July 2025
Volume 1
Issue 2
DOI: 10.48308/ijce.2025.240151.1007

Interdisciplinary Journal of Civil Engineering
Shahid Beheshti University

Economic Valuation of Industrial Water Toward Water Reallocation and Environmental Restoration in Zayandeh-Rood Basin, Iran

Authors:

Shahram Ghobadi[1], Ali Moridi[1,*], Reza Khalili[1]

Abstract

The Zayandeh-Rood basin is one of the regions with high socio-economic importance in Iran, which at the same time has faced the problems of scarcity of water resources. excessive exploitation of water resources in the Zayandeh-Rood River basin, the largest permanent river in Central Iran, has supported significant socio-economic development in the basin, but at the same time, it has caused a severe reduction in the ecological flow of the river and a rapid fall in the groundwater table. This has caused catastrophic subsidence in the Isfahan aquifer, destroyed local ecosystems, and resulted in the complete drying of the terminal lagoon (Gawkhoni). As long as cheap water is provided to the economic sectors of the basin regardless of its economic value, and the overexploitation of the basin's water resources is not adjusted by reallocation, no improvement in the environmental conditions of the basin will be expected. Industries, which are one of the major users of water in the Zayandeh Rood basin, have paid an average of less than 2 percent of the economic value of water as the water price during the study period. Considering that the price elasticity of demand for industrial water is high, and the cost paid for water in the relevant industries has been significantly lower than the economic value of water in these industries. Therefore, adopting the policy of reforming the water pricing system in this sector can lead to substitution between different water qualities, including recycling, and pave the way for environmental restoration and reallocation of water in the basin.

Keywords: Economic Valuation, Environmental Restoration, Water Reallocation, Water Scarcity

1. Faculty of Civil, Water, and Environmental Engineering, Shahid Beheshti University, Tehran 1983969411, Iran

*Corresponding Author: a_moridi@sbu.ac.ir

1. Introduction

Water resources have faced a severe shortage due to the increase in demand caused by various factors such as population growth, increasing urbanization and industrialization, along with the improvement of living standards. Climate change and uncertainties related to it have also added to the deterioration of this issue (Saquib et al., 2022; Seidenfaden et al., 2021). The pollution of water sources caused by the discharge of urban, industrial, and agricultural sewage has also become another threat to the water supply (du Plessis, 2022; Bashir et al., 2020). According to the Falkenmark water stress index, Iran's water resources are unfortunately in a critical condition (Moridi, 2017). The negative water balance of groundwater due to excessive withdrawal from aquifers, transfer of surface water, and drought has caused severe water stress in Iran's wetlands (Neysiani et al., 2022).

Estimating the economic values of increasingly scarce water resources may be an important step to facilitate efficient economic adaptation (Hurd et al. 2004). The economic value of water resources generally refers to the added value of benefits that can be measured in available currencies and generated per unit of water withdrawn from natural storage space (Ma & Zhao, 2019). The general idea in the economic valuation of water is to identify the value of water in its competitive uses so that decision makers can better understand and communicate the values and trade-offs between different uses. Valuation also supports more transparent and informed decision-making about water allocation and use(Ostrom, 1990). Water is one of the main consumables in production processes, especially in the manufacturing industry. Lack of knowledge about the economic value of water may increase the scarcity problems of this resource and can even cause problems in the management of economic processes. In most developing countries, the price paid for water in different sectors of water consumption, including production processes, does not necessarily reflect water scarcities in catchments or reflect the costs of water extraction, transportation, and treatment (Revollo-Fernández et al., 2018). The limitation of water resources in Iran and the problems facing the supply of new water sources have increased the importance of this input in the production process (Tahamipour Zarandi et al., 2020). As Ghobadi & Moridi (2022) have stated, the conditions for water value-based pricing are available for industrial uses. Water saving methods should include pricing as well as properly implemented environmental fines (Tabieh et al., 2022). Population growth and increased prosperity have led to increased demand for water. However, social and political transformation processes, as well as policy regulations leading to new water-saving technologies and improvements, are countering this development by slowing down and even reducing domestic and industrial water use globally(Flörke et al., 2013). In Iran, it is also necessary to take effective measures aimed at improving water conservation and reducing the effects of water scarcity, especially in areas that are facing water crisis (e.g., Mamdoohi et al., 2013). On the other hand, investments in water supply, storage, and transfer facilities, intersectoral competition for water, are all water management problems that involve choices about how to combine water with other resources to obtain the greatest public return from a scarce resource(Varian 2010). Economic valuation of water is very necessary and important for making effective decisions. Policymakers consider the economic valuation of water as a means to shape policies and developments related to water (Australian Water Partnership, 2016).

The Zayandeh-Rood basin is one of the regions with high socio-economic importance in the country, which at the same time has faced the problems of scarcity of water resources. The manufacturing industry has a special importance in the economic activity dynamics of the basin (Arjroodi et al., 2019). In addition, these industries have a significant share of the output value of the country's manufacturing industry. Therefore, the attention of the government and industries has been directed to the options of extracting water from new sources and especially from non-conventional sources of water, including water transfer from the Persian Gulf and the Sea of Oman, and water reuse projects. In this study, the monetary value of water in the manufacturing industry in Isfahan province, which also provides the possibility of comparing different values of water in different industries. Determining the economic value of water in the industries of Isfahan province not only provides the possibility of proper and efficient management of water in the province, but especially it can help to clarify the economic considerations of plans for the use of non-conventional resources, including the transfer of water from the Persian Gulf and the Sea of Oman, and the water reuse in these industries. On the other hand, considering that there is relatively little international literature on the calculations of the economic value of industrial water for developing countries that are facing problems of water resource scarcity. In Iran, these studies have mostly been conducted to investigate the economic value of water in domestic and agricultural uses, and the expansion of these studies to the industry sector has been very limited. Therefore, in this context, this article intends to partially fill the existing study gap by estimating the value of water for the manufacturing industry in a region that is under relative water stress, along with economic-social development.

