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Household Water Consumption and Tariff Structure: The Analysis of Türkiye's Three Metropolitan Cities

Mahmut Akif GÜVEN *(https://orcid.org/0009-0009-2010-9736), Hacettepe University, Türkiye; mahmutakif.guven@hacettepe.edu.tr*

Alparslan Abdurrahman BAŞARAN *(https://orcid.org/0000-0003-1027-8375), Hacettepe University, Türkiye; aab@hacettepe.edu.tr*

Hanehalkı Su Tüketimi ve Tarife Yapısı: Türkiye'de Üç Büyükşehir Üzerine Bir Analizi

Abstract

Analysis of urban water management has been researched in several countries. However, the attention given to this subject in Türkiye remains limited. This study addresses this research gap by focusing on the analysis of water tariffs, a critical tool for urban water management policies of local governments in Türkiye. The research aim is to investigate issues related to the attributes widely studied globally when the Türkiye case is considered. The study utilises a dataset from the Household Budget Survey of the Turkish Statistical Institute (TÜİK) between 2015 and 2018. The research has two folds. First, household water tariffs, average water prices, water consumption levels, and household characteristics are comprehensively examined in three metropolitan cities of Türkiye, namely, İstanbul, Ankara, and İzmir. Secondly, water consumption data is compiled from diverse geographical regions worldwide and compared with the ones in Türkiye. The findings reveal that the accessibility to clean water and the financial burden of clean water on household budgets, particularly for low-income households in Türkiye, are notably disadvantaged compared to many developed countries.

Keywords : Household, Water Utilities, Water Tariff, Local Government Policy.

JEL Classification Codes : H31, L95, L98.

Öz

Kentsel su yönetimi analizleri birçok ülkede araştırma konusu olmuştur. Ancak Türkiye'de bu konuya olan ilgi sınırlı düzeydedir. Bu çalışma, Türkiye'deki yerel yönetimlerin kentsel su yönetimi politikaları açısından kritik bir araç olan su tarifelerinin analizine odaklanarak ilgili araştırma açığını ele almaktadır. Araştırmanın amacı, dünya genelinde yaygın olarak konu ile ilgili incelenen sorunları, Türkiye örneği çerçevesinde incelemektir. Çalışma, Türkiye İstatistik Kurumu (TÜİK) Hanehalkı Bütçe Araştırması 2015-2018 veri setini kullanmaktadır. Araştırma iki aşamadan oluşmaktadır. İlk olarak, hanehalkı su tarifeleri, ortalama su fiyatları, su tüketim düzeyleri ve hanehalkı özellikleri Türkiye'nin üç büyükşehri olan İstanbul, Ankara ve İzmir için ayrıntılı bir şekilde incelenmiştir. Ardından, dünya genelinde farklı coğrafi bölgelerden derlenen su tüketim verileri ile Türkiye bulguları kıyaslanmaktadır. Bulgular, Türkiye'de özellikle düşük gelirli haneler için temiz suya erişimin ve temiz suyun hanehalkı bütçesi üzerindeki mali yükünün birçok gelişmiş ülkeye kıyasla oldukça dezavantajlı olduğunu göstermektedir.

Anahtar Sözcükler : Hanehalkı, Su Hizmetleri, Su Tarifeleri, Yerel Yönetim Politikaları.

1. Introduction

Due to socio-economic changes experienced in the past 30-40 years, globally intensifying wide-spread droughts, and increasing environmental concerns, issues such as the sustainability of water resources and enhancing the service capacities of water institutions have gained increasing interest in the economic literature (Sebri, 2013; Parker & Wilby, 2013). Population growth, industrial development, and urbanisation have led to a substantial increase in water demand. Consequently, ensuring water supply, improving efficiency, and managing water demand have become increasingly important not only for governments and policymakers but also for all stakeholders in Türkiye, as is the case worldwide.

The water industry has distinct characteristics that set it apart from others. Due to municipalities' general establishment and operation of water networks as a public service monopoly, the water industry appears as a collection of 'local monopolies' (Armstrong et al., 1994). Furthermore, the involvement of elected local governments and key actors in water management distinguishes the water industry from other network industries. With these exceptional attributes, water management represents a comprehensive and inherently multi-stakeholder structure that encompasses the development of clean water sources, regulations governing water allocation, pricing arrangements, and the conservation of water resources. In other words, delivering water to the end consumer involves a complex decision-making process encompassing all political, financial, economic, social, and technical aspects.

In the context of water management, the tariff structure, which is the focus of the research, is seen as an important policy tool. Indeed, the local governing body decides on the form of these tariffs (increasing block rates, flat fees, or decreasing block rates), assuming that the decisions are based on prioritised policies. The prioritised policies generally encompass environmental and financial sustainability, economic efficiency, and policies that consider the equitable distribution of water and social justice in access to water (Pinto et al., 2015).

Although the issue of water management is gaining popularity worldwide, water supply security remains a fundamental concern in many developing and underdeveloped countries. Water supply security is the capacity to provide a standard flow of drinking water at a specific quality and pressure, at an acceptable price, under certain conditions, and at any given time (GWP, 2000). However, the water supply provided by local governments must also meet drinking water quality standards to protect public health and prevent water-related diseases (İçme Suyu Kalitesi Yönetmeliği, 2019).

This research examines monthly household water consumption levels, real changes in water prices, and the share of household budgets allocated to water consumption for the three largest metropolitan municipalities in Türkiye, namely, İstanbul, Ankara, and İzmir. The analysis considers the respective municipalities' household income levels,

characteristics, and residential water tariff structures between 2015 and 2018. This research also compares the findings of similar studies in the literature. To achieve this, the literature on water demand and management is first reviewed, highlighting the factors that affect water consumption. The following section provides detailed findings on the components of household-level water consumption based on practices in different countries worldwide. Using data obtained from household budget surveys conducted by the Turkish Statistical Institute (TURKSTAT) for 2015-2018, the water consumption of households in the three metropolitan areas of Türkiye was analysed by income group and compared with findings from other countries. The final section presents comparative findings on household water consumption and offers policy recommendations for water management.

2. Literature Review

In particular, since the second half of the 20th century, population growth, declining freshwater supply, and increasing infrastructure costs have compelled suppliers to redesign demand management through pricing structures and other strategies such as public awareness and consumption restrictions. Worthington and Hoffman (2008) emphasise the lack of consensus among studies on demand management outcomes. Nevertheless, there has been a significant increase in academic research on household water consumption and tariff structures over the past two decades. The growing population and expanding cities are the primary drivers of this trend. Within this context, price and non-price factors emerge as the most important variables in studies examining water consumption and management in the relevant literature.

