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Valuing Water Resources in Turkey
A Methodological Overview and Case Study

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Abbreviations and Acronyms

ACM	Alternative Cost Method
CEM	Choice Experiment Method
COI	Cost of Illness
CVM	Contingent Valuation Method
DD	Derived Demand
DGWM	Directorate General of Water Management
DSİ	State Hydraulic Works
EU	European Union
GDP	Gross Domestic Product
HPM	Hedonic Price Method
IPA	Instrument for Pre-Accession
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resource Management
KOP	Konya Plain Irrigation Project
KOSKİ	Konya Water and Sewerage Authority
MDGs	Millennium Development Goals
MoD	Ministry of Development
MoEU	Ministry of Environment and Urbanization
MoFAL	Ministry of Food, Agriculture and Livestock
MoFWA	Ministry of Forestry and Water Affairs
MP	Market Pricing
NCA	Natural Capital Accounting
OECD	Organization for Economic Co-operation and Development
PF	Production Function
PWFA	Physical Water Flow Accounts
RBMP	River Basin Management Plan
RCM	Replacement Cost Method
RM	Residual Method
SEEA-CF	System of Environmental-Economic Accounting - Central Framework
SDGs	Sustainable Development Goals
TA	Technical Assistance
TCM	Travel Cost Method
TEV	Total Economic Value
TurkStat	Turkish Statistical Institute
UN	United Nations
WAVES	Wealth Accounting and Valuation of Ecosystem Services
WFD	Water Framework Directive
WRM	Water resources management
WTP	Willingness to Pay
WWF	World Wide Fund for Nature

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Executive Summary

Water is an essential component of Turkey's economy and environment. The country's annual average potential of economically exploitable water resources is 112 billion m^3. Annual freshwater consumption is about 44 billion m^3, of which 74% is used for agriculture, 15% for domestic uses, and 11% towards industrial ones. Besides its contribution to economic production, water and its related ecosystems (e.g. lakes, wetlands, coastal zones, etc.) provide a wide range of benefits such as flood protection, pollution abatement, and biodiversity conservation.

Water resources are under strong pressure in terms of both quantity and quality. Throughout the country, water resources are unevenly distributed in time and space, and the rivers often have irregular flows due to climate conditions and variations in topography. Surface and groundwater resources are fairly limited in the highly urbanized and industrialized western part of Turkey. In addition, recent studies demonstrate that in the near future, Turkey will become hotter, more arid, and unstable in terms of its precipitation patterns, meaning that water will inevitably become a very sensitive and critical issue. The above factors, along with population growth (100 million people by 2030), are expected to reduce water availability in many areas. This is particularly important for basins such as Marmara Basin, K. Menderes Basin and Asi Basin, where water availability is already less than 1000 m^3/capita. In addition, water pollution due to the discharge of untreated wastewater from urban and industrial areas is another problem associated with the growing economy.

Freshwater productivity in Turkey (US\$20/m^3) is low compared to that of high-income countries (US\$47/m^3), and of some upper middle-income countries of the region, such as Belarus, and Bosnia and Herzegovina (US\$50-58/m^3) (World Bank, 2016). As the largest user of water, agriculture has extensive irrigation systems, however the existing irrigation practices are not very efficient. Water delivery systems in irrigation schemes are comprised of classical open canals and canalettes resulting in high losses due to leakage and evaporation. Similarly, at the farm level, surface irrigation methods that have low water efficiency are widely used. Without significant improvement in irrigation efficiencies, it is indisputable that water availability would become a serious constraint for Turkey.

The Turkish government is considering a set of policy issues related to water resource management (WRM), including estimating the economic value of water and incorporating this into strategic decision-making on water allocation and pricing. There is a request for developing a tool for water valuation and accounting. According to a diagnostic analysis the World Bank carried out in 2014, there is a wide range of policy questions related to water resource management, from water's economic contributions to national growth, to tradeoffs among competing users in managing water resources, to water pricing and cost recovery, to planning and prioritizing investments to compensate for or offset the loss of water due to depletion. The need for water-related policy analysis and decision-making from the agencies responsible for development planning, water resource management, and environmental protection are a strong motivation for the development and application of the water valuation and accounting tool.

Economic valuation of water is a basic step in making well-informed policy decisions on WRM. Government agencies, namely the Ministry of Development (MoD) / TurkStat, Ministry of Forest and Water Affairs (MoFWA), are keen on conducting valuation to better understand water resources' economic contributions to the economy and to accordingly modify the national accounts. Furthermore, MoD and MoFWA are willing to integrate water valuation as a key component in the river basin management processes, which would contribute to analyzing the challenging issues of WRM such as assessing trade-offs, allocation planning, investment prioritization, ecosystem conservation, setting standards for water quality, water pricing, compensation for damage or use, and adaptation to climate change. To support the government agencies in natural resources management, the World Bank launched a natural capital accounting (NCA) program in Turkey. The program aims to improve the valuation and accounting systems of natural resources.

The identification of water goods and services is based on the Total Economic Value (TEV) framework, which includes use and non-use values. Use values originate from actual water use and include three categories: direct use values (e.g. water for irrigation, municipal and industrial uses, recreation), indirect use values (e.g. nutrient retention, pollution abatement, flood control), and option values (e.g. potential future uses of water ecosystems). Non-use values are not related to any use of water resources, but reflect the economic value that can be attached to the mere existence of a water-related aspect. They include existence, bequest, and altruistic values, and refer to the conservation of biodiversity, cultural heritage, and other potential uses of the resource.

The economic valuation of water benefits can be based on a wide range of valuation methods. The literature review conducted for this study shows a wide range of methods applicable for estimating different water values. They include market-based approaches (e.g. market pricing, replacement cost, avertive expenditures), revealed preference methods (e.g. Travel Cost, Hedonic Pricing, residual method, productive functions) and stated preference methods (e.g. Contingent Valuation Method and Choice Experiments). These methods have been applied worldwide to estimate values mostly related to surface water, such as water for irrigation, recreation, and biodiversity. In Turkey, water valuation is a relatively new field, with limited expertise and applications: most efforts concentrate on valuing recreation, while some estimate improvements in water quality. Little has been done to estimate other values (e.g. water for irrigation, industry, drinking) and no studies have been found related to indirect use values (e.g. flood control, pollution abatement).

The study presented in this report focused on water valuation with the objectives of introducing the concept and methods of water valuation, and demonstrating their use through actual application of valuation methods to Turkey's water resources. As part of the NCA program, the valuation studies were carried out in the forestry and water sectors. The forestry valuation study was done in 2015. The present study addressed the issue of economic valuation of water in Turkey by: 1) providing a comprehensive analysis of methods that can be used to estimate each water value; 2) reviewing existing efforts to estimate water values at the international and national levels; and 3) applying existing methodology to demonstrate the value of different water uses through a case study in Beyşehir Lake subcatchment.

A case study was quickly carried out in Beyşehir Lake subcatchment, the largest freshwater lake in Turkey. Located in the southwest of Konya Closed Basin, Beyşehir Lake subcatchment covers about 414,000 ha and has a total population of 120,000 people. It is the main surface water in the Konya Closed Basin, with water transfer and irrigation facilities being operated by water authorities since the early 1900s. Agriculture, tourism, and industry are the subcatchment's main economic sectors. About 330-340 million m^3 water is taken every year from the Lake for the irrigation of Konya Plain. The subcatchment also provides water for the small-scale irrigation projects in the eastern and northeast part of the Lake. The Lake and its water body systems are the source of drinking water for the Beyşehir district and some of the area's small towns.

Despite several protection statuses implemented in the Lake area, the Beyşehir Lake subcatchment suffers from serious threats. Decreasing water levels due to excessive abstraction of water for irrigation; pollution from agricultural, industrial and urban wastewaters; lack of effective coordination between different authorities; and unsustainable fishing practices and unplanned urbanization which threaten both the sustainability and the services provided by the Lake. In particular, the government authorities' main challenge is to balance water demands for irrigation with the need to preserve the Lake for fish and wildlife habitat. Valuing the Lake's water services would help in better understanding the uses of water and pointing out economic, efficient, or cost-effective solutions to its problems.

The TEV framework and several valuation methods were applied to estimate the economic value of water benefits provided by the Beyşehir Lake subcatchment. The exercise focused on estimating the gross benefits the Lake provided during 2015. Valuation was based on data obtained from interviews with local authorities conducted during April-May 2016, complemented by secondary information. Due to limited time and budget constraints, the results are orders of magnitude that often underestimate the real value of these benefits.

