from 8% in 1971 to 43% in 2015 (MWWF, 2013). The balance sheet of Mashhad plain is 88 million cubic meters and the aquifer's water table faces an annual drop of more than 70 cm (Khorasan Razavi Regional Water Authority, 2015).

As the trend continues, in the not too distant future, the aquifer of Mashhad plain will be destroyed either qualitatively or quantitatively. Given the mentioned challenges, the following questions can be raised: How far is this basin from the volume of water that can offset the reservoir deficit in the studied area of Mashhad plain? At what cost can this water be transferred? Will there be no future demand for more water if this amount of water is supplied? What is the current status of water demand management in Mashhad plain? What is people's and managers' perception of water demand management and water conservation and maintenance?

Mashhad plain as the most important plain of Razavi Khorasan province is under the conditions of extreme population growth and increasing economic development and has been banned since 1968 due to the drop in the groundwater level. Human activity in this plain, like other plains in the east of the country, has been, to this day, based on groundwater resources to supply its water. Currently, water supply decisions in Mashhad plain are mostly centered around the following four basic issues:

- Shifting the allocation of limited water resources to industrial uses and services from authorized agricultural resources with emphasis on prohibition of any development in the western part of the plain

- Recycling and purifying lower-quality inlet waters based on the type of their use
- Emphasizing the sustainable goals such as the imposition of some serious restrictions on water use and non-structural management.
- Water transfer from outside the basin
- Restrictive development planning especially in west of Mashhad plain

Results

Water demand trend in Mashhad plain

The main sectors of water consumption in Mashhad plain include agricultural, urban (drinking water) and industrial consumption respectively (Figure 5). This plain is an exception among other plains of the province in terms of consumption type so that the percentage of agricultural consumption therein is about 30% lower than the average consumption in plains of the province

Tables, figures and diagrams

Figure 1: The studied area of Mashhad plain and location of the city and the villages therein