2.1. Pricing

The main determinants of household water consumption are price, income, and household characteristics (Arbués et al., 2003). Water tariffs serve as the fundamental instrument of demand-oriented policy design. Urban water tariffs consist of separate prices for households, the industrial and service sectors, public sector subscribers, and disadvantaged segments. Considering water scarcity and value as limited resources, pricing considers demand management as well as the sustainability of the service. Over time, different approaches have emerged and been implemented to create water tariffs.

The World Bank (2003) discussed two primary justifications for supplying water at a specific price: restricting water consumption and generating income for operational and infrastructure investments. Consequently, water can be regarded as an economic good, and excessive consumption can be prevented (The Dublin Statement and Report of the Conference, 1992). Price policies are expected to serve the objectives of water organisations. Price policies aim to ensure access to clean water resources through affordable tariffs for all income groups.

If the water price is utilised as a policy tool, it can enable more efficient use of water resources, promote sustainability, and ensure a fairer distribution of water supply costs

(Barberán et al., 2022). Additionally, the price must serve as an effective instrument for generating revenue capacity, economic efficiency, environmental sustainability, and affordability principles to sustain the services of water organisations (Gam & Rejeb, 2021; Meran et al., 2021). However, developing a price policy aligning with these trade-off objectives is quite complex. Because efficiency often conflicts with accessibility and affordability, and income generation often conflicts with the equitable and fair distribution of water (Meran et al., 2021), implementing a rational decision-making process to achieve these goals can be quite challenging.

Policymakers aiming for equitable and fair water distribution tend to sell essential goods such as water below the cost (Depoorter, 1999). However, this situation contradicts full-cost pricing, which entails allocating all water service costs to those who consume and pollute water to ensure the continuity of maintenance, repairs, operations, and investment expenses of water organisations (Massarutto, 2007; Zetland & Gasson, 2013). Implementation of the full-cost rule is more feasible in developed countries. For instance, while Germany applies full-cost pricing to 99% and Austria to 93% of their water services (Reynaud et al., 2015), a similar practice in developing countries, such as Jordan, could further complicate the issue for low-income groups facing difficulties in accessing clean water (Klassert et al., 2018). In developing countries, the full-cost rule can be adopted through cross-subsidy practices that involve financing the difference between the price applied to low-income consumers and the cost of the water supply by higher-income individuals (Depoorter, 1999). Full-cost pricing can become an applicable method for developing countries when water tariffs are designed to encompass cross-subsidies.

In the urban water supply industry, high fixed costs result in average costs exceeding marginal costs, leading to the consideration of the urban water sector as a natural monopoly (Massarutto, 2007; Meran et al., 2021). While achieving economic efficiency is possible through marginal cost pricing in perfect competition (Viscusi et al., 2018), implementing marginal cost pricing in the urban water industry would lead to revenue loss for service-providing institutions. The assumption that consumers have complete information about the structure of water tariffs suggests using marginal pricing (Borenstein, 2009). However, Binet et al. (2014) and Barberán et al. (2022) argue that consumers have incomplete information about water tariffs; however, with increased awareness levels, marginal pricing can be effectively utilised in water pricing. Gaudin (2006) demonstrates through his study in the United States that informing consumers about the structure of water tariffs can increase the price elasticity of demand by 30-40%. On the other hand, due to incomplete information, there is a consensus that consumers are more sensitive to average prices than marginal prices (Gaudin, 2006; Grafton et al., 2011; Wichman, 2014; Clarke et al., 2017; Marzano et al., 2018; Tortajada et al., 2019; Puri & Maas, 2020). Therefore, considering Armstrong's (1994) characterisation of local monopolies in urban water supply, average cost pricing is the optimal method in terms of the effectiveness of price policy.

Furthermore, there is a consensus in the literature that price, which serves as a deterrent to promote water conservation, should be utilised as an important tool to achieve

one of the fundamental objectives of water utilities (Dalhusien et al., 2003; Nauges & Thomas, 2003; Arbues et al., 2004). Indeed, Timmins (2003), investigating the combined effect of pricing and non-price strategies in discouraging water consumption, found that a regulation increasing water prices resulted in a more significant reduction in water consumption compared to a policy that mandates the use of low-flow meters. Aubuchon and Roberson (2012) also analysed the United States' water consumption reduction through price and non-price variables. They concluded that non-price variables have a limited impact on water demand management. In summary, this approach considers price and tariff structure as fundamental instruments in managing water demand while predicting that the influence of non-price factors will be limited.

However, Martínez-Espiñeira (2003) found that the impact of increasing block tariffs or changing the price within tariff blocks on water conservation was lower than expected. Generally, households in higher-income groups, particularly those residing in houses with swimming pools or gardens, are less responsive to price increases when promoting water conservation. In other words, relying solely on increasing the progressive nature of water tariffs to encourage water savings without resorting to extraordinary price hikes is not an effective policy approach to incentivise water conservation among middle-to-upper-income households (Tortajada et al., 2019). These findings lead to a discussion of whether non-price factors in water management can serve as useful policy options.

2.2. Non-Price Strategies

Although increasing household water prices is considered a means to reduce demand, some views suggest that the price elasticity of water demand is insignificant, particularly among high-income households, thus asserting that price is an ineffective tool for regulating demand and consumption (Wichman et al., 2014). From this perspective, non-price strategies aimed at reducing water consumption are considered important factors for policymakers when developing policies related to water consumption (Wichman et al., 2016). Indeed, studies supporting this viewpoint suggest that awareness campaigns targeting the public, as well as programs that restrict water usage and incorporate more efficient technological innovations, can yield more successful results in reducing water consumption (Kenney et al., 2008; Grafton et al., 2011; Tortajada et al., 2019).

The main theme of urban water conservation programs is based on directing demand-oriented tendencies by raising public awareness and providing discounts and incentives to certain disadvantaged groups (Diamond et al., 2000). Grafton et al. (2011) argue that while water-saving devices and household characteristics statistically do not have a significant impact on reducing water consumption, behavioural tendencies and environmental concerns can be used as alternatives to price policies. However, Mayer et al. (1999) and Deoreo et al. (2016) emphasise in their studies conducted in the United States that environmental concerns and water-saving devices effectively reduce water consumption. Deoreo et al. (2016) also stated that a decrease in household size reduces water consumption. Tortajada et al. (2019) demonstrate that behavioural effects, education, awareness campaigns, and increased use of

household water-saving devices are more effective in reducing water consumption in Spain's five major regions.