The valuation shows that the TEV of Beyşehir Lake reaches TL271 million, or 13% of Beyşehir subcatchment's GDP in 2015. Water supply for agriculture appears to be the most important component, followed by water for municipal uses. However, this is because the quantity of water used by agriculture is much higher than that for municipal use; in fact, the unit value of water allocated for irrigation (TL0.5/m^3) is considerably lower than that for municipal use (TL5/m^3). In addition, the Lake's economic value is about seven times higher than its financial value, suggesting the high importance of preserving this resource. The gap between the two values is largely explained by the difference between the economic value of the water supply per different uses (irrigation, municipal) and its financial value. In this light, the analysis demonstrates that the economic value of water is much higher than its financial value for both municipal (TL5/m^3 vs. TL2.7/m^3 on average) and agricultural uses (TL0.5/m^3 vs. TL0.03/m^3).

Even though incomplete, these estimates show the Lake's additional importance in terms of non-market benefits, such as recreation, biodiversity and pollution abatement. These values, together with all of the other water benefits, need to be preserved and even improved whenever possible. In this light, a recent survey found that Beyşehir residents have a positive WTP for projects to improve the Lake's water quality, of at least TL4 million in 2015. Although conservative, this value calls for the need for action to improve and preserve the benefits of the largest freshwater lake in Turkey.

The study further identified the need for the following actions:

- **Nurture the political will and institutional arrangements to support the incorporation of valuation into decision-making**. High-level political will and commitment, particularly from the National Government, are fundamental to ensure that valuation is integrated into decision-making processes. Other measures are equally important, such as helping to promote coordination among stakeholders—by forming an Expert Advisory Group under the coordination of MoD, and comprised of experts and officials from relevant government agencies (TurkStat, MoFWA, MoEU), academia, and civil society organizations—in order to ensure that NCA efforts are effectively carried out inter-ministerially. The Expert Advisory Group would also explore new developments related to NCA studies at the global scale; pioneer the discussions in the country; and help to harmonize different approaches and methodologies for Turkey.

- **Adopt natural capital valuation and accounting as supporting tools in implementing the 2030 Agenda and delivering the Sustainable Development Goals (SDGs).** The 2030 Agenda for Sustainable Development with 17 SDGs requires better and more integrated information on how the economy, environment, and society interact. In that sense, NCA and the SDGs are highly compatible. Both recognize the need for understanding the interactions and trade-offs between the social, environmental and economic dimensions of sustainable development. NCA can help deliver the SDGs by making explicit the links between the economy and the environment, enabling sustainable policy decisions and actions. Furthermore, NCA can also support the process of monitoring and reporting the progress on the SDGs. Turkey, a successful implementer of Millennium Development Goals (MDGs), is keen on implementing SDGs and improving its performance on sustainable development. MoD, as the overall coordinator of the 2030 Agenda in Turkey, is in the preparation stages of the 11th Development Plan and in updating the country's long-term vision aligned with the 2030 Agenda and SDGs. In this context, it is crucial to integrate NCA and valuation efforts into Turkey's SDGs implementation roadmap and adopt these tools for delivering SDGs.

- **Carry out in-depth valuation studies, covering a wider range of water values and river basins**. In Turkey, water valuation efforts have been uneven, concentrating mostly on valuing recreation and to a lesser degree on the purification function of water bodies. Little work has been found on the value of water for irrigation, industry and municipal use and none on indirect use values (e.g. flood control, pollution abatement) or the costs of water degradation (i.e. impacts of water pollution and overexploitation). Moreover, the existing studies have been concentrated in a few river basins. To better understand the importance of water resources and water-related ecosystems, and to be able to prioritize and design interventions aimed at reducing problems, there is a need for a more comprehensive set of studies that would cover both a ***wider range of values*** and a ***wider range of river basins***.

- **Improve the valuation of water benefits in Beyşehir Lake subcatchment through extended data collection and site-specific studies concerning the economic value of water uses (i.e. agricultural, municipal, recreational, and biodiversity).** The TEV of Beyşehir Lake was estimated to be about TL271 million, or 13% of the Beyşehir subcatchment's GDP in 2015, with the greatest value being generated by water supply for agriculture, followed by water for municipal uses. However, the unit value of water allocated for irrigation (TL0.5/m^3) is estimated to be considerably lower than that for municipal use (TL5/m^3), even though water use by agriculture is much higher than that for municipal use. The analysis thus suggests that water allocation is inefficient. To confirm this conclusion and improve allocation, a more comprehensive assessment of the economic benefits of water resources - focusing particularly on the value of *water for irrigation, municipal use, recreation and biodiversity* - and of the trade-off between water uses and food security as well as rural development is required. A better understanding of the value of water in its various uses will help design systems that improve the total benefits of water use by improving its allocation; the allocation experiences of other countries can provide a useful starting point for such efforts.

- **Develop *national guidelines* on water valuation and accounting to facilitate future studies and scale/implement existing efforts nationwide**. These guidelines should propose a stepwise approach for practitioners at all levels and have a general context of "ecosystem valuation" with differentiated aspects of forest, water, and marine valuation. Prior to that, national circumstances (e.g. data limitations, government priorities, institutional capacity, etc.) have to be properly analyzed.

- **Establish a national water accounting system**. The fragmented structure of water management and administrative units in Turkey makes the establishment of water accounting a *challenge*. Furthermore, earlier efforts to develop water accounts remained as "pilot projects" and have not yet result in proper institutionalization. In that sense, Turkey still needs to gain experience and conduct further studies to improve its existing water accounting framework in a standardized and consistent way. Existing physical water accounts can be improved with new modules, and data should be collected beyond the current administrative boundaries, and standardized across all river basin levels. Data quality frameworks should be developed and the quality of existing water statistics should be assessed. Extra effort is needed for additional data compilation in water-related economic sectors like fisheries, energy, forestry, tourism and agriculture. Monetary accounts need to be based on the economic value of water in terms of its exploitation, depletion, and contribution to the national economy. In the end, physical and monetary water accounts will be incorporated into a national water accounting system.

- **Integrate water valuation into RBMPs**. Turkey is making concerted efforts to prepare RBMPs for 25 river basins aligned with the EU-WFD, with the main goal of reconciling economic development and ecosystem maintenance. In particular, the Turkish government prioritizes water allocation planning in some river basins where increasing conflicts exist between competing water uses. Water valuation could provide valuable knowledge in terms of the benefits from actual and alternative uses as well as the costs of degradation, thus helping to prioritize problems and find solutions for improved water management. Water valuation could also provide useful insights in designing economic instruments (subsidies, taxes, and pricing mechanisms) to increase water efficiency, particularly in water stressed regions like Konya Closed Basin and in western basins where water quality is low.

In Turkey, it is particularly important to conserve water and improve its allocation among different uses. This study has demonstrated that water valuation is an important tool for improving water management at both the river basin and national levels. However, to better understand the valuation results and their policy implications in the implementation of the polluter pays principle, pricing, and full cost recovery, as well as the efficient allocation of water resources by sector (and more) further studies and consultations with stakeholders are needed.

I. Introduction

Water is among the most important natural resources in Turkey. Annual freshwater consumption is about 44 billion m^3, of which 74% is used for agriculture, 15% for domestic needs and 11% for industrial uses.[1] Besides its contribution to economic production, water and its related ecosystems (e.g. lakes, wetlands, coastal zones, etc.) provide a wide range of benefits such as flood protection, pollution abatement and biodiversity conservation.

Despite its importance, water is facing several threats. According to DSİ (2015), population growth and natural factors such as climate change, are expected to reduce water availability from 1519 m^3 per capita today to 1120 m^3/capita by 2030. In addition, water pollution (e.g. by untreated industrial wastewater discharge in rivers[2]) could induce a significant reduction in water quality. Given this context, conserving the quantity and quality of water resources is essential for the country's long-term growth and sustainability.

Understanding water's contribution to the economy and environment is a crucial step towards its conservation. In Turkey, as in many other countries, the value of non-market services such as biodiversity, pollution reduction, and recreation is only partly known; worldwide, studies primarily focus on areas of special importance, such as Ramsar sites or national parks (e.g. Birol et al., 2010; Wang et al., 2004). Even water resources' contribution to the economy is not fully understood, with efforts concentrating particularly on valuating water used for agriculture (e.g. Petrie and Taylor 2007; Mukherjee and Schwabe, 2012; Tabieh et al., 2015) and much less around industry and other uses (e.g. Harpman, 2006; Stone and Whittington, 1984). These gaps highlight the importance of an economic valuation of each type of water use as a precondition for making well-informed decisions on water policies related to its exploitation and allocation.