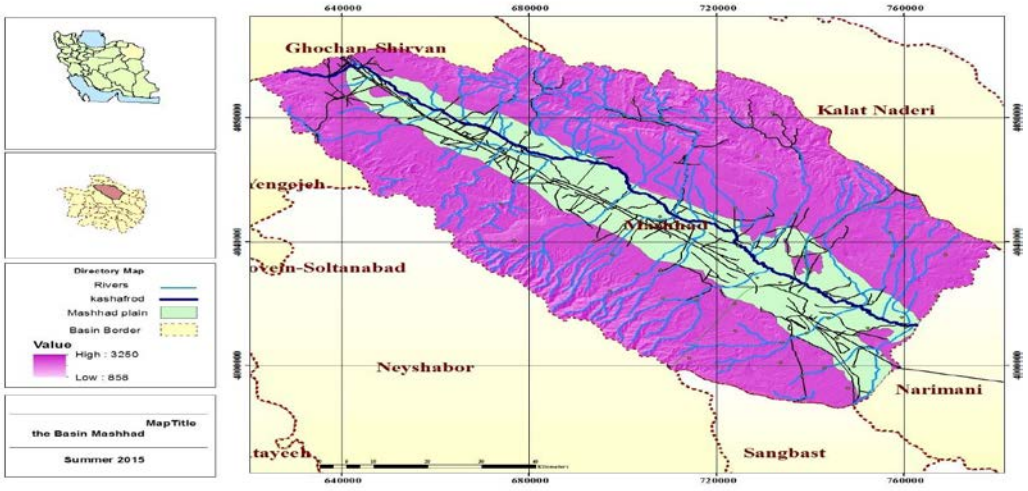


Figure 2: Hydrograph map of Mashhad plain

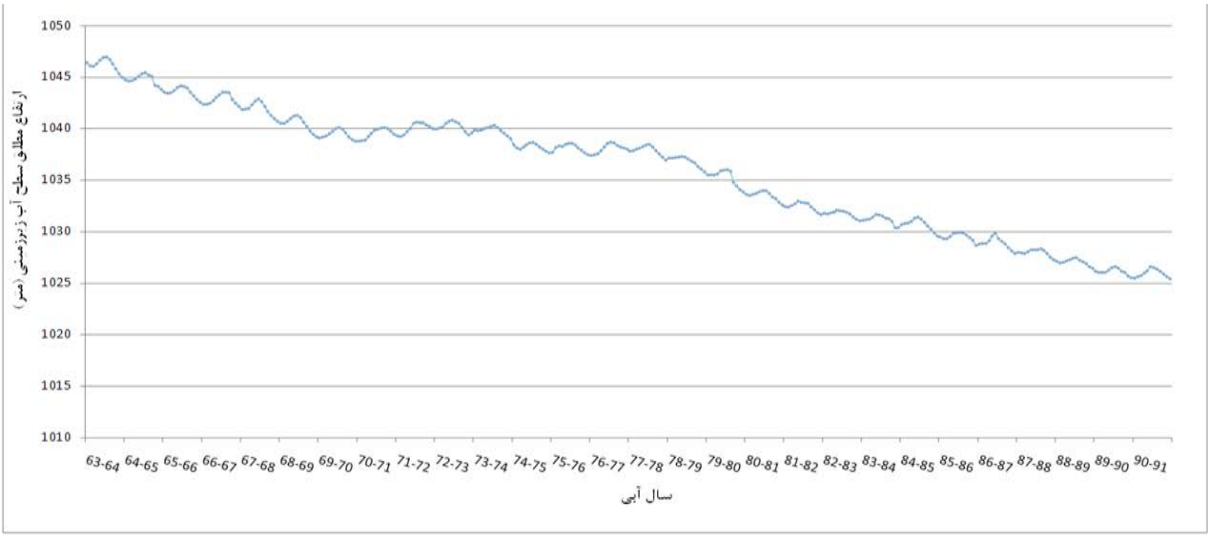


Figure 3: Salinity in the water year 2013-2014 in Mashhad

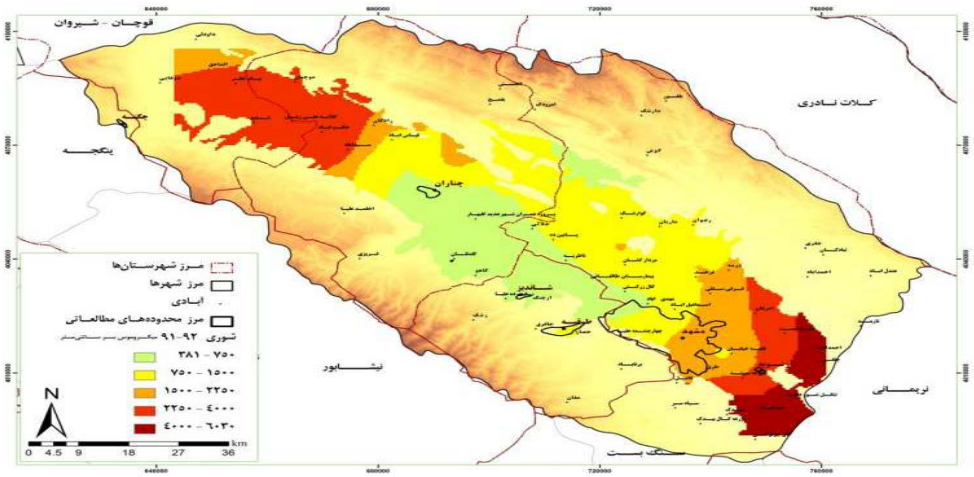


Figure 4: Water consumption in Mashhad plain (Khorasan Razavi regional water, 2016)