Restricting outdoor water consumption has a stronger impact on reducing water demand in high-income households, which usually own larger plots of land (Renwick & Green, 2000). However, Kenney et al. (2008) state that when considering the consumer profiles of different income groups before and after drought periods, price-based policies that restrict water consumption and policies that increase prices interact with each other, and the total water savings are not simply the sum of each policy working independently. In other words, it has been found that pricing policies are effective in the long term for households that consume a large amount of water, while restrictions are effective in coping with problems such as drought in the short term (Kenney et al., 2008). Policymakers aim to achieve overlapping goals, such as efficiency and conservation measures, within the framework of these programs. Further research is needed to determine the interactions of simultaneous policies and programs implemented to reduce water demand during peak and drought periods to understand how they affect the overall reduction of water demand (Renwick & Green, 2000).

3. Water Consumption in the World

Explaining the issue of water consumption and pricing, which is the focus of this study, with examples from around the world and comparing it with the current situations in Türkiye (based on three metropolitan cities) is important for understanding how the subject has been shaped. The findings compiled from academic studies on residential water consumption based on different geographical locations are summarised in Table 1. Table 1 provides information on the daily per capita water consumption of households, the average price of water in cubic meters, the size of residential area in square meters, the average number of people in households, and the ratio of water expenditure to household income in different countries, states, and cities.

Countries such as Canada, Australia, South Korea, and Italy have significantly higher per capita daily water consumption than others. These countries' per capita daily water consumption levels were 535, 411, 379 and 356 litres, respectively. On the other hand, Belgium, Jordan, Germany, Norway, and France are countries with the lowest per capita water consumption. Per capita water consumption in Canada was approximately six times higher than that in Belgium. Various explanations have been proposed for such significant variations in water consumption levels worldwide (Domene & Sauri, 2006; Grafton et al., 2011; Reynaud et al., 2015). Factors such as water prices, tariff structures, climate, behavioural effects, education and income levels, and household characteristics are the main drivers in this context (Mayer et al., 1999; Domene & Sauri, 2006; Grafton et al., 2011; Reynaud et al., 2015; Tortajada et al., 2019; Rondiel & Sarmiento, 2020).

Reynaud et al. (2015), in their analysis of 28 EU countries (not all included in this study), found that predominantly southern European countries such as Greece, Cyprus, Italy,

Portugal, and Sweden had an average daily per capita water consumption of more than 164 litres. In contrast, Eastern European countries such as Bulgaria, the Czech Republic, Estonia, Norway, Lithuania, Poland, and Slovakia had an average daily per capita water consumption of fewer than 110 litres. Among the countries with the highest water consumption, the price of a unit cubic meter of water was 0.72€ in Cyprus, while in Belgium and Germany, countries with the lowest water consumption, the price of a unit cubic meter of water was 3.7€ and 3.9€ respectively. This study suggests that the variation in water prices among EU countries can be attributed to differences in water supply costs in each country. However, other significant factors include the implementation of cross-price subsidies among consumers, the failure of every country to adopt full-cost pricing, and the lack of a competitive structure in the water industry (Reynaud et al., 2015).

Grafton et al. (2011) analysed the 10 OECD countries, considering explanatory variables such as average price, household characteristics, water-saving devices, behavioural tendencies, and environmental concerns to explain the variations in residential water consumption. They found that the average price was the most influential variable in regulating water consumption. According to Tortajada et al. (2019), based on their studies conducted for Barcelona, Seville, Zaragoza, Malaga, and Madrid covering 2002 and 2016, water prices have increased over time, resulting in significant reductions in water consumption.

The assumptions regarding household characteristics as a determining factor for water consumption align with the findings presented in Table 1. Indeed, it was observed that less water is consumed in smaller houses measured in square meters where low-income households reside, while larger households with higher housing areas tend to consume more water. Studies conducted for Barcelona, Kentucky/Louisville, and Lima have demonstrated a positive correlation between housing size and water consumption (Domene & Sauri, 2006; Rockaway et al., 2011; Rondiel & Sarmiento, 2020).

Mayer et al. (1999) and (2016) analysed data from North America and found a 15% decrease in water consumption during the studied period. They attributed this decline to an increase in the usage of water-saving devices and a reduction in the average household size. Rockaway et al. (2011) conducted a regression analysis based on data from the U.S. The Census Bureau covering 1990-2007 found that household size positively affected daily water consumption, with an average increase of 20.4 litres per day (Rockaway et al., 2011).

Domene and Sauri's (2006) analysis of Barcelona, which examined the relationship between household characteristics, housing area, and water consumption, yielded similar results regarding these variables. In small-sized apartment units (measured in square meters), per capita water consumption was 120 litres, whereas, in relatively larger housing complexes with shared gardens or pools, it was 156 litres. In detached houses with the most significant housing areas and private gardens or pools, the per capita water consumption reached 203 litres. Domene and Sauri (2006) concluded that water consumption in high-income households, particularly those residing in detached houses, increased during summer due to

seasonal effects. Furthermore, they found a direct relationship between indoor water use in households, housing size, and the number of occupants, independent of income level.

Similar findings indicating an increase in water consumption associated with the type of dwelling occupied based on household income can also be observed in Canada, Australia, and the United States. Conversely, the average daily per capita water consumption in water-stressed Jordan is estimated to be 92 litres (Klassert et al., 2018). These figures demonstrate that an average Jordanian consumes only about 1/6 of the daily water consumption of an average Canadian. Moreover, it can be inferred that Jordan falls below the threshold of water poverty, as defined by the World Health Organization (2003), which states that a minimum of 100 litres per capita daily water consumption is necessary to meet basic human needs.

In the analysis conducted by Rondiel and Sarmiento (2020) for the capital city of Peru, Lima, it was observed that water consumption increases along with housing areas in regions ranked from low to high income. In this study conducted for three different local units of Lima, the daily per capita water consumption was determined as 112 litres in Villa El Salvador, which has a high concentration of low-income households; 158 litres in Brena, a region with moderate income levels, and 207 litres in San Isidro, a high-income area (Rondiel & Sarmiento, 2020). Gardens and pools in these residences contribute to increasing water consumption. As is evident from studies conducted in different regions of the world, an increase in income leads to a rise in housing areas and the number of occupants, resulting in higher water consumption.

Temperature and climate are important factors influencing water consumption. Mayer et al. (1999), Rockaway et al. (2011), and Deoreo et al. (2016) found a positive causal relationship between temperature and water consumption. Rockaway et al. (2011) concluded that the highest household water consumption occurs in California, where a hot climate prevails, while the lowest water consumption is observed in Alaska, which has a cold climate.