The Turkish Government is currently making efforts to improve water valuation and accounting, and has collaborated with the World Bank in its natural capital accounting (NCA). To assist the Government, the Bank conducted a rapid study on water valuation methodology and its applications from February - May 2016. The purpose of this report is to introduce the concept and methods of water valuation, and to demonstrate their use through actual application to Turkey's water resources.

The report contains six chapters. Following this introduction, Chapter 2 provides an overview of Turkey's current water sector. Chapter 3 introduces the concept of total economic value, and Chapter 4 further discusses the valuation methods for each type of water use. To demonstrate the applicability of valuation in Turkey, Chapter 5 applies these methods to Beyşehir Lake subcatchment in Konya Closed Basin, based on readily available information. Finally, Chapter 6 provides some conclusions and recommendations.

[1] Data refer to 2015, when freshwater consumption was about 40% of its total exploitable potential (based on DSI).
[2] According to TurkStat, 1.9 billion m^3 of industrial wastewater was discharged to receiving bodies in 2014, of which only 11 % was treated.

II. Overview of the Water Sector in Turkey

Water availability and uses

Turkey's per capita internal availability of freshwater is only half of the world average. The country averages an annual 112.5 billion m^3 of economically exploitable freshwater, which represents 1519 m^3 per person each year (DSİ, 2015). When taking into account the TurkStat's projected population growth—to around 100 million people by 2030—the per capita exploitable water is expected to drop to approximately 1120 m^3/person/year.

Due to high variations in topography and climate, Turkey's water resources are distributed unevenly across the country. Some basins (e.g., Konya Closed Basin) have annual precipitation with almost less than half the national average. Furthermore, due to differentiated socio-economic characteristics, there are regional variations in water supply and demand, which makes it difficult for some basins to meet demand during critical periods. Three out of the 25 river basins - Marmara Basin, K. Menderes Basin and Asi Basin – have a water availability of less than 1000 m^3 per capita; other six river basins, including Konya Closed Basin which covers the Beyşehir Lake pilot study area, are close to the water stress threshold. These basins are mainly concentrated on the western and central parts of the country where highly populated and industrialized cities are located (TUSIAD, 2008).

The table below outlines the basic data related to Turkey's water availability and uses. Among the total economically exploitable water available each year, 74% is used for agriculture, 15% for domestic needs and 11% for industrial uses (DSİ, 2015).

Table 1. Turkey's water resources

Turkey's Water Resources	
Mean annual precipitation	643 mm/year
Total surface area	783.577 km^2
Annual precipitation	501 million m^3
Evaporation	274 billion m^3
Leakage to aquifers	41 billion m^3
Surface Water	
Annual surface runoff	186 billion m^3
Annual exploitable surface water	98 billion m^3
Groundwater	
Groundwater reserve	18 billion m^3
Annual exploitable groundwater	14.6 billion m^3
Total Exploitable Water (net)	**112.6 billion m^3**
Actual consumption	
Agricultural use (irrigation)	32 billion m^3 (74%)
Domestic use	7 billion m^3 (15%)
Industrial use	5 billion m^3 (11%)
Total Actual Consumption	**44 billion m^3**

Source: DSİ, 2015 based on the data from 1935 - 2008.

A recent study (WWF-Turkey, 2014a) estimated the water footprint in Turkey, a concept that measures the quantity of freshwater used for producing a good or service within the entire supply chain (or including both direct and indirect water use). The study found that agriculture is the main contributor of the country's water footprint of production (and using 89%), followed by domestic (7%) and industrial water uses (4%). Box 1 summarizes the main findings of the study.

Box 1. An Alternative Way of Understanding the Sectoral Use of Water: The Water Footprint of Turkey

"Water footprint" is a relatively new concept that can be used to establish a better understanding of the critical role played by water and its sound management for economic growth. It measures the quantity of freshwater used for producing a good or service, covering the whole process from manufacturing raw materials, to direct operations, and consumer use of a product. Therefore, the concept includes not only direct water use, but also indirect water use generated by the production process. As such, it is an alternative indicator of water use, and differs from the one used by traditional water statistics in that it looks at consumptive water use instead of water withdrawals.

By analyzing a country's water footprint, decision makers can follow water's path through economic activity with a basis of knowledge that can be used to inform their decisions on allocation, trade, comparative advantages, and ecosystem support.
The Water Footprint of Turkey report puts forward Turkey's water footprint with a specific focus on the relationships between water, trade, and production. The report's key findings are:

- Turkey's total water footprint of production amounts to approximately 139.6 billion m^3 per year. Agriculture is the primary contributor of the water footprint of production, at 89%. Domestic water use accounts for about 7%, and industrial production represents approximately 4% of the total water footprint.

-Water footprint of agriculture consists of 92% crop production and 8% livestock grazing. A closer look at the water footprint of crop production shows that the primary crops contributing to the water footprint of production for Turkey's crops are cereals (38%), followed by fodder crops (31%).

-The low share of the water footprints of industry and the domestic water supply in Turkey's total water footprint does not indicate that the impact on water resources is also low. While assessing the water footprint of agriculture, the focus is on green and blue water footprints (water quantity implications). However, when considering water footprints of industrial production and domestic water supplies, the focus is altered and shifts to grey water footprint, which is an indication with implications on water quality.

-Turkey's water footprint of consumption amounts to approximately 140 billion m^3 per year. In other words, this is the total amount of freshwater used in producing the goods and services consumed within Turkey.

-As the figures show, the water footprint of consumption is almost equal to the water footprint of production. Similarly the virtual water that enters the country through imports equates approximately to the export of virtual water. This means that Turkey's virtual water budget is in balance, and that it is important to preserve Turkey's water resources for its economic growth and sustainability.

-Examining Turkey's blue, green and grey water footprint rates of consumption and production shows that the green water footprint is the biggest component. This situation highlights the importance of rainfall and thus climate variability for the country's production and consumption.

-The agricultural sector contributes the most towards the overall blue and green water use in production, while the industrial sector is the primary contributor towards Turkey's grey water footprint. The service sector makes use of comparatively negligible volumes of water. (WWF-Turkey, 2014a).

Irrigation systems for agricultural production have been well developed; the area of irrigated land has increased by about 250% since the 1970s. Today, of the 28 million ha of arable land, almost

6.2 million ha is irrigated by DSİ projects, and the objective is to increase irrigated areas to 8.5 million hectares by 2023 (DSİ, 2015). However, the majority of irrigation is done through gravity irrigation, which has low water efficiency. The use of water saving irrigation techniques (sprinkler and drip irrigation systems) has gained momentum in the last decade but these still occur in limited proportion (about 10%) to the overall irrigation practices. The Turkish government has provided subsidies and interest-free loans to farmers for the promotion of water saving irrigation technologies since 2009. Today, modern irrigation systems are especially being used in areas with high climate vulnerability and water scarcity like Konya Closed Basin. Water consumption per ha amounts to more than 7,000 m^3 (OECD, 2010).

Municipalities and villages are the second most important water user (after agriculture), with a total of 5.7 billion m^3 water abstracted from natural resources—the per capita use of water in municipalities is 203 liters per day (TurkStat, 2014a and b). Based on the data supplied in TurkStat's Sectoral Water and Wastewater Statistics Press Release, in 2014 the total amount of water abstracted by industry (manufacturing industry establishments, mining establishments, organized industrial zones and thermal power plants) was about 9.1 billion m^3 and 90% of this water was used for cooling purposes. About 1 billion m^3 of the above mentioned amount was directly withdrawn from freshwater resources (TurkStat, 2014a).

Hydropower generation is another important water using sector. According to DSİ, Turkey's gross theoretical hydropower potential is 433 billion kWh/year. As of 2015, technically feasible hydropower potential is reported as 216 billion kWh/year, while economically feasible potential stands around 180 billion kWh/year with the development of new projects. There are currently 562 hydropower plants with the total installed capacity of 26.161 MW, and average annual electricity production is about 90 billion kWh, providing approximately 60% of the total economically feasible potential in 2015 (DSİ, 2015).

Problems and threats

The challenges to water resource management are intensifying as the Turkish economy and population grows, and water resources are under more and more pressure in almost all river basins, both in terms of quality and quantity. Turkey's water management experiences over the past decades—with some dramatic and irreversible habitat losses and environmental and social impacts—revealed that water management requires more than just hydraulic engineering and technical solutions, it necessitates integrated water resource management involving institutional, economic, environmental and social aspects.