In addition, this study has tried to reveal the role of reforming the pricing system in water reallocation and environmental restoration by comparing the economic value of water with the price paid by industries for water. Therefore, this study, which estimates the economic value of water in regional industries, has been done as the first step in creating a proper economic view of the value of water use in this basin. As Ward & Michelsen (2002) state, information on the economic value of water enables decision makers to make informed decisions about the development, conservation, allocation, and use of water when growing demands for all uses are made in the face of increased scarcity. It is obvious that in order to obtain a more complete set of information, it is necessary to value water in other sectors of water consumption in the Zayandeh-Rood river basin, including agriculture, urban, and ecosystem services.

Because of the limited role that markets play in water allocation, competitive market prices on which to base water resource allocation decisions are usually not available. Because of this, economists have developed techniques to measure the economic value associated with priceless natural resources. The theoretical foundations of non-market economic valuation of natural resources are well developed (e.g., Freeman 2014). Advances in methods for estimating economic benefits in real cases have also progressed well. Some areas of water valuation have received less attention. Especially for intermediate goods or products derived from water. Water valuation is based on the normative framework of neoclassical welfare economics and is an application of cost-benefit analysis (Johansson 1993; Richard et al. 2004). Since the way of valuing water in each specific case is different depending on the specific characteristics of the situation (such as the use of water and the place of use) and according to the desired decision, therefore, several methods have been invented in the economic valuation of water. In this regard, many efforts have been made to introduce economic valuation methods of water.

Gibbons (1986) uses the water consumption approach as the basis of his classification and for this purpose, considers seven specific categories of water consumption. According to this classification of water uses and the usual methods of water valuation in the fields of urban, irrigation, industrial, navigation and water transportation, recreational and aesthetic, pollutant absorption, and hydroelectric power plants have been investigated. According to Ward & Michelson (2002), water economic valuation methods can be used as market and managed prices, changes in net income due to water consumption when water is an intermediate good, and measuring efficiency, such as increased productivity based on increased water consumption.

Young & Loomis (2014) have also compiled an explanation about the methods of determining the economic value of water. They present methods of economic valuation of water in the form of different categories, considering different aspects and fields. Therefore, water economic valuation approaches can be classified according to the quantification techniques used. Most of the water evaluation methods are divided into two general categories, which differ in mathematical methods and the type of data used in the valuation process. One group includes inductive methods that use inductive logic, such as statistical or econometric methods, to derive generalizations from individual observations. Another group includes deductive methods that use logical processes to reason from general premises to specific conclusions. In sum, there is no single economic value for water, and each method is useful in certain circumstances. Examples of studies in the field of industrial water valuation are mentioned below:

Wang and Lal (2002) have determined the economic value of water for different branches of Chinese industry. In this work, the Cobb-Douglas cost function is used to estimate water price elasticity and water value. According to research findings, the economic value of water in Chinese industries has varied from 0.05 to 26.8 Chinese yuan per cubic meter of water.

Renzetti & Dupont (2003), using the data of 1981, 1986, and 1991 of Canadian manufacturing companies, estimated the final shadow value of water in Canadian industries. Based on the results, the average value is 0.046 dollars per cubic meter of water.

Kumar (2006) conducted a study using a linear programming approach on a sample of 92 companies over three years. The results show that the average shadow price of water is 7.21 rupees per cubic meter, and the derived price elasticity of water demand is high, averaging -1.11. This suggests that water charges may be an effective tool for water conservation.

Nahman & De Lange (2012), Using data and information from annual reports and sustainability reports of 58 companies, it has estimated the economic value of water in South African industries. According to the results, the average economic value of water in the investigated industries is equal to 369.10 South African Rand (equivalent to 21.44 US dollars) per cubic meter of water. It goes on to explain that, for example, this is the maximum amount companies are (in theory) willing to pay for an additional cubic meter of water.

Ku & Yoo (2012) state that a sustainable water supply is very important for manufacturing companies, because industrial water is used for various purposes as one of the important inputs in the production process. Despite the importance of industrial water use and the increasing demand for industrial water, relatively few studies have been conducted on industrial water consumption in Korea. In this work, the marginal productivity approach is used to estimate the economic value of water in the Korean manufacturing industry, and it uses data from 53,912 factories in Korea in 2003. This study estimates the final production value and industrial water output elasticity using the Cobb-Douglas production function and the Translog production function. Estimated values vary by sector, ranging from a high of 13,760 KRW per cubic meter of water in the transportation equipment sector to a low of 428 KRW per cubic meter of water in the instrumentation sector. This research states that the findings provide the possibility of drafting future water pricing scenarios by the Korean government based on the available estimated value information.