Finally, based on the findings in Table 1, it can be reported that the affordability criterion proposed by the UNDP (2006) states that water bills should not exceed 3% of household income, which is generally adhered to worldwide. However, when looking at the results obtained by Klassert et al. (2018), it is evident that households in Jordan grappling with water poverty issues have to bear a significantly higher water consumption cost than other countries. For the ten OECD countries, this ratio was calculated to be 0.875. Among these countries, households in the Czech Republic and Mexico bear a relatively high burden in terms of water expenses.

Table: 1
Water Consumption in the World

The Articles		Water Consumption (Person, Daily, Liter)	Average Unit Water Price	Residential Area (m^2)	Number of Occupants (Average)	Water Expenditure (Bill/Total Revenue) (%)
Reynaud et al. (2015)	England	147	1,9€			
	Germany	119	3,9€			
	Italy	183	1,4€			
	South Cyprus	246	0,72€			
	Belgium	87	3,7€			
Grafton et al. (10 OECD Countries) (2011)	Australia	411	1,170€	113	2,9	0,6
	Canada	535	1,391€	138	2,7	0,66
	Czech Republic	178	1,727€	97	3	1,74
	France	133	3,0€	109	2,6	0,9
	Italy	356	1,127€	112	3,1	0,78
	South Korea	379	0,522€	91	3,7	0,45
	Mexico	276	0,563€	114	3,7	1,4
	Holland	208	2,089€	96	2,2	0,71
	Norway	132	2,369€	152	2,8	0,51
	Sweden	236	2,588€	144	2,5	1
	OECD (10)	269	1,703€	110	2,9	0,875
Mayer et al. (1999)	Colorado, Oregon, Washington, California, Florida, Arizona, Ontario	262,3			2,77	
Klassert et al. (2018)	Jordan	92	0,32JOD[a] 0,37JOD[b]		5,6	2,99[a] 2,01[b]
Deoreo et al. (2016)	Washington, Colorado, Oregon, California, Florida, Arizona, Ontario, Alberta, Nevada, New Mexico, Texas, Georgia, North Carolina, Illinois, Pennsylvania, Connecticut	221,8			2,65	
Rockaway et al. (2011)	Louisville, Kentucky *(1990-2007)*	312-297		200-212	2,52-2,38	
Tortajada et al. (2019)	Barcelona *(2002-2016)*	355-283	1€ - 2,14€			1,49*
	Zaragoza *(2002-2016)*	362-266	0,75€ - 1,18€			0,76*
	Malaga *(2002-2016)*	358-308	0,78€ - 1,22€			0,92*
	Madrid *(2002-2016)*	478-357	0,95€ - 1,44€			0,76*
	Sevilla *(2002-2016)*	386-313	1€ - 1,77€			1,11*
Rondiel & Sarmiento (Lima) (2020)	Villa El Salvador	112	2,78PEN	m^2>100	4,7	
	Breña	158	2,78PEN	50< m^2 m^2<100	4,3	
	San Isidro	207	4,08PEN	m^2>100	3,7	
Domene & Sauri (2006)	Barcelona (Apartment Home)	120,1	1,187€	85,6	2,7	0,64
	Barcelona (Site Home)	156,7	1,029€	109,6	3,2	0,55
	Barcelona (Detached Home)	203,3	1,085€	173,0	3,3	0,87
Ramulongo et al. (2017)	Makhado Newtown	225,13				

** We calculated it based on the data in the relevant study. (a) High-income households. (b) Low-income households.*

4. Data and Methodology

The water administrations (İSKİ (İstanbul), ASKİ (Ankara), İZSU (İzmir)) in the three selected metropolitan cities are responsible for providing water services to 27.1% of the Turkish population. The data used in this study for İstanbul (TR10), Ankara (TR51), and İzmir (TR31), which are among the 26 sub-statistical regions (Level 2) according to the Statistical Regions Classification of Türkiye, were obtained from the Household Budget Survey conducted annually by the Turkish Statistical Institute (TURKSTAT) between 2015 and 2018. These surveys enable cross-sectional monitoring of changes in household consumption patterns over time. (TURKSTAT, 2020).

The findings of the conducted analysis using the Household Budget Survey data from TURKSTAT, specifically related to residential water consumption in İstanbul, Ankara, and İzmir, are summarised in the following section by presenting separate tables for each city. These tables include the monthly water consumption quantities of households in terms of income groups *'Q(m^3)'*, water prices *'WP(₺)'*, the ratio of water bills to household income *'B/I(%)'*, the percentage change in real water prices *'RWP(%)'*, number of occupants in the household *'NO'*, and size of residential areas in square meters *'RA(m^2)'*.

A detailed analysis of household water consumption by income groups in Türkiye's top three largest metropolitan areas by population is the main focal point of this study. The aim is to examine how water prices differ regarding budgetary burdens for households in low- and high-income groups. In this regard, the real increase in water prices and changes in water tariff structures in the respective years were considered. Additionally, the causal relationship between the size of the occupied dwelling (m^2) and the number of individuals in the household and household water consumption, as discussed in the literature, will be examined to assess its validity in Türkiye.

In this context, using data obtained from the TURKSTAT Household Budget Surveys conducted for each year between 2015 and 2018 in İstanbul, Ankara, and İzmir, the sample was divided into income ranges (N/5), and the average water prices and monthly water consumption of households in each income range, the ratio of water bills to household income *'(B/I)'*, real price changes *'(RPC)'*, the number of household member *'NoHM'*, and the size of the residential areas *'(RA)'* were analysed. Thus, the financial burden households bear on access to clean water, the level of water consumption by households, and the factors influencing water consumption, which are essential for meeting basic human needs, can be examined. Finally, the daily average per capita water consumption in the three largest metropolitan areas of Türkiye is compared, considering the findings for other countries provided in Table 1.

5. Findings

One of the most significant factors influencing household water consumption is the tariff structure determined and implemented by local governments. Within the scope of the research, it was observed that the water tariff structures differ significantly from each other for the three major cities examined in the respective years. In İstanbul and İzmir, a progressive tariff structure is applied, in which the price increases gradually based on prespecified consumption levels. By contrast, Ankara applies a single-scale fixed tariff, where the same price is used for all consumption levels.

5.1. The Case of İstanbul

In İstanbul, a residential water tariff is applied in an increasing block-rate structure consisting of three scales in the respective years. Table 2 presents the water tariffs applied to the dwellings in İstanbul between 2015 and 2018. The first scale corresponds to

consumption ranging from 0 to 10 m^3, the second encompasses consumption between 10 and 20 m^3, and the third represents consumption exceeding 21 m^3. Water prices determined by the İstanbul Water and Sewerage Administration (İSKİ) for each tariff range are applied (adjusted at the beginning of each month throughout the year due to inflationary conditions), and the rate of price increase between ranges is kept constant for all examined years.