The water use in Turkey is much less efficient than that in high-income countries. For example, GDP per ton of water used in Turkey is only about 40% of that of high-income countries. The inefficient use of water in agriculture results in over-abstraction of water from both surface and groundwater in several river basins. Currently, water delivery systems in irrigation schemes are comprised of classical open canals (39%), canalettes (44%) and piped systems (17%), and water losses from leakage and evaporation in open canals is high compared to that in closed systems (DSİ, 2014). Additionally, surface irrigation methods (flooding, furrow, border, etc.) are widely applied in many regions (almost 90% of total irrigated areas), while water-saving sprinkler and drip irrigation systems are applied in a small portion of areas (Topçu, 2011). Irrigation efficiency, measured at scheme scale, is about 51% in irrigated areas operated by DSİ (MoD, 2015).

Pollution of water resources is another problem generated mostly by industrial and urban wastewater. In 2014, about 12.7 billion m^3 wastewater was discharged to receiving bodies from residential areas (municipalities and villages) and industries (manufacturing industry establishments, mining establishments, organized industrial zones and thermal power plants). Approximately 79% of the total residential wastewater is treated to a certain degree, and 61% of industrial wastewater (excluding cooling water) is treated before discharging to natural water bodies (TurkStat, 2014a). Without an integrated planning and cumulative impact assessment, over-abstraction, water pollution, and infrastructure and urban development within or near water bodies, are threatening the ecological integrity and health of freshwater ecosystems.

Turkey is one of the most vulnerable countries in Europe and Central Asia to climate change. Scientific climate modelling studies indicate that Turkey will get hotter, more arid and unstable in terms of precipitation patterns in the near future. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), regional and global simulations project an increase in duration and intensity of drought in Mediterranean Region. The IPCC Report also indicates that declines in flows are projected for Turkey and water allocation between upstream and downstream countries will become a challenging issue for regions exposed to prolonged droughts, such as the Euphrates-Tigris river basin (Kovats et al., 2014). Therefore, the climate trend would inevitably make water a very sensitive and critical issue, which poses a potential problem to the economy and environment in Turkey.

Organizational setup for WRM in Turkey

WRM in Turkey involves a large number of stakeholders including governmental agencies, institutions, and non-governmental or private groups such as water user associations. They can be categorized at three levels: the decision-making level, executive level, and user level. Table 2 shows the organizational setup for WRM, with the main government agencies and stakeholders involved in different levels of water management.

On the national level, MoD, MoFWA, Ministry of Environment and Urbanization (MoEU), Ministry of Food, Agriculture and Livestock (MoFAL) are all at the decision-making level. State Hydraulic Works (DSİ), Directorate General of Water Management (DGWM), Directorate General of Environmental Management (DGEM), municipal water authorities, and other governmental organizations are at the executive level, whereas water use organizations such as irrigation unions and cooperatives are at the water user level.

Table 2. Main agencies and stakeholders involved in Turkish water sector

<table>
<tr><th colspan="4">Government Agencies</th></tr>
<tr><th colspan="2">Decision-Making Level
(National)</th><th>Executive Level
(River basin and Provincial)</th><th>User Level
(Provincial)</th></tr>
<tr><td>Primary Agencies</td><td>Ministry of Development (MoD)
Ministry of Forestry and Water Affairs (MoFWA)
Ministry of Environment and Urbanization (MoEU)
Ministry of Food, Agriculture and Livestock (MoFAL)</td><td>State Hydraulic Works (DSİ)
Directorate General of Water Management (DGWM)
Directorate General of Environmental Management (DGEM)
Directorate General of Agricultural Reform (DGAR)
Municipal water authorities
Bank of Provinces</td><td rowspan="2">Households

Commercial entities

Water user associations (irrigation unions and cooperatives)</td></tr>
<tr><td>Secondary Agencies</td><td>Ministry of Foreign Affairs
Ministry of Health
Ministry of Energy and Natural Resources
Ministy of Tourism
Ministry of EU Affairs
Water Institute
TUBİTAK
TurkStat</td><td>Local governments
Other general directorates under different ministries
Regional Development Agencies
River Basin Management Commissions</td></tr>
<tr><th colspan="4">Non-governmental Agencies</th></tr>
<tr><td colspan="4">Universities & research institutes
National & local NGOs
International organizations
Trade & industry chambers
Agriculture chambers</td></tr>
</table>

Source: the authors

MoFWA is the key authority for the management of water resources with its two general directorates; DSİ and DGWM. DSİ, established in 1954, is in charge of development, planning, and management of surface and groundwater, and land resources with 26 regional directorates in Turkey, whose boundaries correspond primarily to the river basin boundaries. DSİ's responsibilities cover the observation, field investigation, master plan, feasibility, design, construction and management plans for irrigation, hydropower, domestic water supply and flood control purposes. Whereas, DGWM, a relatively new agency, is responsible for developing policies for protecting and sustaining water resources, and coordinating and preparing river basin management plans (RBMPs) together with relevant stakeholders. DGWM is also in charge of developing water quality standards and water quality monitoring systems for the whole country.

At the user level in urban areas, the municipal water and sewerage administrations in metropolitan municipalities are in charge of constructing, operating, and maintaining water supply and treatment facilities, and also responsible for networks of industrial facilities within the boundaries of these areas. The General Directorate of the Bank of Provinces is also responsible for supplying municipal water to all municipalities by assisting in financing, developing and constructing water supply and sewerage projects.

National Development Plan and Policies Related to Water Resources

Turkey has various national strategies, plans, and programs dealing with WRM (see the Box below). The 10^{th} Development Plan of Turkey is one of the main plans to set clear objectives and targets for the sustainable use and effective management of water resources. It does so through insights on critical topics like basin-level planning, integration of quantity and quality measures, enhanced coordination among different government authorities, and increased water efficiency. Fundamental objectives within the Plan are defined as the preservation and development of quantity and quality water and land resources, and development of a management structure providing sustainable use of these resources, especially in the highly demanding agriculture sector.

The 10^{th} Development Plan devotes a “transformational program” (2014-2018) for improving the efficiency of water use in agriculture. The targets of this program include: increasing the percentage of arable land subject to DSI investments for irrigation from 62% to 68%; raising irrigation efficiency from 42% to 50%; expanding the use of water saving modern irrigation systems by 10% per year; and decreasing the use of groundwater by 5% during the plan period. The program also indicates the importance of considering regional water constraints and environmental protection in the design of agricultural support policies and encourages the development of drought resistant crops (MoD, 2014b). Another “transformational program” is designed to promote domestic resource-based energy production. Its main objective is to increase the share of domestic resources in primary energy production, putting into operation an additional 10,000 MW hydraulic capacity by the end of 2018 (MoD, 2014b).

Box 2. Main plans and programs relevant to water management

National	*Regional/ River Basin Level*
• 10^{th} Development Plan and Priority Transformation Programmes • National Environment Strategy and Action Plan • National Biodiversity Strategy and Action Plan • Turkey EU Integrated Environmental Approximation Strategy • National Basin Management Strategy • National Flood Management Action Plan • National Climate Change Strategy • National Climate Adaptation Strategy • National Action Program on Combatting Desertification • National Wetlands Strategy	• Regional Development Plans by MoD • Watershed Master Plans by DSİ • River Basin Protection Action Plans by DGWM • River Basin Management Plans by DGWM (in the preparation process) • Water Allocation Plans (in the preparation process) • Special Provisions for Drinking Water Catchments by DGWM (in the preparation process)

Source: the authors

In the EU Accession process since the beginning of the 2000s, Turkey is also taking steps towards re-organizing its water sector in terms of institutional structure, policy, and legislative framework. Improved legislation, increased institutional capacity for the components of EU Water Acquis, and improved infrastructure for the delivery of drinking water and waste water treatment are priority action fields for the Turkish government in the EU Harmonization process. Furthermore, the government has been putting significant effort into the preparation of RBMPs, drought and flood management plans, and sectoral water allocation plans over the past couple of years. They have also prepared a draft Water Law to eliminate overlapping responsibilities for different government authorities in order to ensure effective coordination and enable the public's participation in water management practices.

Water pricing is one of the most critical areas in need of reform in the Turkish water sector. Water pricing for agriculture, domestic, and industrial uses varies among sectors, and is determined by different authorities in Turkey. Area-crop based charging is widely applied in irrigation, whereas volumetric charges are common for domestic and industrial uses. In general, operation, management, amortization, rehabilitation, and expanding costs are reflected in water tariffs; whereas environmental and resource costs are hardly covered.