Rodríguez-Tapia et al. (2021) conducted a study on the manufacturing industry in Mexico. The applied method includes estimating the marginal productivity of water from the translog production function. The information comes from the 2014 Economic and Industrial Census, which reports data on 476,753 economic units across the country. The results show that one cubic meter of water used in the Mexican manufacturing industry creates an added value equal to 7.8 dollars

Around the world, less research has been done on the economic value of water in industrial uses than in agriculture and domestic use, and there are only a handful of studies in this field in Iran. In the study conducted by Tahamipour Zarandi (2017), the production function method and the residual method were used. In this research, the purpose of which was to determine the economic value of water in the chemical industries of Iran, the economic value of water using the production function method was estimated as 36697 Rials, and using the residual method, it was equal to 35867 Rials per cubic meter of water. And he states that this value is far from the current price of water and thus, the price paid for water in the country's chemical industries is much lower than the economic value of water in this part of the industry.

Tahamipour Zarandi et al. (2020) have devoted their research to determining the economic value of water in Iran's industry. In this research, which used the residual method, the weighted average of the economic value of water during the period of 2004-2013 was equal to 87347 Rials per cubic meter of water.

Mousavi et al. (2021), in a study that they conducted in order to determine the economic value of water in environmental, agricultural, and industrial uses in the Urmia lake basin, used the residual method to estimate the economic value of water in industry. This study has estimated the economic value of water in industrial use in 2018 as 33342 Rials per cubic meter of water.

Among the previous works in the field of industrial water valuation in the Zayandeh-Rood basin, we can refer to the studies of Yekom Consulting Engineers (2013) based on industry data in the period of 2001-2006 that estimated the average economic value of water in the industrial sector of the Gawkhoni basin. In another study published in the Inter3 report (2013) to estimate the economic value of water in the industry sector of the Zayandeh-Rood basin, the generalization of global works was used, and the calculations were not done in a region-specific manner and separately by industry branches.

In this way, the work of economic valuation of industrial water for the Zayandeh-Rood basin using statistical data of the industry in the period of 2002-2019 using the residual method for the whole industry of Isfahan province, and also by separating the four two-digit ISIC codes, for the first time by This study has been conducted and has no previous history. In addition, none of the previous studies on the economic valuation of industrial water for the Zayandeh-Rood basin have compared the resulting value with the price paid by industries for water. In this study, for the first time, an attempt has been made to reveal the potential of reforming the pricing system in environmental restoration of the Zayandeh-Rood Basin by comparing the economic value of water with the price paid by industries for water.

2. Methodology

2.1. Case study

Zayandeh Rood River is the largest permanent river in Central Iran, which has supported significant socio-economic development in the basin. But at the same time, over-extraction from water resources in the Zayandeh-Rood river basin has caused a severe reduction in the ecological flow of the river and a rapid fall in the groundwater table (Abou Zaki et al., 2020). This has caused the pronounced subsidence in the Isfahan aquifer (Beni et al., 2024; Sorkhabi et al., 2022), destroyed local ecosystems, and resulted in the complete drying of the terminal lagoon (Gawkhoni) (Hekmatpanah et al., 2012). Fig. 1 depicts the location of the Zayandeh-Rood basin and Isfahan city.

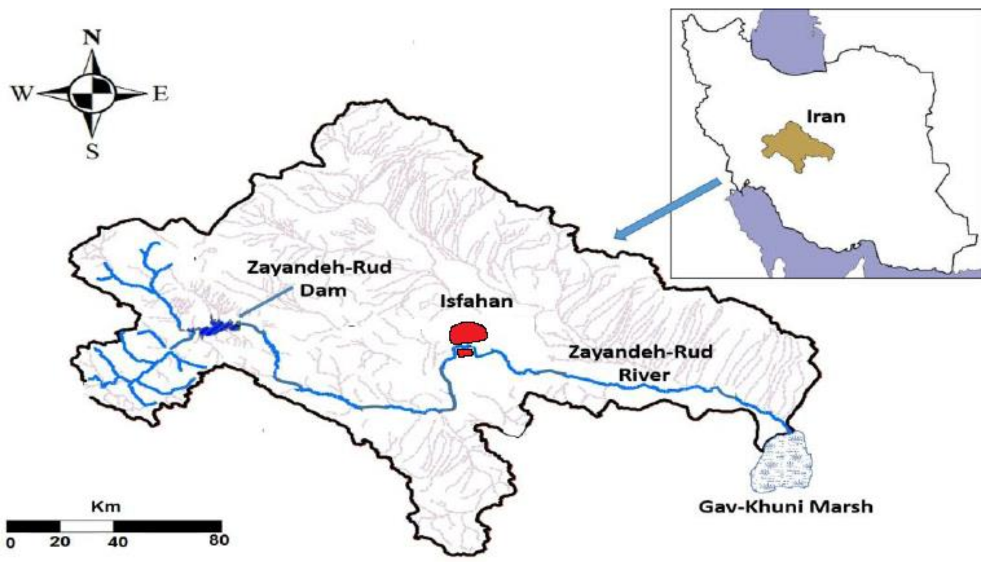

Figure 1. Location of the Zayandeh-Rood basin and Isfahan city

The methods of determining the economic value of water as a production input can be classified into two categories: parametric and non-parametric methods. One of the non-parametric methods for determining the economic value of water that has been used in various studies is the residual method (Young & Loomis, 2014).In this study, due to the limitation of data, among the various methods for measuring the economic value of water, the residual method has been used, which will be briefly explained below. With the data that is available in the Statistical Centre of Iran on industrial workshops in the form of a time series for a maximum period of eighteen years in each branch of industry, it is not possible to estimate the production function correctly. In addition, due to the difference in the industries of Isfahan province in terms of the nature of production, it is not possible to consider them as competitors in water consumption in a mathematical programming model, so this method is also out of the scope of selection. Regarding other methods, it should be noted that the method of observations of water market transactions is used in countries that have a water market, which does not match the conditions of this research. The value-added method greatly exaggerates the value of water and is not suitable for this task. The alternative cost method is used only when the value of water cannot be easily estimated using other methods. Therefore, the residual method has been used in this research. This method was used in various studies to determine the economic value of water, such as Lowe et al. (2022), Rodrigues et al. (2021), Tehamipour Zarandi et al. (2020), and LIU et al. (2019). The residual method is applied to estimate the value of water when it is used as an input or an intermediate good of production. The residual value approach actually measures average value because it is based on measures of the total value of production and the total cost of non-water inputs.