Table: 2
İstanbul Dwelling Water Tariff (₺*)

İSKİ	2015	2016	2017	2018
1) 0-10m^3	4.21	4.36	4.79	5.13
2) 11-20m^3	6.12	6.37	7.01	7.51
3) 21-∞m^3	8.94	9.27	10.20	10.93

*Source: İSKİ. * Unit m^3 prices (Turkish Lira). * Wastewater cost is included in the prices.*

However, based on data from TURKSTAT, the position of households in İstanbul within the increasing block rate structure, as shown in Table 2, according to their monthly water consumption, can be observed in Table 3. According to Table 3, households on the first scale with monthly water consumption of up to 10 m^3 account for 34.75% of all households, representing 19% of the total water consumption and covering 16.5% of the total water bill. More than half of the households (54.6%) were billed within the first two scales for their monthly water consumption, accounting for 59% of the total water consumption and covering 56.9% of the total water bill. Finally, 10.6% of households had a monthly water consumption exceeding 20 m^3, including the third scale. In this scale, households accounted for 21.9% of the total water consumption and covered 26.5% of the total water bill. Considering the tariff scale, households' average monthly water consumption levels are 6.63 m^3, 13.07 m^3, and 25 m^3, respectively.

Table: 3
İstanbul Water Tariff Structure (2015-2018)

Tariff Scales	*Average Consumption(m^3)*	*Total Consumption (%)*	*Total Water Payment (%)*	*Total Observation (%)*
1) 0-10m^3	6.63	19.05	16.57	34.75
2) 11-20m^3	13.07	59.05	56.9	54.66
3) 21-∞m^3	25	21.9	26.53	10.59

** Prepared by TURKSTAT Household Budget Surveys data and İSKİ residential water tariffs.*

The detailed findings regarding household water consumption in İstanbul are presented in Table 4. It is evident that, as income levels increase, households tend to have higher monthly water consumption, which conforms to the findings in the literature. In İstanbul, where an increasing block rate tariff is implemented, water prices *(P)* are expected to increase as consumption levels increase. However, despite high-income households having approximately 50% higher monthly water consumption than low-income households in 2015, the average water bill they pay is only 7% higher than that of low-income households.

On the other hand, over the years, there has been no significant change in the water consumption levels of low-income households, while a decreasing trend in the water consumption levels of high-income households can be observed. Based on the sample

averages, it can be stated that there is a decreasing trend in household water consumption *(Q)* in İstanbul over time. In 2015, an average of 12.54 m^3 of water was consumed per household monthly, which decreased to 11.9 m^3 per month in 2018, indicating a reduction in household water consumption by approximately 5.3%.

The "Bill/Income(B/I)" findings show a similar causality between income and water consumption increases. The proportion of high-income households' budget allocated to water bills was significantly lower than that of low-income households. In fact, in 2015, the share of water bills in the income of low-income households was about 3.6 times higher than that of the higher-income groups. Moreover, this ratio has increased, reaching approximately four times in 2018.

Additionally, Table 4 depicts that the ratio of water bills to household income in the lowest income group, indicated in the first row, remains above 3% in 2015, 2016, and 2017 but falls below the threshold of 3% set by the UNDP in 2018. The main reason for this positive downward trend can be found in the *"Real Price Change (RPC)"* column in the fourth column. Indeed, these findings show that water prices in İstanbul have decreased in real terms for all income groups. Considering the 2015 baseline, water prices in İstanbul decreased by 5.53%, 5.62%, and 8.54%, respectively. This explains the continued decline in the *"Bill/Income"* data.

The water bill shares of the household budget was an average of 1.82% in 2015, which decreased to 1.49% in 2018. However, this situation presents another problem. According to "Real Price Change" findings, this declining trend does not occur equally in every income group. Moreover, as income levels increase, the price decrease also increases. In other words, a decline in prices favours higher-income groups.

Furthermore, the size of the residential areas *(RA(m^2))* and household size *(NoHM)* increased in parallel with the household water consumption. In fact, in the analysed years in İstanbul, with a few exceptions, it was observed that the number of household members and the size of the occupied dwelling increased along with household income level, and household water consumption levels positively correlated with these findings. These theoretical assumptions suggest that changes in household characteristics increase water consumption and can be considered applicable to İstanbul.

Table: 4
İstanbul Household Water Consumption Data (2015-2018)

İSTANBUL						
2015						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	10.30	4.11	3.08	0	3.08	89.56
2.	11.31	4.15	2.04	0	3.54	96.95
3.	12.58	4.24	1.78	0	3.54	97.81
4.	13.33	4.30	1.37	0	3.99	105.88
5.	15.21	4.43	0.85	0	3.32	135.63
x̄	12.54	4.24	1.82	0	3.49	105.14

2016						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	10.55	4.31	3.28	-4.23	3.21	89.56
2.	10.94	4.30	2.00	-5.51	3.43	96.71
3.	12.64	4.42	1.79	-4.87	3.75	99.95
4.	12.00	4.39	1.19	-6.95	3.41	103.06
5.	14.12	4.56	0.86	-6.10	3.78	119.96
$\bar{x}$	12.05	4.39	1.82	-5.53	3.51	101.84
2017						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	10.14	4.67	3.02	-5.08	3.07	87.00
2.	11.83	4.79	2.17	-3.59	3.44	93.90
3.	12.17	4.81	1.62	-5.38	3.64	97.66
4.	12.52	4.83	1.21	-6.22	3.55	104.02
5.	12.98	4.89	0.76	-7.85	3.56	119.40
$\bar{x}$	11.92	4.79	1.75	-5.62	3.45	100.38
2018						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	10.18	4.99	2.54	-8.02	3.04	90.92
2.	11.28	5.07	1.79	-7.55	3.34	94.08
3.	11.50	5.08	1.36	-9.35	3.45	96.67
4.	13.03	5.23	1.14	-8.03	3.60	104.71
5.	13.54	5.28	0.62	-9.72	3.45	128.18
$\bar{x}$	11.90	5.13	1.49	-8.54	3.37	102.89

** Data used in this study were obtained from the Household Budget Survey conducted by the Turkish Statistical Institute (TURKSTAT). * Real price change was calculated using the Consumer Price Index (CPI). The base year for the calculations was 2015. * The notation "N/5" represents income groups, with "1" indicating the lowest income group and "5" indicating the highest income group. * The number of observations for each year is 1.318 - 1.402 - 1.436 - 1.444.*

5.2. The Case of Ankara

In Ankara, during the years considered in this study, the residential water tariff was implemented using a single-block flat-rate structure, in which the same price was applied for all consumption levels. Table 5 provides information on the water tariff applied to residential properties by ASKİ (Ankara Water and Sewerage Administration) between 2015 and 2018. In a tariff structure similar to that in Ankara, where water prices are determined independently of consumption and are billed at the same rate for all consumption levels, water tariffs cannot be used as a policy tool to encourage households to save water.