Concerning the water pricing mechanism in irrigation, with the financial support of the World Bank, in 1993, DSİ transferred its operation and maintenance responsibilities for the irrigation systems to the water user associations under the Accelerated Transfer Programme. The water user associations (irrigation unions and cooperatives) determine the water charges based on expected operation, maintenance, and investment cost for the year (OECD, 2010). Each association sets its tariff independently and uses different methods depending on region and scheme: the "area-crop based" charging system, in which the charge per hectare is determined by the type of irrigated crop, is used mostly for gravity irrigation, while "volumetric pricing" is widely used in pumping schemes (Topcu, 2011).

Turkey's candidacy for the EU brings a new dimension to the water pricing issue. EU-WFD introduces economic principles and methods for the management of Europe's waters, and clearly integrates economics into water management and policy-making. To achieve its environmental objectives (good water status for all water) in the most effective manner, the WFD introduces three key economic principles: 1) Polluters pay principle (water users pay for the full costs of the water services they receive); 2) Cost-effectiveness (Member states should use economic analyses in managing their water resources, and assessing both the cost-effectiveness and overall cost of alternatives when making key decisions); 3) Applying economic instruments (e.g. water pricing). EU-WFD clearly states that Member states should develop an understanding of and measurement for the "environmental and resource costs" associated with damage or negative impacts to the aquatic environment. In this context, Turkey is obligated to move towards the full cost recovery principle in their pricing mechanisms, both for agriculture and domestic/industrial water use.

Policy request and need for water valuation and accounting

As concluded in a diagnostic note prepared by the World Bank (World Bank, 2014), the Turkish government is considering a set of policy issues related to WRM, ranging from the economic contribution of water to national growth, to tradeoffs among competing users to manage water resources, to water pricing and cost recovery, to planning and the prioritization of investments to compensate or offset the loss of water due to depletion. The needs for water-related policy analysis and decision making are a strong motive for the development and application of the water valuation and accounting tool.

Economic valuation of water and its application to making strategic decision on water allocation are a basic step in making well-informed decision in the water sector. Government agencies, namely MoD and its affiliated TurkStat, MoFWA, are keen on conducting valuation to explore and to better understand the economic contribution of water resources to the national growth and to modify the national accounts accordingly. Furthermore, MoD and MoFWA are willing to integrate water valuation as a key component in river basin management processes which would contribute to analyze the challenging issues of WRM, such as assessing trade-offs, allocation planning, investment prioritization, ecosystem conservation, water quality standard setting, water pricing, compensation for damage or use, and adaptation to climate change. These agencies have shown a strong interest in developing a tool of water valuation and water accounts for policy analysis.

Water accounting provides a conceptual framework for organizing economic and hydrological information, enabling a consistent analysis of the contribution of water to the economy and of the impact of the economy on water resources (Box 3). In Turkey, TurkStat, with its 26 regional offices, is the leading authority for overall data collection, statistical accounts, analysis and reporting services. In case of water and environmental accounts, the Department of Environment, Energy and Transport Statistics has been in charge of collecting and analysing data sets based on an OECD core set of environmental data and indicators since 1990. Data on water, wastewater, waste, air emissions, environmental employment, environmental expenditure and revenues, environmental accounts are collected via questionnaires filled in by municipalities and other agencies. TurkStat has implemented some pilot projects for the development of Physical Water Flow Accounts (PWFA), which refer to the abstraction of water resources from the environment into the economy, the water flows within the economy and finally, the flows of water back to the environment. But there are no monetary water accounts or hybrid water accounts as yet established in Turkey.

Box 3. The System of Environmental Economic Accounting-Central Framework

The System of Environmental-Economic Accounting 2012- Central Framework (***SEEA-CF***), adopted by the United Nations Statistical Commission as an international statistical standard in 2012, is a multipurpose conceptual framework that describes the interactions between the economy and the environment, and the stocks and changes in stocks of environmental assets. The SEEA-CF includes the physical flow accounts, asset accounts, environmental activity accounts and combined physical and monetary accounts for natural resources.

Water has been identified by the United Nations Statistics Division as a priority area for implementation of the SEEA. ***SEEA-Water***, a SEEA 'sub-system', provides compilers and analysts with agreed concepts, definitions, classifications, tables, and accounts for water and water-related emission accounts.

SEEA-Water covers the following information on water: stocks and flows of water resources within the environment; pressures imposed on the environment due to water abstraction, and emissions added to wastewater and released into the environment or removed from wastewater; supply of water and its use as an input in the production proces and by households; water re-use within the economy; costs of collection, purification, distribution and treatment of water, as well as service charges paid by users; financing of these costs, that is, who is to pay for the water supply and sanitation services; payment of permits for access to abstract water or to use it as a sink for the wastewater discharge; the hydraulic stock in place, as well as investments in hydraulic infrastructure made during the accounting period (UN, 2012)

Further details on SEEA-CF and SEEA-Water can be reached at http://unstats.un.org/unsd/envaccounting

The Turkish Government is currently making efforts to improve water valuation and accounting, and has collaborated with the World Bank through a natural capital accounting (NCA) program. The program conducted a study on water valuation methodology and its applications in a case study of Beyşehir Lake subcatchment from February to May 2016. This report is an output of the study and it aims to introduce the concept and methods of water valuation, and to demonstrate their use through actual application to Turkey's water resources.

III. Overview of the Economic Values of Water

Water resources provide a wide range of benefits. Many of them, however, are not traded on regular markets, while others have prices that do not necessarily reflect their economic value. These failures often result in increased pressure on water resources through the degradation of their quality (e.g. due to discharge of untreated wastewater in rivers), reduction of available quantity (e.g. due to groundwater over-extraction) or increase in available quantity (e.g. due to flooding).

Why is economic valuation necessary?

Water is a unique natural resource. Its special characteristics distinguish it from most other resources and commodities, and pose significant challenges for its allocation and management. According to Young and Loomis (2014), these characteristics include:

- ***Hydrological and physical attributes***: *(1) Mobility*. Water tends to flow, evaporate and seep as it moves through the hydrologic cycle; often, water flow covers substantial distances and crosses national boundaries. This mobility makes it difficult to establish and enforce exclusive property rights on water. *(2) Variability*. Typically water supplies are variable in time, space, and quality; this variability is usually unpredictable and outside human control. At the extreme, floods and droughts can have devastating effects on people, assets and local economies. *(3) Absorption capacity*. Water has the capacity to absorb wastes and pollutants, as well as to dilute and transport such hazards to different locations. *(4) Externalities*. For example, the quantity and releases of water from users located upstream in a watershed can affect downstream water users. These interdependencies, called "externalities," are side effects of individual economic activities that are not internalized by the upstream individual producer or consumer activities.

- ***Water demand characteristics.*** Water resources provide a variety of benefits to different end users: municipal, industrial, agricultural, and environmental (fishing, boating and ecosystem services). The demand for water varies according to the user: those related to municipal water are fairly stable and predictable over time; the needs of agriculture vary in response to temperature and rainfall patterns over the course of seasons each year; industrial water demand also varies from weekdays to weekends. In addition, some water uses are consumptive (agriculture, industry), while others are not (hydro-power, recreation). All of these differences call for specialized management approaches, which need to be based on sound knowledge of the economic value of each water use.

- ***Social and cultural attitudes.*** The social and cultural values related to water often are in conflict with their economic values. Some people believe they have a right to use water for legal social, religious, or cultural reasons. At times, these perceptions may conflict with the appropriate management of water.

- ***Collective action problems.*** Water decision makers are confronted with many problems related to water. One such issue arises when each individual act of water use taken alone has a negligible impact; but the sum of many individual decisions can be of major importance ("*the* *tyranny of small decisions*"; Kahn, 1966). This problem is common in groundwater extraction by many individual wells, nonpoint pollution of chemicals carried by runoff from farmer fields, and reservoir sedimentation due to unsustainable agricultural practices upstream. Effective public regulation of small-but-many decisions is difficult, but it is increasingly necessary. Economic estimation of the damages to water resources could provide a useful signal to identify areas where the need for action is urgently required.

The above characteristics show that the sustainable management of water presents significant challenges. Market failures[3] (e.g. absence of or distorted market prices) and policy failures (e.g. subsidizing electricity for groundwater extraction) are leading to pressures on water resources through the degradation of its quality (e.g. untreated wastewater discharge in rivers) and reduction of quantity (e.g. depletion of scarce resources).