In the practical model of applying the residual method using the available data of the Statistical Centre of Iran on industrial workshops of 10 or more workers during the period of 2002 -2019, in the first stage, all intermediate costs except water cost are deducted from the output value until the added value that includes the cost of water is obtained. Then the amounts of service compensation, operating surplus, depreciation, and net tax are calculated, and their sum is deducted from the added value. In this way, the total value of water is calculated. Finally, by dividing the total value of water by the amount of water consumed, the value of each unit of water will be obtained. The data related to compensation for the services of employees and net tax were extracted from the data of the Statistical Centre of Iran on industrial workshops of 10 or more workers during the period of 2002 -2019. Depreciation is calculated according to Article 151 of the Direct Taxes Law and based on the descending method equal to 12% of the book value of capital formation per year. To calculate the operating surplus, the share of the operating surplus from the added value for each code and for the whole industry of Isfahan province was extracted from the input-output table of 2015, and the operating surplus was calculated according to the obtained share.

Thus, in this research, to determine the economic value of water in the industries of Isfahan province, the residual valuation method has been used for the whole industry of Isfahan province, as well as for 4 two-digit ISIC codes, including codes 19(manufacture of coke and refined petroleum products), 20(manufacture of chemicals and chemical products), 23(manufacture of other non-metallic mineral products) and 24(manufacture of basic metals), which are the major consumers of industrial water.

3. Results and Discussion

The production value of the industrial sector of Isfahan Province in 2019 has crossed the border of 2300 trillion Rials. Figure 2 presents the share of selected codes in the production of added value in Isfahan province based on average values during the period from 2002 to 2019. The share of the 4 selected codes was about 78% of the total production value of the industry sector of Isfahan province, and the share of the added value of the 4 selected codes was 73% of the total added value of the industry of Isfahan province. In addition, these 4 selected codes have consumed about 85% of the total water in the industrial sector of Isfahan province. Figure 3 presents the share of water consumption in the industrial sectors of Isfahan province.

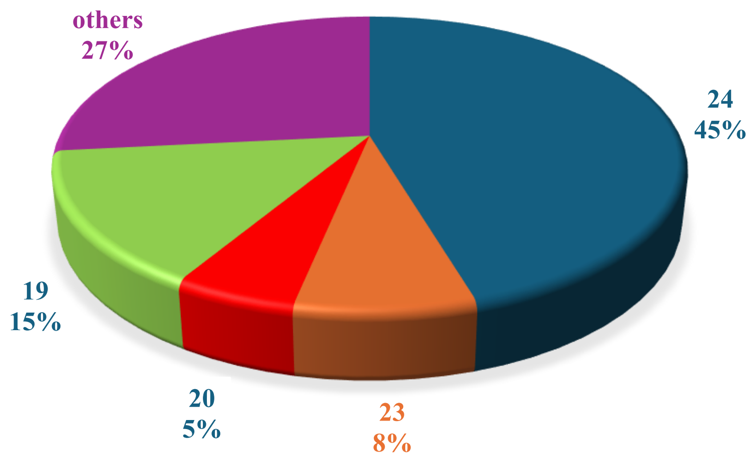

Figure 2. Added value in different industrial sectors of Isfahan province

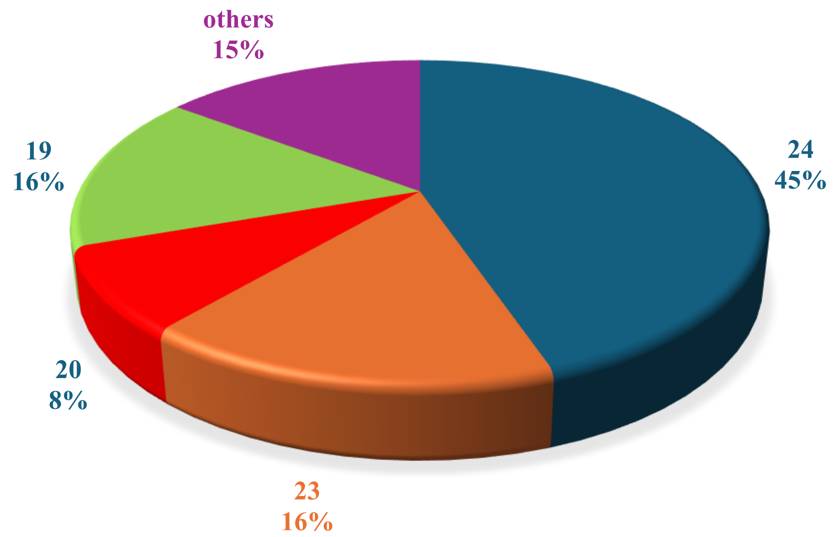

Figure 3. Water consumption in different industrial sectors of Isfahan province

In Figure 4, input value, output value, added value, and water cost of 4 selected codes compared to the whole industry of Isfahan province, based on the average values during the period from 2002 to 2019, are displayed.