Table: 5
Ankara Dwelling Water Tariff (₺*)

ASKİ	2015	2016	2017	2018
0- ∞ m^3	4.45	5.57	6.44	7.52

*Source: ASKİ. * Unit m^3 prices (Turkish Lira). * Wastewater cost is included in the prices.*

The detailed findings regarding household water consumption *(Q)* in Ankara are presented in Table 6. As income levels increased in Ankara, per capita water consumption also increased. However, households in the upper-income group showed a decreasing trend in monthly water consumption during the observation period. In 2015, high-income households had an average monthly water consumption of 13.05 m^3, which decreased to 11.51 m^3 in 2018, indicating a 13% decline. Similarly, low-income households in the first group experienced an 11% decrease in the average monthly water consumption during the same period. Additionally, the sample means demonstrate a similar decline of approximately 8.7% in average monthly water consumption.

According to Table 6, another important aspect is that low-income households in Ankara fail to meet the affordability criterion set by the United Nations Development Programme (UNDP, 2006), suggesting that the share of water bills in household income should not exceed 3%. Findings from the *"Bill/Income(B/I)"* ratio, which indicates the burden of water bills on household budgets, reveal that in 2015, low-income households in Ankara allocated approximately four times more to monthly water consumption than high-income households. By 2018, this ratio had decreased to 3.2, reaching relatively lower levels.

When examining the findings of the *"Price Change"* variable, which indicates the real change in prices, it can be observed that water prices in Ankara have significantly increased over the years. These data are critical because the water prices in the other two major cities under study generally show a downward trend. According to ASKİ, compared to the base year of 2015, there has been a real increase in water prices of 5%, 11%, and 18% in 2016, 2017, and 2018, respectively. In contrast, it has been found the monthly average household water consumption (m^3) decreased by 11% for low-income households and 13% for high-income households. This indicates that tariff structures and prices are significant policy tools for household water consumption, consistent with the literature.

Finally, in Ankara, household size *(NoHM)* and residential area *(RA(m2))* increased in parallel with monthly average water consumption. Similar to İstanbul, it can be stated that there is a positive correlation between household characteristics and monthly average water consumption for different income groups.

Table: 6
Ankara Household Water Consumption Data (2015-2018)

ANKARA						
2015						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	9.45	4.45	3.93	0	2.75	87.68
2.	9.39	4.45	2.16	0	3.13	99.79
3.	10.65	4.45	1.77	0	3.53	105.05
4.	11.07	4.45	1.37	0	3.37	105.83
5.	13.05	4.45	0.96	0	3.62	121.70
$\bar{x}$	10.71	4.45	2.03	0	3.27	103.98
2016						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	8.99	5.16	3.65	5.82	2.78	93.42
2.	9.65	5.16	2.10	5.82	3.19	99.32
3.	10.28	5.16	1.62	5.82	3.43	101.23
4.	11.67	5.16	1.35	5.82	3.55	109.07
5.	13.35	5.16	0.93	5.82	3.40	131.62
$\bar{x}$	10.78	5.16	1.93	5.82	3.27	106.9

2017						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	8.58	5.96	3.33	11.91	2.61	97.70
2.	9.08	5.96	2.12	11.91	3.13	104.08
3.	10.57	5.96	1.87	11.91	3.42	106.09
4.	11.37	5.96	1.51	11.91	3.59	109.41
5.	12.61	5.96	1.03	11.91	3.71	121.17
$\bar{x}$	10.44	5.96	1.97	11.91	3.29	107.67
2018						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	8.46	6.96	2.95	18.43	3.04	102.35
2.	9.56	6.96	2.15	18.43	3.14	106.05
3.	9.44	6.96	1.59	18.43	3.37	109.23
4.	10.30	6.96	1.30	18.43	3.41	114.87
5.	11.51	6.96	0.91	18.43	3.35	126.32
$\bar{x}$	9.85	6.96	1.78	18.43	3.26	111.75

** Data used in this study were obtained from the Household Budget Survey conducted by the Turkish Statistical Institute (TURKSTAT). * Real price change was calculated using the Consumer Price Index (CPI). The base year for the calculations was 2015. * The notation "N/5" represents income groups, with "1" indicating the lowest income group and "5" indicating the highest income group. * The number of observations for each year is 798 - 784 - 822 - 772.*

5.3. The Case of İzmir

In İzmir, the residential water tariff was applied in an increasing rate structure consisting of two blocks during the analysed years. The first block includes consumption up to 20 m^3, whereas the second block consists of consumption exceeding 21 m^3. At the beginning of each year (often multiple times due to inflationary conditions), the water prices determined by İZSU are applied for each tariff block.

Table: 7
İzmir Dwelling Water Tariff (₺*)

İZSU	**2015**	**2016**	**2017**	**2018**
1) 0-20m^3	3.7	3.89	4.38	5.07
2) 21-∞m^3	8.67	9.12	10.02	11.30

*Source: İZSU. * Unit m^3 prices (Turkish Lira). * Wastewater cost is included in the prices.*

Based on the data from TURKSTAT, the combined data for 2015, 2016, 2017, and 2018 were used to determine the placement of households in İzmir within the increasing rate structure of the water tariff based on their monthly water consumption. This information is presented in Table 8. According to Table 8, in İzmir, households in the first block, with monthly water consumption of up to 20 m^3, accounted for 84% of all households. These households contribute 71% of the total water consumption and cover 67% of the total water bill. On the other hand, 16% of households exceeded the 20 m^3 threshold and were billed under the second block. These households represent 29% of the total water consumption and cover 32% of the total water bills. The average monthly water consumption levels for households in each tariff block are 10.79 m^3 and 23.11 m^3, respectively.

Table: 8
İzmir Water Tariff Structure (2015-2018)

Tariff Scales	***Average Consumption(m^3)***	***Total Consumption (%)***	***Total Water Payment (%)***	***Total Observation (%)***
1) 0-10m^3	10.79	70.95	67.35	83.94
2) 21-∞m^3	23.11	29.05	32.65	16.06

** Prepared by TURKSTAT Household Budget Surveys data and İZSU residential water tariffs.*

Table 8 indicates that the water tariff for residential properties in İzmir during the analysed period had a wide range within the blocks, suggesting the existence of an increasing rate tariff structure. However, a closer examination reveals that most households (84%) are subject to the same price, similar to the tariff structure in Ankara. An increasing tariff rate is apparent due to adopting a wide consumption range (0-20 m^3) for the first block. As a result, only 16% of households are subject to an increasing tariff rate, undermining the effectiveness of the water tariff as a policy tool.