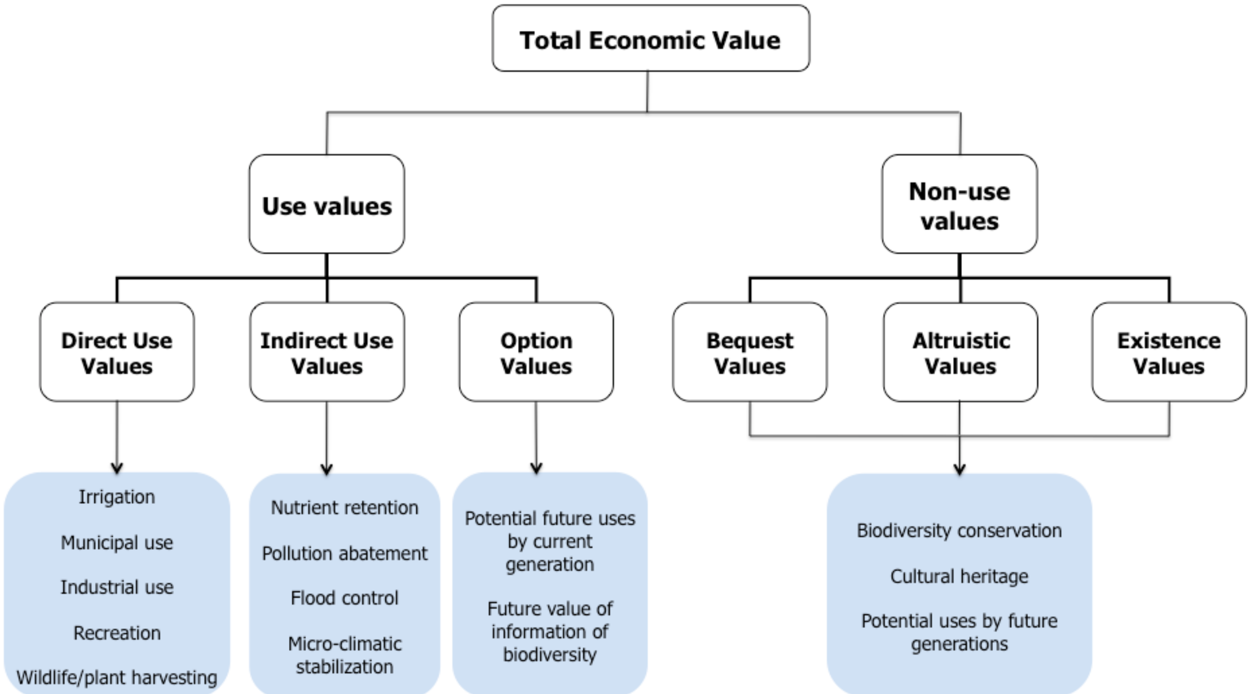
In this context, ***economic valuation has an important role*** in providing signals of water scarcity that are otherwise not available. Monetary valuation of water-related benefits and costs can be used in many ways, for example: to estimate the cost of environmental damage related to water resources; to estimate the benefits of improved water quality; to assess the economic feasibility of investments in water supply, storage and conveyance facilities; and to make the best choice of investments for allocating limited water availability among different sectors.

The Total Economic Value framework

Ecosystems provide a wide variety of services. The TEV framework has been developed through environmental economics to capture the economic value of the services provided by any ecosystem or natural resource (Pearce and Moran, 1994; TEEB, 2010). It has been used to estimate the economic value of forests (Merlo and Croitoru, 2005; World Bank, 2015), coral reefs (Access Economics, 2007), water (Gürlük, 2010), and wetlands (Franco et al., 2008). TEV includes use and non-use values. The paragraphs below and Figure 1 summarize the main types of values linked to water resources.

[3] Due to market failures, many valuable services may not be traded directly or even indirectly through markets. Examples of services that are indirectly traded may include the amenities associated with housing located near water bodies. Water values that may not be even indirectly traded include biodiversity conservation for future generations. Other benefits, while traded, have prices that do not necessarily reflect their full economic value (e.g. water for agriculture).

Figure 1. TEV of water resources



Source: adapted from Birol et al. (2006); Turner and Schaafsma (2015); Brouwer et al. (2009)

Use values are benefits derived from the actual water use, and comprise three types of values:

(1) *Direct use values*, which arise from direct interaction with aquatic resources:

- Water supply, which can be used for irrigation (e.g. agricultural lands, gardens, or lawns), municipal uses (e.g. household uses for sanitation, drinking, cooking, as well as commercial and other public uses); and industrial uses (production processes which can be consumptive, such as beverage and food industries, and non-consumptive, such as hydro-power, cooling, navigation)
- Recreation, or the benefits associated with leisure activities such as swimming, diving, boating, recreational fishing and enjoying the aesthetic view of aquatic resources.
- Wildlife and plant harvesting, or the benefits of tangible goods extracted from water, either for consumptive uses (e.g. commercial fishing, algae, reeds) or non-consumptive uses (shells for decoration).

(2) *Indirect use values*, which are benefits associated with services provided by aquatic resources, but which do not entail direct interaction. These include:

- Nutrient retention, through the capacity of water bodies to retain excess nutrients.
- Pollution control, or the ability of the ecosystem to trap sediments and retain pollutants.
- Flood control, through the ecosystem's ability of capturing, storing, and slowly releasing water over time, thus reducing the occurrence of floods.

- Micro-climatic stabilization, which is the capacity to stabilize climatic conditions such as an area's temperature and humidity.

(3) *Option values* are benefits originating from having the option of using water resources in the future[4]. They include:

- Potential future uses of direct and indirect uses. These are benefits associated with the current generation's option of using the wetlands in the future, for example for fish consumption, recreational opportunities, etc.
- Future value of information of biodiversity. Benefits derived from potential future use of wetland plants as inputs in the production of pharmaceuticals, cosmetics, etc.

Non-use values are benefits unrelated to the current use values, but reflect the economic value that can be attached to the mere existence of a water-related aspect. They can be divided in three types of value, which may overlap:

(4) Existence values, refers to the values individuals may place upon the conservation of water resources, though they may never use them directly themselves, such as conservation of certain species of fish or mammals, and preservation of a site for its cultural value.

(5) Bequest values, related to the values that individuals place for a future generation's opportunity to enjoy an aquatic resource.

(6) Altruistic values, related to the fact that even if individuals themselves do not use or intend to use the aquatic ecosystem, they may still be concerned that the environmental good in question be available to others in the current generation (Birol et al., 2006).

While this study is primarily focused on water, it is worth noting that the notion of water as a resource (e.g. water bodies, such as rivers and lakes) is closely linked to that of wetlands (e.g. deltas, mangroves, marshes). For example, rivers often form deltas, which can be highly valuable ecosystems for extractive materials, and especially for protective functions. Because of this close relationship, some of the economic values related to water are common for wetlands also (Box 4).

Box 4. Total economic value of wetlands

Wetlands[5] include many types of ecosystems, such as mangroves, unvegetated sediment, salt/brackish marsh, freshwater marsh, and freshwater woodland, and provide a wide variety of goods and services useful to humans. While specific goods and services depend on the type of wetland, a general classification of the TEV related to wetlands is similar to that of water resources, including (Brander et al., 2006):

- ***Direct use values***, derived from the uses made of a wetland's resources and services, for example wood for energy and building, water for irrigation, fishing and hunting, and harvesting of other natural materials (e.g. algae, non-wood products).

[4] Whether these belong to the use or non-use values categories remains controversial in the environmental literature.

[5] The Ramsar convention on wetlands defines wetlands very broadly as (Article 1.1): areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters, and points out (in Article 2.1) that wetlands may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands (http://www.ramsar.org).

- ***Indirect use values***, associated with the indirect services provided by the wetland's natural functions, such as: flood protection, storm protection, shoreline stabilization, groundwater recharge, carbon sequestration and micro-climate stabilization.
- ***Non-use values***, which are related to the mere existence of a wetland, such as biodiversity and cultural heritage.

It should be noted that some of the values cited above are common also to water resources, such as water supply for irrigation and fishing, while others are specific to wetland ecosystems, such as shoreline stabilization (i.e. the capacity of wetland vegetation to provide soil stability through their extensive root systems), storm protection (i.e. the ability of coastal wetlands to dissipate wave energy, thus protecting against storm damages) and carbon sequestration (i.e. carbon storage within the live and preserved plant biomass).

The public good characteristics of many of the goods and services wetlands provide often result in their being undervalued in decisions related to their use and conservation. As a result of this situation, there is now substantial literature about the economic value of wetlands (e.g. Barbier et al., 1997; Brouwer et al., 2003). Brander et al. (2006) conducted a meta-analysis of 191 studies related to wetland valuation, from 25 countries representing all continents. Results showed that, depending on the type of ecosystem, wetland values range widely, from as low as US$400/ha for mangroves to as high as US$9000/ha for unvegetated sediment ecosystems. In addition, the biodiversity service of wetlands was found to have the highest average value (US$17,000/ha/year), while use of wetlands for collecting fuel wood and other raw materials has the lowest value (US$73-300/ha/year).