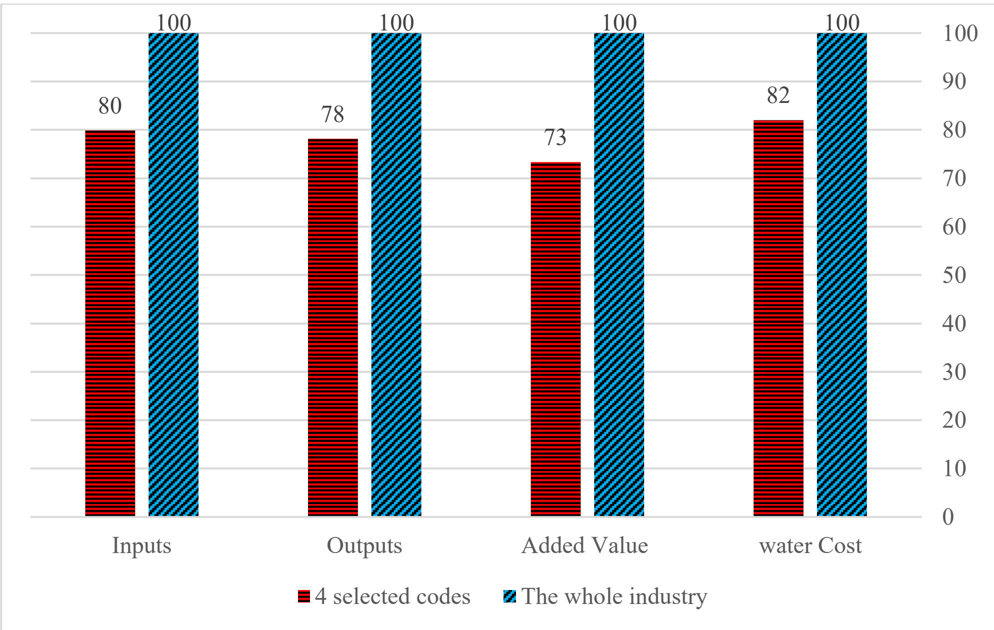

Figure 4. Comparison of input value, output value, added value and water cost of 4 selected codes with the whole industry of Isfahan province

In this work, the economic value of water in the industry of the province and in 4 selected codes in the period from 2002 to 2019 was calculated using the residual method .The Producer Price Index (PPI) can be used to remove the effect of inflation by serving as a deflator for other economic data or as a basis for adjustments. Therefore, in order to eliminate the effect of inflation and create a perspective based on the current value of water in large industries in the basin, the Rial value of water was adjusted using the Producer Price Index (PPI) of the industrial sector in manufactured products for April 2025. Accordingly, during the study period, the average current value of water per cubic meter of water in the entire industry of Isfahan province was 6,648,818 Rials, in code 19 (Manufacture of coke and refined petroleum products) 7,411,597 Rials, in code 20 (Manufacture of chemicals and chemical products) 3,245,207 Rials, in code 23 (Manufacture of other non-metallic mineral products) 2,960,888 Rials, and in code 24 (manufacture of basic metals) 8,732,424 Rials. The adjusted Rial values of water based on the April 2025 PPI for the total industry sectors and for the four selected codes are shown in Figure 5.