Table 8 indicates that, with a few exceptions, there were no significant changes in households' average monthly water consumption during the analysed years, similar to the patterns observed in İstanbul and Ankara. Furthermore, owing to the structure of the applied water tariff in İzmir during the relevant years, there is little variation in water prices among income groups, with low-income and high-income households subjected to nearly the same prices. However, in 2015, it was estimated that high-income households consumed approximately 30% more water on average than low-income households. By 2018, this gap was reduced to 16%, suggesting that additional consumption did not create an additional financial burden due to the adopted tariff structure, as indicated in the *"Price (P)"* column. According to the sample averages, there has not been a significant change in households' average monthly water consumption (Q) over the years.

Considering the UNDP's affordability criterion, the findings in Table 9 indicate that households in the low-income group, as presented in the first row, face the most disadvantageous budget burden *(B/I)* in terms of water consumption compared to İstanbul and Ankara. Additionally, when analysing the *"Real Price Change (RPC)"* data based on the year 2015, it is observed that water prices in İzmir show a downward trend in real terms. However, this trend appears to be unfavourable for low-income households. The price change for low-income households in 2016 was calculated to be -3.6%, while for high-income households, it was -5.94%. In 2018, water prices increased by 4.06% for low-income households and 0.68 for high-income households. These findings indicate that the current structure of the applied water tariff has a biased trend toward low-income households.

On the other hand, household size *(NoHM)* and residential area *(RA)* tended to increase with income level, indirectly explaining the increase in water consumption. These factors contribute to the rise in water consumption, which aligns with assumptions in the theoretical literature (Domene & Sauri, 2006; Grafton et al., 2011; Rondiel & Sarmiento, 2020). These observations hold for the three metropolitan cities analysed.

Table: 9
İzmir Household Water Consumption Data (2015-2018)

İZMİR						
2015						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	10.69	3.48	3.58	0	2.41	91.68
2.	12.32	3.49	2.28	0	2.95	101.11
3.	12.86	3.50	1.74	0	2.97	107.04
4.	13.29	3.53	1.34	0	3.17	114.20
5.	13.88	3.54	0.81	0	3.11	127.39
$\bar{x}$	12.6	3.51	1.95	0	2.92	108.26
2016						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	12.49	3.68	4.23	-3.60	2.41	84.71
2.	12.33	3.65	2.33	-4.61	3.00	92.64
3.	12.55	3.67	1.74	-4.33	3.01	99.00
4.	13.01	3.67	1.32	-5.12	3.23	106.55
5.	13.60	3.65	0.82	-5.94	3.13	115.90
$\bar{x}$	12.79	3.66	2.09	-4.72	2.95	99.74
2017						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	11.21	4.13	3.55	-0.88	2.20	84.25
2.	12.64	4.17	2.40	-0.30	2.94	98.37
3.	13.21	4.15	1.77	-1.01	3.00	101.62
4.	13.95	4.21	1.42	-0.41	3.15	105.45
5.	13.55	4.17	0.88	-1.76	3.33	113.69
$\bar{x}$	12.91	4.16	2	-0.87	2.92	100.65
2018						
N/5	**Q(m^3)**	**P(₺)**	**B/I(%)**	**RPC(%)**	**NoHM**	**RA(m^2)**
1.	11.34	4.78	4.29	4.06	2.64	77.85
2.	12.81	4.77	2.50	3.32	3.00	93.42
3.	12.01	4.70	1.59	1.53	3.03	96.92
4.	14.55	4.86	1.48	4.24	3.37	108.42
5.	13.17	4.71	0.73	0.68	3.20	126.01
$\bar{x}$	12.77	4.76	2.12	2.77	3.04	100.5

** Data used in this study were obtained from the Household Budget Survey conducted by the Turkish Statistical Institute (TURKSTAT). * Real price change was calculated using the Consumer Price Index (CPI). The base year for the calculations was 2015. * The notation "N/5" represents income groups, with "1" indicating the lowest income group and "5" indicating the highest income group. * The number of observations for each year is 752 - 776 - 819 - 767.*

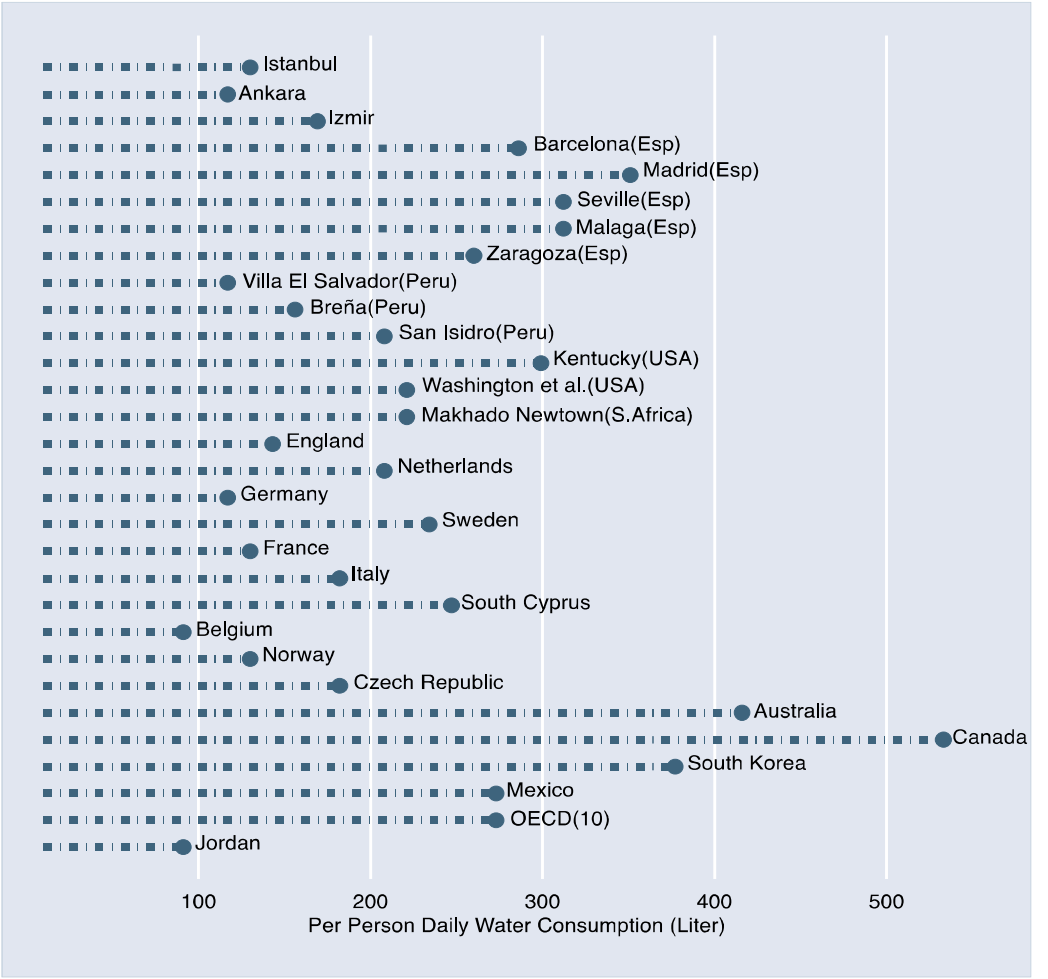
5.4. Comparison of Water Consumption in Türkiye and the World