It should be stressed that the TEV is only part of an ecosystem's total value. TEV is an anthropocentric concept that stresses values bringing benefits to human beings, whether directly or indirectly. Many also consider water and other ecosystems to have *intrinsic value* independent of human preferences and whether they contribute to human welfare (Goulder and Kennedy, 1997; Millennium Ecosystem Assessment, 2003). In addition, certain sites may also have value for traditional, historical, or religious reasons; this is called *socio-cultural value*. Some of these values can, only in part, be captured within the TEV through contingent valuation surveys.

Existing water valuation literature: a brief overview

Considerable effort has been expended in recent decades on estimating the partial value or the TEV of water resources. Existing literature is extremely diverse in terms of ***types of water values*** estimated, area of focus, and valuation methods used. Most studies focus on estimating values related to surface water. Among them, the majority concentrate on estimating a single water service, such as any of the following: water supply for irrigation (e.g. Petrie and Taylor, 2007; Mallios et al., 2009); for domestic use (e.g. North and Griffin, 1993); for industrial use (e.g. Stone and Whittington, 1984); recreational value (e.g. Fleming and Cook, 2008; Chen et al., 2008; Nandagiri, 2015); flood control (e.g. Harrison et al., 2001; Schultz and Fridgen, 2001) and marine biodiversity (e.g. Birol et al., 2006; Birol et al., 2008). A significant number of studies however value two or more services of water resources (e.g. Birol et al., 2010; Gürlük and Ward, 2009) and a small number estimate the TEV of all water services (e.g. Gürlük, 2010). Substantially less work attempts to estimate values related to groundwater—most of these address the cost of groundwater depletion (World Bank, 2007; Tentes and Damigos, 2012) and the benefits of improving groundwater quality (Groom and Koundouri, 2011).

In terms of area of focus, most water valuation examples relate to the use of water for irrigation and recreation; such studies have been conducted in several countries on all continents (e.g. United States, Philippines, South Africa, Australia, and Greece). Valuations of other benefits, such as flood control, water for navigation, and industry are more difficult to find, with examples concentrated primarily in North America.

A broad range of ***valuation methods*** has been applied to estimate different water values. Valuation methods range from market pricing (e.g. to estimate the fish, algae and other materials harvested from water) to demand-curve approaches (e.g. travel cost method to value recreational value; contingent valuation method and choice experiments to value biodiversity) and non-demand curve approaches (e.g. expenditures to prevent reduction of benefits due to reduced water quality). A thorough discussion of the valuation methods and their empirical application to different water services is the topic of the next chapter.

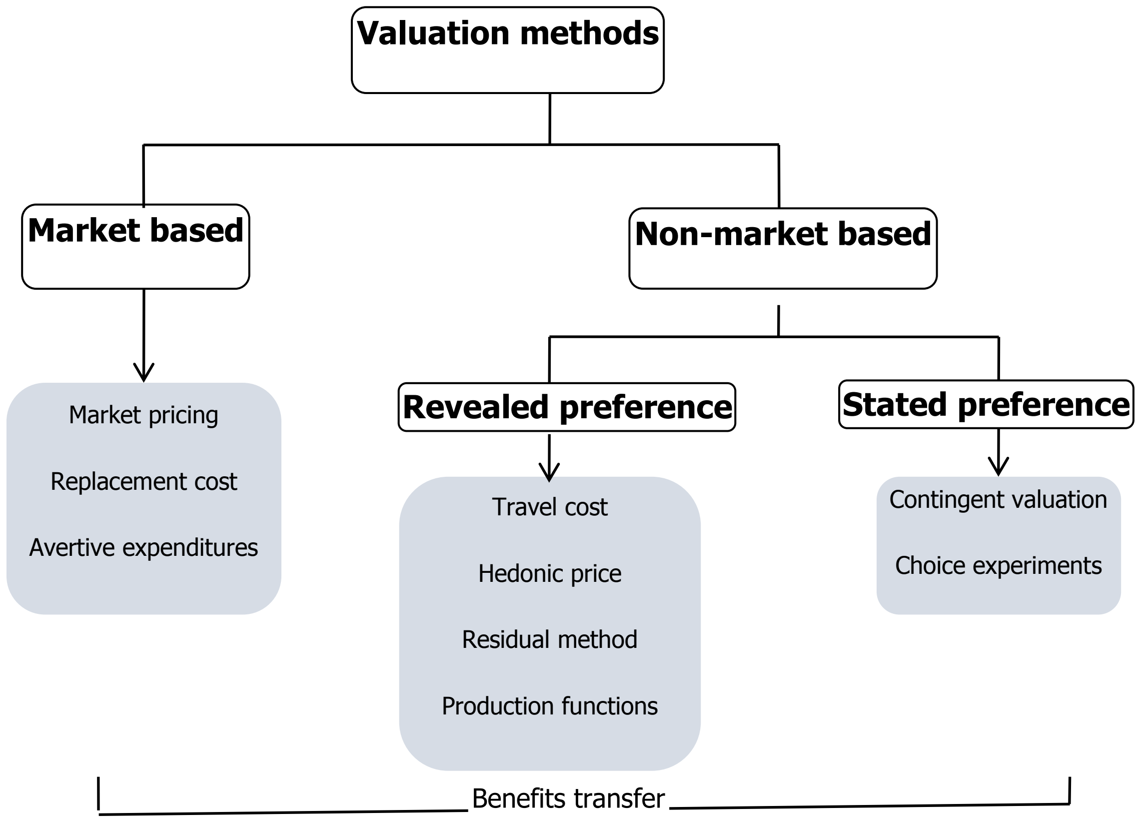
IV. Methods for Estimating Water Values

Estimating the TEV of an ecosystem involves placing a monetary value on each of the benefits it provides. A wide range of valuation methods exists to assess the environmental benefits related to water, as described below.

Overview of valuation methods

Several classifications exist for environmental valuation methods (Dixon et al., 1994; Barbier, 2007; FAO 2004; Markandya, 2014; Mendelsohn and Olmstead, 2009; Brouwer et al., 2009). Here we follow Brouwer et al. (2009), who distinguish market-based and non-market based methods (Figure 2). Market-based methods use market behavior and transactions as a basis for valuation. In contrast, non-market based methods estimate the value of environmental benefits when markets are non-existent or distorted. When no data is available, benefit transfer methods are used to enable the application of existing estimates to new contexts.

Figure 2. Taxonomy of environmental valuation methods



Source: adapted from Brouwer et al. (2009); Birol et al. (2006); Markandya (2014).

(a) Market-based methods

Market-based methods use evidence from markets to estimate an environmental benefit. They include:

- ***Market pricing (MP)***. This is the simplest valuation approach, which estimates the value of goods based on their market price. In some cases, it may be necessary to adjust market prices to correct for distortions, such as subsidies or taxes ("shadow pricing"). This method is commonly used to estimate the value of tangible goods extracted from water (e.g. fish catch, algae) for which markets exist. In addition, it can be used to derive the economic value of water in countries with free water markets. For example, market pricing has been applied to estimate the economic value of water for irrigation in the United States (Loomis, 1992; Bunch, 2004; Brown, 2006) and Australia (Grafton et al., 2011a); and the value of water for municipal uses in Chile (Anderson et al., 2012).

- ***Replacement cost method (RCM)***. This method estimates the value of an ecosystem service based on the cost of replacing it. It assumes that the environmental damage is measurable, and that the value of the ecosystem service is no greater than the cost of replacing it. It has been occasionally applied in the context of water resources, for example to estimate the benefit of flood protection through the cost of afforestation on coastal areas (Barbier, 2009).

- ***Avertive expenditures***. This method (also called "defensive expenditures") assumes that individuals spend money on eliminating or reducing damages caused by adverse environmental impacts. This is the case with double-glazed windows for reducing traffic noise, extra filtration or boiling used to purify polluted water, and air conditioning for avoiding polluted air[6]. Several applications exist in the context of water resources, reflecting different cost aspects: household-level costs associated with groundwater contamination in the United States, such as the purchase of bottled water or water filters, and cleaning and repairing water systems (Abdalla, 1994); the additional cost of purchasing bottled water in Lebanon (Sarraf et al., 2004); or the cost of boiling water in Bolivia (Strukova et al., 2011).