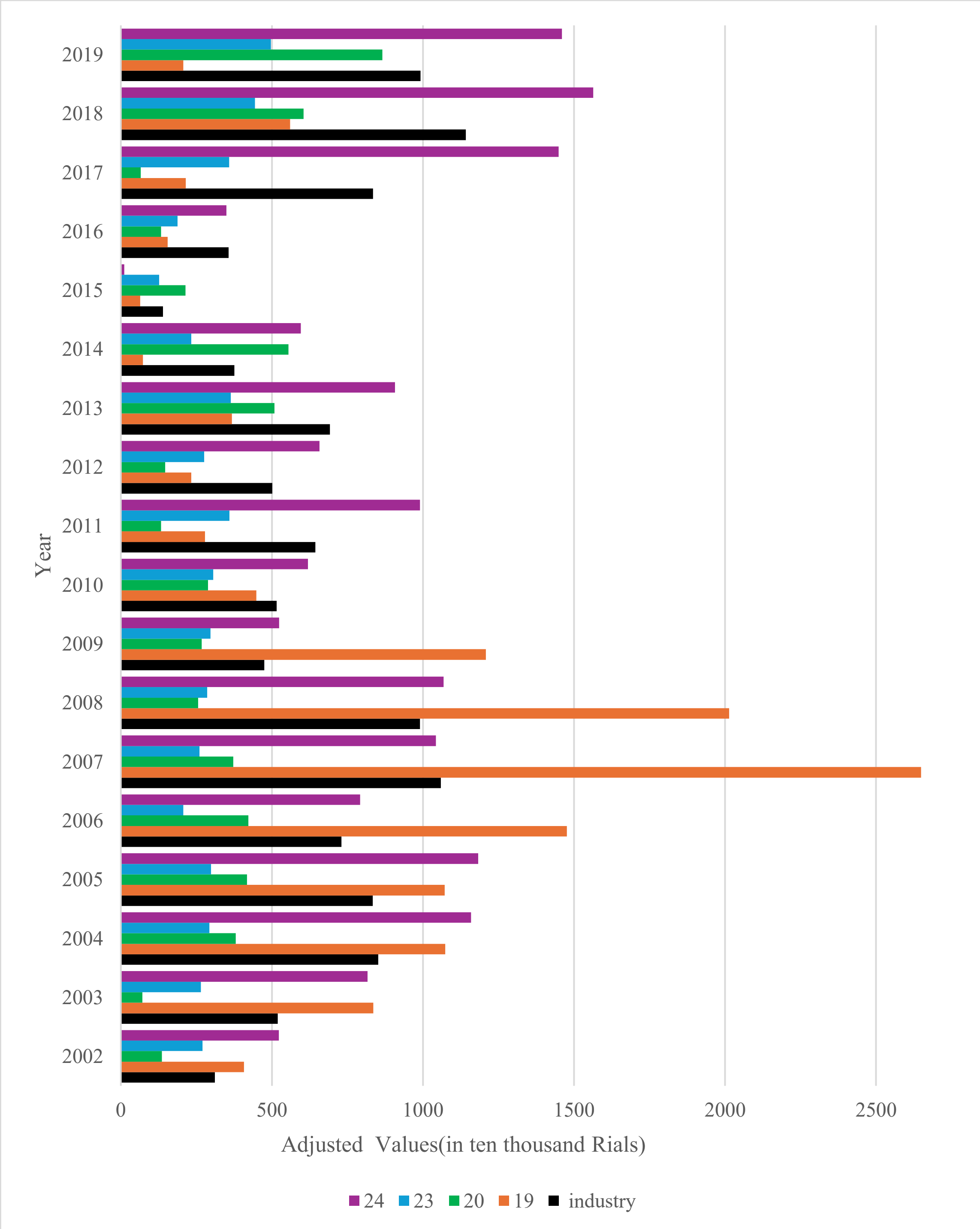

Figure 5. Adjusted economic value of water in the industry of the province and 4 selected codes

The cost paid for water in the production process of the industry of Isfahan province during the period from 2002 to 2019 was between 0.05 and 0.25% of the total production costs of the industry, and on average, less than 0.2% of the total production costs. In addition, in this research, the economic value of water in industries was also examined and compared with the cost paid for water during the study period, and the relevant results are given in Table 1.

Accordingly, the ratio of the cost paid for water in the industrial production process of Isfahan province to the value of water during the study period ranged from less than 0.6 percent to 5.35 percent, and the average ratio of the cost paid for water to the value of water during the period was 1.87 percent.

Table 1. The ratio of water cost to water value in the industry sector

Year	The ratio of water cost to water value (percentage)
2002	1.58
2003	1.10
2004	0.78
2005	0.61
2006	0.74
2007	0.96
2008	0.92
2009	2.32
2010	1.94
2011	1.85
2012	4.50
2013	1.74
2014	1.85
2015	5.35
2016	3.62
2017	0.68
2018	2.33
2019	0.79

In addition, in this work, the value of water in each sector and the share of each sector in value-added production, and the share of each sector in the total water consumption in the production process for 2019 were compared. The results are shown in Figure 6. Therefore, the most efficient sector among the 4 selected codes is code 24 (manufacture of basic metals), and at the same time, this sector is the largest water consumer in all the industries of the Zayandeh-Rood basin, which consumes almost half of the industrial water in the basin. Therefore, one of the sectors It is noteworthy that reforming the water pricing system can help to improve water consumption in the basin.

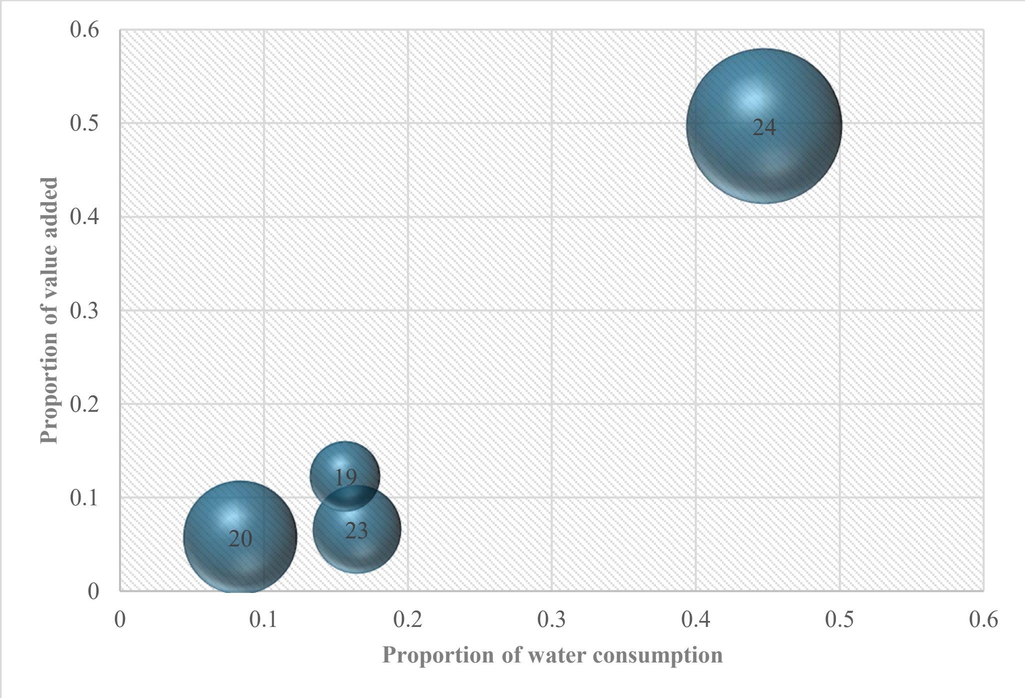

Figure 6. The water value, water consumption, and added value in 4 selected codes