The comparative results of the average per capita daily water consumption quantities for İstanbul, Ankara, and İzmir were analysed within the scope of the study, along with the summarised findings of global studies presented in Table 1, shown in Figure 1. During the relevant period, the daily per capita average water consumption in İstanbul was 134.67 litres; in Ankara, it was 119.43 litres; and in İzmir, it was 167.32 litres.

Regarding water consumption levels, İstanbul, Ankara, and İzmir are similar to countries such as the United Kingdom, Germany, France, Italy, Norway, and Peru. Jordan and Belgium had the lowest water consumption, while Canada, Australia, South Korea, Spain (Madrid), the United States (Kentucky), Mexico, and Northern Cyprus had the highest daily water consumption. Factors such as water price, water supply capacity, household characteristics, housing type, behavioural effects, climate, and temperature can be considered the most significant factors explaining the differences in water consumption. In

Turkey, specifically for the three metropolitan cities, it can be stated that the average per capita daily water consumption is close to the average water consumption of European countries, with certain exceptions.

Figure: 1
Comparison of Water Consumption in Türkiye and the World



** Reynaud et al. (2015) was chosen as a reference for Italy because of its more recent publication date.*

6. Conclusion and Assessment

Within the scope of the research, household water tariffs in the three largest cities in Türkiye between 2015 and 2018 were implemented with different structures. İstanbul

applies a progressive tariff consisting of three blocks, Ankara employs a single flat-rate tariff without blocks, and İzmir utilises a relatively progressive tariff with two blocks. Ankara is the city where water is the most expensive for households and where the least water consumption occurs, whereas İzmir is the city where water is the cheapest and where the highest residential water consumption takes place. When considering the burden of water consumption on household budgets and the real changes in water prices, the tariff structure implemented in İstanbul results in a more equitable and fair distribution compared with Ankara and İzmir.

Indeed, during the examined period in İstanbul, while water prices decreased in real terms, households' average monthly water consumption decreased. In Ankara, water prices have increased in real terms over the years, leading to a significant reduction in average monthly water consumption by households. In İzmir, no significant change was observed in either water price or households' average monthly water consumption during the relevant period. Based on this, it can be stated that the tariff structure in İstanbul and prices in Ankara are used as policy instruments to promote water conservation.

As expected, household-level monthly water consumption (m^3) in all three major cities increased with household income throughout the study period. However, the size of the residential area (m^2) in which higher-income households reside also increases, which is considered another factor explaining the increase in household water consumption. Similar trends were observed in the number of household members. Studies in the global context presented in Table 1 also support this assertion.

Additionally, within the scope of the research, water price changes have been adjusted for inflation, and it has been observed that these changes vary across cities. It is evident that realised water prices decreased for all income groups in İstanbul, remained constant for all consumers in Ankara during this period, and showed a continuous increase, disadvantageous for low-income households in İzmir. It should be emphasised that metropolitan municipalities affect water distribution when determining water prices. Furthermore, disclosure of the cost recovery ratio of these prices to the public is another important finding.

The per capita daily water consumption data indicate that water consumption in İstanbul (134 litres) and Ankara (119 litres) is similar to that of England (147 litres), Germany (119 litres), and France (133 litres), while İzmir's (167 litres) water consumption is close to that of the Mediterranean country, Italy (183 litres). Based on 2015 data, the price per cubic meter of water is 1.4€ in İstanbul, 1.47€ in Ankara, and 1.16€ in İzmir. Water prices for England, Germany, France, and Italy are 1.9 - 3.9 - 3 and 1.4, respectively (Grafton et al., 2011; Reynaud et al., 2015). According to these figures, the water prices in Türkiye's three major cities are similar to Italy's nominal value without considering purchasing power parity. The average water price per cubic meter in the OECD countries is 1.7€ (Grafton et al., 2011).

Based on the research findings, another critical aspect that needs to be emphasised is ensuring the basic human right to access clean water. It is evident that in Ankara and İzmir, the water consumption of low-income households exceeds the affordability principle envisaged by the UNDP, whereas in İstanbul, there has been some progress due to the decrease in real water prices. Developing policies that align with the "right to water" concept to which the United Nations attaches great importance, particularly for low-income households in the three major cities, is another noteworthy recommendation.

In the literature, expanding a set of policy priorities that aim to provide advantageous water tariffs to specific segments of society, commonly called "social tariffs", is crucial to making access to clean water affordable for low-income individuals and removing it from being considered a luxury. The fact that low-income households allocate more than 3% of their budgets to water consumption according to the affordability criteria of the UNDP indicates that the currently implemented discounted tariffs (for martyrs' families, veterans, people experiencing poverty, students, etc.) may not be sufficient.

In light of these findings, it is important to reevaluate the tariff structures and pricing and the regulatory policies to be implemented by central governments within the framework of water supply security and water management. Consistent with the literature, the implementation of practices (Bağdadioğlu et al., 2009) that address the high operational and investment costs through cross-subsidization from higher-income household consumption, thereby relieving low-income groups from an additional financial burden on their bills should be prioritised and extensively supported with impact analyses.

It is now an undeniable fact that concerns about the effective use and sustainability of water resources are increasing. Despite not having a high per capita water consumption level (133 litres), France, which experiences water scarcity, carries out intensive awareness campaigns on water conservation and imposes certain restrictions on water consumption (Valo, 2023). From this perspective, it becomes evident that the issue of water management cannot be solely considered from the perspective of consumption (demand) but requires a comprehensive approach that encompasses water supply, necessitating the development of national-level policies. Therefore, the importance of water management at both local and national levels has increased.

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