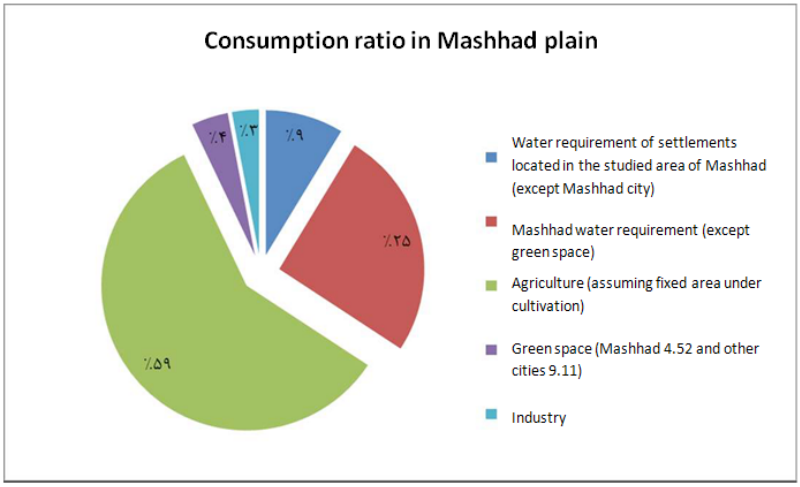


Figure 5: Water resources management including supply and demand management

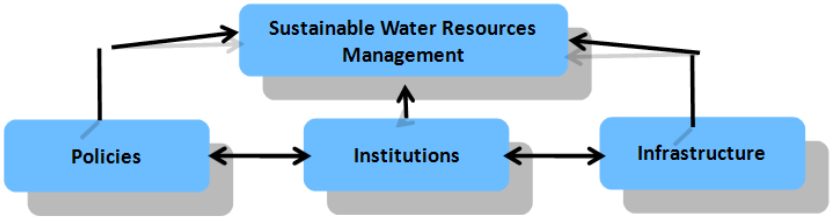
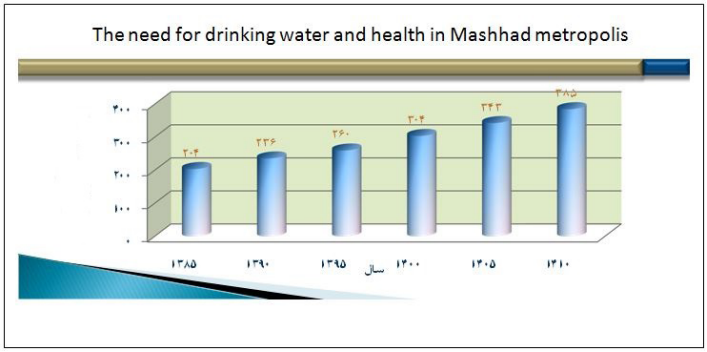


Figure 6: The need for drinking water and health in Mashhad in Horizon 1410



Statement of questions and hypotheses

Can local water market in Mashhad's sphere of influence be effective in optimal water consumption?

The results of various studies have shown that even in the most efficient formal water markets in the world (like the US and Australia), only a small proportion of resources (10-20%) have been allocated through the market process. The reason is mainly related to economic and technical constraints rather than institutional restrictions. Accordingly, the role that can be assumed for the market in dealing with water scarcity and optimal use of water resources in Mashhad's sphere of influence is within these limits. Thus, in answering the above question, we can say:

First hypothesis: It seems that the local water market in Mashhad's sphere of influence can be effective in optimal water consumption and in all sectors of consumption, including drinking and health, industry, agriculture and so on and its purpose is to investigate the role of the local water market in optimal water consumption in Mashhad's sphere of influence.

What can the requirements for establishing an efficient, fair and sustainable water market be in Kashafrood basin?

The formation of an efficient water market requires the provision of conditions for exchange and market, structural and institutional reforms at different national, regional, urban and local levels and the implementation of appropriate public policies to remedy the inefficiencies resulting from market failure. According to the above and based on the rules and regulations governing the management and utilization of the country's water resources (Fair Water Distribution Law, the Law of Consolidation of Water Prices for Agricultural Products, general policies of the system in the water sector, Principle 45 of the Constitution and Principle 155 of the Civil Code of the Islamic Republic of Iran, etc.) and also with respect to the previous studies conducted in the country about water marker (Sadr, 1999; Ja'fari, 2004; Jufra & Alizadeh, 2009; Shahnoushi, 2014), its basic requirements can be described as follows:

- Revision and clear definition of water rights with emphasis on behavior monitoring
- Issuance of water document for water right holders
- Modification of water structure and laws (according to the conditions of each region, district, city and neighborhood)
- Establishment of a regulatory body for the local water market rules

Second hypothesis: Based on the foregoing, it seems that the separation of water ownership from land ownership is among the necessary conditions for the formation of a local water market in Mashhad's sphere of influence.