4. Conclusion

In this research, in order to estimate the economic value of water, the residual method was used for the whole industry of Isfahan province and also for 4 two-digit ISIC codes that constitute the most water-consuming industries in Isfahan province. The reason for using this method is the limitation of available data, because the available information is very general and does not provide the necessary multiplicity for the possibility of fitting the production functions with sufficient reliability. In this way, by using the residual method and using the data of the Statistical Centre of Iran on industrial companies of 10 or more employees during the period of 2002 -2019, the work of estimating the economic value of water in the industries of Isfahan province was carried out. Due to the relatively high inflation rate in Iran during the period under review, in order to eliminate the effect of inflation and create a perspective based on the current value of water in large industries in the basin, the Rial value of water was adjusted using the Producer Price Index (PPI) of the industrial sector in manufactured products for April 2025. According to the findings of the research, the average current economic value of water for each cubic meter of water in the whole industry of Isfahan province is equal to 6,648,818 Rials, in code 19 (manufacture of coke and refined petroleum products) equal to 7,411,597 Rials, in code 20 (manufacture of chemicals and chemical products) was equal to 3,245,207 Rials, in code 23 (manufacture of other non-metallic mineral products) it was equal to 2,960,888 Rials, and in code 24 (manufacture of basic metals) it was equal to 8,732,424 Rials. Based on the results, according to the value of water in each industry code, the share of each sector in value-added production, and the share of each sector in the total water consumption in the production process for 2019, it was determined that the most efficient sector among the 4 selected codes is code 24 (manufacture of basic metals).

During the time period examined in this research, which is related to the period from 2002 to 2019, the ratio of the cost paid for water to the total cost of production in the whole industry of Isfahan province was between 0.05 and 0.25%. This figure for the whole industry of Isfahan province was equal to 0.145 percent on average, which shows that the cost of water has a very small share in the production cost of these industries. This is despite the fact that the economic value of water in these industries has been much higher than the cost paid for water. The results of the research showed that the average ratio of payment for water to the value of water during the mentioned period was equal to 1.87 %. In other words, during the mentioned period (2002 to 2019), industries have paid less than 2% of the economic value of water as water cost. This indicates the need to reform the water pricing system for industrial uses. Price signals can encourage conservation of water resources and help increase the efficiency of water use. Price elasticity of demand for industrial water is significantly higher than for residential consumption. This suggests that industrial demand for water is potentially more sensitive to price and may therefore indicate opportunities for substitution between different water qualities, including recycling (Worthington, 2010). As long as cheap water is provided to the economic sectors of the basin regardless of its economic value, and the overexploitation of the basin's water resources is not adjusted by reallocation, no improvement in the environmental conditions of the basin will be expected.

5. References

Abou Zaki, N., Torabi Haghighi, A., Rossi, P. M., Tourian, M. J., Bakhshaee, A., & Kløve, B. (2020). Evaluating impacts of irrigation and drought on river, groundwater, and a terminal wetland in the Zayanderud Basin, Iran. Water, 12(5), 1302.

Australian Water Partnership. (2016). *Valuing Water: A Framing Paper for the High-Level Panel on Water*.

Arjroody, A.R., Mahpour, A., Hamdollahii, M., and Nazifi, A. (2019). Estimating the effects of Human Capital on the Economic Growth of the Road Transport Sector (Using the Cobb-Douglas Production Function). In the *26th World Road Congress World Road Association (PIARC)*.

Bashir, I., Lone, F. A., Bhat, R. A., Mir, S. A., Dar, Z. A., & Dar, S. A. (2020). Concerns and threats of contamination on aquatic ecosystems. Bioremediation and biotechnology: sustainable approaches to pollution degradation, 1-26.

Beni, F. A., Entezari, M., Sadeghi, A., & Salehi, A. (2024). Quantifying land subsidence and its nexus with groundwater depletion in Isfahan-Borkhar plain: An integrated approach using radar interferometry and spatial bivariate relationships. Remote Sensing Applications: Society and Environment, 35, 101248.

du Plessis, A. (2022). Persistent degradation: Global water quality challenges and required actions. One Earth, 5(2), 129-131.

Flörke, M., Kynast, E., Bärlund, I., Eisner, S., Wimmer, F., & Alcamo, J. (2013). Domestic and industrial water uses of the past 60 years as a mirror of socio-economic development: A global simulation study. *Global Environmental Change*, *23*(1), 144-156

Freeman III, A. M., Herriges, J. A., & Kling, C. L. (2014). The measurement of environmental and resource values: theory and methods. Routledge.

Ghobadi, S., & Moridi, A. (2022). Economic valuation of water. Water and Irrigation Management. (In Persian)

Gibbons, D. C. (1986). The economic value of water. Washington, DC: Resources for the Future

Hekmatpanah, M., Nasri, M., & Sardu, F. S. (2012). Effect of industrial and agricultural pollutants on the sustainability of Gavkhuni lagoon wetland ecosystem. Afr J Agric Res, 7(20), 3049-3059.

Hurd, B. H., Callaway, M., Smith, J., & Kirshen, P. (2004). Climate change and US water resources: from modeled watershed impacts to national estimates 1. *JAWRA Journal of the American Water Resources Association*, *40*(1), 129-148.

inter3 (2013) Studies for Integrated Water Resources Management in Isfahan, Iran, Zayandeh Rud Catchment Area, Value of Water: PRESENTATION OF PRILIMINARY RESULTS, Isfahan Water Company, Isfahan, Iran.

Johansson, P. O. (1993). Cost-benefit analysis of environmental change. Cambridge University Press.

Kumar, S. (2006). Analysing industrial water demand in India: An input distance function approach. *Water Policy*, *8*(1), 15-29.

Ku, S. J., & Yoo, S. H. (2012). Economic value of water in the Korean manufacturing industry. Water Resources Management, 26(1), 81-88.

LIU, W. Z., TANG, L., Wang, X. Q., & WANG, J. H. (2019). Estimating the economic value of irrigation water and analysis of influencing factors: A case study based on the residual value method and farmers' data in the Guanzhong area of Shaanxi. Journal of Natural Resources, 34(3), 553-562.

Lowe, B. H., Zimmer, Y., & Oglethorpe, D. R. (2022). Estimating the economic value of green water as an approach to foster the virtual green-water trade. Ecological Indicators, 136, 108632.

Mamdoohi, A.R., Masudi, M., Mahpur, A., Noruzoliaee, M.H., and Puryari, M. (2013). Estimation of road capacity in case of disasters by incorporating simulation & bottleneck concepts. *Journal of Transportation Engineering*, *4*(3), pp.263-273.

Ma, M., & Zhao, M. (2019). Research on an Improved Economic Value Estimation Model for Crop Irrigation Water in Arid Areas: From the Perspective of Water-Crop Sustainable Development. *Sustainability*, *11*(4), 1207.

Moridi, A. (2017). State of water resources in Iran. International Journal of Hydrology, 1 (4), 1-5

Mousavi, Seyed Morteza, Sarai Tabrizi, & Talachi Langroudi. (2021). Investigation of the economic value of water in environmental, agricultural, and industrial uses (Case study: Urmia Lake catchment). Man and the Environment, 19(3), 79-95. (In Persian)

Nahman, A., & De Lange, W. (2012). Valuing water for South African industries: A production function approach. Agricultural Economics Research, 5(2), 1-15.

Neysiani, S. N., Roozbahani, A., Javadi, S., & Shahdany, S. M. H. (2022). Water resources assessment of Zayandeh-Rood River basin using integrated surface water and groundwater footprints and the K-means clustering method. Journal of Hydrology, 614, 128549.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.

Revollo-Fernández, D. A., Rodríguez-Tapia, L., & Morales-Novelo, J. A. (2018). Economic Value of the Water in the Manufacturing Industry in the San Juan River hydrological sub-region, Mexico. Tecnología y ciencias del agua, 9(5), 218-245

Renzetti, S., & Dupont, D. P. (2003). The value of water in manufacturing. CSERGE.

Richard, E., Heuth, D. L., & Schmitz, A. (2004). The Welfare Economics of Public Policy. Books.

Rodrigues, G. C., da Silva, F. G., & Coelho, J. C. (2021). Determining farmers' willingness to pay for irrigation water in the Alentejo Region (Southern Portugal) by the residual value method. Agronomy, 11(1), 142.

Rodríguez-Tapia, L., Revollo-Fernández, D. A., Morales-Novelo, J. A., & Medina-Rivas, C. M. (2021). Water in Mexican industry: an economic value study. Applied Economics, 53(41), 4799-4809.

Saquib, S., Gupta, A., & Joshi, A. (2022). Emerging water crisis: Impact of urbanization on water resources and constructed wetlands as a nature-based solution (NbS). In Current Directions in Water Scarcity Research (Vol. 6, pp. 447-468). Elsevier.

Seidenfaden, I. K., Jensen, K. H., & Sonnenborg, T. O. (2021). Climate change impacts and uncertainty on spatiotemporal variations of drought indices for an irrigated catchment. Journal of Hydrology, 601, 126814.

Sorkhabi, O. M., Nejad, A. S., & Khajehzadeh, M. (2022). Evaluation of Isfahan City subsidence rate using InSAR and artificial intelligence. KSCE Journal of Civil Engineering, 26(6), 2901-2908.

Tabieh, M.A., Al-Karablieh, E.K., Salman, A.Z., Al–Assaf, A., Majdalawi, M.E., & Qtaishat, T.H. (2022). An estimate of the economic value of domestic water services: a case study in Jordan. Academy of Strategic Management Journal, 21(S6), 1-14.

Tahamipour Zarandi, Khazaei, Kolivand, & Fataneh. (2020). Analysis of the tariff system and economic value of water in Iran's industrial sector. Water and Sustainable Development, 6(3), 19-30. (In Persian)

Tahamipour Zarandi. (2017). Economic value, an approach to managing water demand in industrial use: Case study: Chemical industry. Journal of Water and Wastewater, 28(1), 74-83. (In Persian)

Varian, H. (2010). Intermediate Microeconomics: A Modern Approach, 8th Edition. W.W. Norton & Company. New York, NY.

Wang, H., & Lall, S. (2002). Valuing water for Chinese industries: a marginal productivity analysis. Applied Economics, 34(6), 759-765.

Ward, F. A., & Michelsen, A. (2002). The economic value of water in agriculture: concepts and policy applications. Water policy, 4(5), 423-446

Worthington, A. C. (2010). Commercial and industrial water demand estimation: Theoretical and methodological guidelines for applied economics research. *Studies of Applied Economics*, *28*(2 2), 237-258MONOGRÁFICO.

Yekom Consulting Engineers (2013). Studies for updating Iran's integrated water plan (Gavkhouni River Basin), Final report, Economic studies report, Ministry of Energy, Tehran, Iran. (In Persian)

Young, R. A., & Loomis, J. B. (2014). Determining the economic value of water: concepts and methods. Routledge