What are the potential challenges of the local water market in Mashhad's sphere of influence?

There are multiple challenges to the formation of efficient local water markets. Some of them are rooted in legal restrictions and regulatory laws. Alongside numerous potential benefits mentioned in the economic theory and subject literature for the local water market (including effective economic and social allocation of water by internalizing the opportunity cost of water resources, transparent pricing, encouragement of investors for long-term investments in the water sector, saving in urban and industrial water supply costs, better supply of necessary consumption in times of drought and so on), some potential risks should also be addressed by policymakers. On the demand side, the water market may lead to increased water harvesting since with the market formation, it is possible for the farmer to sell all his water right at high prices in the market.

Third hypothesis: It seems that water owners and water right holders are, in the long run, concerned about their ownership rights being compromised.

Conclusion

Increased gross domestic product and encouragement of private sector investment on the one hand and reduced social costs due to pollution on the other lead to the creation of

more opportunities for water suppliers and applicants to compete. Improved flexibility in water reallocation among different uses by increasing the response to changing seasonal, economic, social and environmental conditions is another result of the discussion.

References

Bohlulvand, A. & Sadr, K. (2007). **Justice, market and fair price SAMT Publisher.**

Garrido S. (2011). **Governing scarcity.** Water markets, equity and efficiency in pre-1950s eastern Spain. International Journal of the Commons, 5: 513–534.

Gomez-Limon JA, Martinez Y. (2006). **Multi-criteria modeling of irrigation water market at basin level:** A Spanish case study. European Journal of Operational Research 173(1):313-336.

Grafton RQ, Landry C, Libecap GD, O'Brien JR. (2009). **Water markets:** Australia's Murray-darling basin and the U.S. Southwest. International Center for Economic Research. Working paper series, ICER, and Turin Italy Pp:68-83

Hatami Yazd, A. & Davari, K. (2017). **Identifying water management conflicts using cognitive mapping analysis of actors.** Iranian Water Resources Research.
Iranian Water Policy Research Institute. (2015). Pricing and water market in Iran.
Ja'fari, A. (2004). Water market approach and its requirements. Journal of Agricultural Economics and Development, 48.

Jafari, M. and Alizadeh, S. (2009). **Investigation of market role in optimal allocation of water resources.** Journal of Economic Sciences 2-95 .75.

Keramatzadeh, A. & Chizari, A. (2011). **The role of the water market in determining the economic value of water.** Iranian Journal of Agricultural Development Economics Research, 1.

Kiani GH, Sadr K, and Saleh I. (2008). **Modelling supply and demand functions in the water, market under uncertainty conditions.** Environmental Sciences.

Kiani, Gh. (2008). **The Role of Market in Water Resources Allocator** (Case Study: Mojen Bazaar). PhD thesis of Agricultural Economics. Tehran University.

Nouri Esfandiari, A. (2014). **"Pricing and Market of Water in Iran",** Iran Water Management Institute.

Sadr, K. and Behlulvand, A. (2007). **"Measuring Competition in the Mojen Water Market",** Economics Quarterly.

Shahnoushi, N. (2014). **Study design of water market organization and formation in Razavi Khorasan**. Ferdowsi University of Mashhad.

Soleymaniha, S. (2016). Water: **An economic or non-economic commodity?**

Water markets as a response to scarcity. **Peter Debaere et al. Water Policy** 16. (2014). 625–649.

Recebido em 20 de dezembro de 2019.
Aceito em 21 de fevereiro de 2020.