(b) Revealed preference methods

These methods are used to estimate non-market values based on observations of actual consumer behavior in markets for the goods or services of interest, or in surrogate markets for related goods or services. Commonly used methods in the water context include:

- ***Travel cost method (TCM)***. The TCM is used to estimate use values associated with ecosystems or sites (such as forests, wetlands, parks, and beaches) that are used for recreation (hunting, fishing, hiking, or watching wildlife). The basic premise of the TCM is that the time and travel cost expenses people incur to visit a site represent the "price" of their access to the site. The information on the value of an environmental benefit can be obtained by posing direct questions to consumers about their willingness to pay (WTP). Thus, in TCM people's WTP to visit the site can be estimated based on the number of trips

[6] These expenses can be considered minimum estimates of the benefits of mitigation, since the benefits derived from avoiding damage are higher than, or at least equal to, the costs incurred for avoiding it (Markandya, 2014).

that they make at different travel costs.[7] The travel cost itself is not the recreational benefit, but it reveals preferences for the ecosystem service, based on which demand for a site is derived. This method has been widely applied in Western Europe as well as the United States (Flemming and Cook, 2008), Australia, Philippines, and other countries (Choe et al., 1996).

- ***Hedonic price method (HPM)***. This method assumes that any good can be described as a bundle of characteristics and the levels they take; and that the price of the good depends on these characteristics/levels. For example, the price of a house will reflect its relevant characteristics (e.g. number of bedrooms, size), in addition to local environmental characteristics (e.g. water quality or quantity, aesthetic views). It follows that an implicit price exists for each characteristic. Thus, the value of water quality or quantity can be determined by isolating its contribution to the total price of the marketed good. This method has been applied to estimate the economic value of water for irrigated agriculture in the United States (Petrie and Taylor, 2007; Mukherjee and Schwabe, 2012), Greece (Latinopoulos et al., 2004; Mallios et al., 2009), and Iran (Esmaeili and Shahsavari, 2011; Kakhki et al., 2010). Esmaeili and Shahsavari (2011) indicated that the availability of irrigation water was one of the most important variables influencing land prices.

- ***Residual method (RM)***. This method subtracts the costs of other inputs in production (purchased inputs and opportunity costs of owned inputs other than water) from total revenue, then ascribes the difference to the value of water. It can be based on a simple farm crop budget, or may extend to mathematical programming models portraying the optimal allocation of farm water and other resources (land, materials, labor) among several potential crops. It has been widely employed to derive the value of water for irrigation. Applications were found throughout the world, including in China (World Bank, 2007), South Africa (Speelman et al., 2008) and Jordan (Tabieh et al., 2015). Tabieh et al. (2015) analyzes farmers' ability to pay for irrigation water in the Jordan Valley and concludes that increasing water prices could encourage more efficient water use and a shift to higher-value crops. However, it should be noted that applying this method could generate overestimates, because: (1) by its nature, the method attributes a considerable part of the net revenue as the value of water; and (2) from the empirical viewpoint, estimation of the opportunity costs of owned inputs is often overlooked in farm budgets, leading to an over-appreciation of the net revenue compared to its real value.

- ***Production function (PF)***. This approach can be used to value non-marketed goods and services that serve as inputs to the production of marketed goods. It relates the output of a particular marketed good or service (e.g. agricultural production, timber, fish catch) to the inputs necessary to produce them (e.g. labor, capital, land, soil quality, water quality and quantity). Thus, the implicit value of water can be calculated by measuring its contribution to profits. The production function can be constructed based on econometric models (e.g. crop water production functions), or mathematical programming or general equilibrium approaches (Johansson, 2005). Examples of this technique's application were found in

[7] The TCM encompasses a variety of models, ranging from the simple single-site TCM to regional and generalized models that incorporate quality indices and account for substitute sites (CGER, 1997).

China, to estimate the value of crop water yields (Liu, 2007), and Poland, to analyze industrial water demand for a power plant (Stone and Whittington, 1984).

- ***Cost of illness method (COI).*** A particular class of production function approaches used to estimate the monetary value of an environmental change through its impact on illnesses. It can be used to value the benefits of pollution reduction by estimating possible savings in direct out-of-pocket expenses resulting from illnesses (e.g. medicine, doctor and hospital bills) and opportunity costs (e.g. loss in earnings associated with sickness); or actual health impacts from the degradation of the environment through WTP to avoid illness. In the context of water resources, this method has been used to estimate costs resulting from water-borne diseases, such as diarrhea and malnutrition (e.g. World Bank, 2016 in Morocco and World Bank, 2012 in Iraq).

- ***Derived demand functions (DD)***. A household's demand function can be employed to estimate the user's WTP for water. Transactions concerning water are observed between water utility suppliers and individual water users at specific prices. When sufficient observations are made across variations of the real price, it is possible to infer the WTP and demand for water. The method has been used to derive the demand and value of water for municipal use in several countries such as Honduras, Madagascar and Vietnam (Nauges and Whittington, 2009).

- ***Alternative cost method (ACM)***. This method (also called "substitute" cost method) refers to the cost of available alternatives for a particular non-priced service or good. The non-priced good can be either a consumer good (e.g. parks) or an input factor (e.g. land, water). In the context of water resources, the input factor can be surface water for irrigation (which could be substituted by groundwater); water for hydropower generation (which can be replaced by thermal or renewable energy); or water for navigation (which can be substituted by rail or trucking). The method assumes that if the two alternatives provide an identical service, the value of the non-priced good (in this case, water) is the saved cost from using the alternative. Applications of this technique were found in the United States to estimate the economic value of water for hydro-power generation (Harpman, 2006), for navigation (Gibbons, 1986), and for irrigation (Holland and Moore, 2003).

(c) Stated preference methods

These methods rely on asking consumers to state their preferences directly, in terms of hypothetical markets or payments, i.e., their WTP or, alternatively, their willingness to accept (WTA) cash compensation for losing the benefit. The most commonly used methods include:

- ***Contingent valuation method (CVM)***. This method can be useful for eliciting the value of several aspects of water resources, including water quality, recreation, and biodiversity. It can be employed to estimate both use and non-use values.[8] It has been used to estimate use values, such as the use of recycled wastewater in agriculture in Cyprus (Birol et al., 2008a) and irrigation water in the Chalkidiki rural area in Greece (Mallios and Latinopoulos,

[8] A survey instrument is used to measure individuals' maximum WTP for an aspect of a water resource, presented to them in a hypothetical market with a proposed improvement.

2001). It has also been employed to estimate non-use values, such as biodiversity conservation in wetlands in Cyprus (Birol et al., 2008b) and Lake Sevan in Armenia (Wang et al., 2004).

- ***Choice experiment method (CEM)***. Similar to the CVM, this method can be used to estimate the economic value of use and non-use values of any environmental resource[9]. However, CEM enable estimation not only of the value of the environmental resource as a whole, but also of the implicit value of its attributes, their ranking and the value of changing more than one attribute at once (Hanley at al., 1998; Bateman et al., 2003). Concerning water resources, CEM has been applied to estimate the WTP for different functions, such as flood risk reduction, biodiversity conservation, and improved recreational access in Poland (Birol et al., 2009), biodiversity conservation in Greece (Birol et al., 2006), and improved water quality, quantity and biodiversity conservation in Cyprus (Birol et al., 2010).

(d) Other approaches

The direct and indirect techniques presented above are usually costly and time-consuming. Fortunately, over the past three decades there has been a wealth of literature on non-market valuation of water resources (Pendleton et al., 2007). Based on the available estimates of value at the "study site," one can estimate the value at another "policy site." This approach, called ***benefits transfer***, is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context.[10]

Water valuation literature in Turkey: a summary

Natural resource economics is a new field of research with limited experts and study examples in Turkey. Apart from some projects being implemented by the central government agencies responsible for natural reserve and forestry—namely DG Nature Protection and Natural Parks and the DG Forestry, few works on natural capital accounting and water valuation have been done by either academics or national/local governments.

One of the most well-known and comprehensive studies conducted by the government (DG Nature Protection and Natural Parks) is the ***Valuation of Eco-services of Kayseri Sultansazlığı (Sultan Marshes) Natural Park***. This study quantified the ecological values of Sultansazlığı, a large wetland complex with salty and freshwaters and one of the fifteen Ramsar Sites in Turkey. The direct and indirect values of the site were estimated at TL1.4 billion in 2012 prices.

[9] The environmental resource is defined in terms of its attributes (e.g. bathing water quality of coastal waters) and attribute levels (e.g. high, medium, low). Profiles of the resource in terms of its attributes and attribute levels are then constructed, by combining the levels of attributes into different scenarios. Two or three alternative profiles are then assembled in choice sets and presented to respondents, who are then asked to state their preference (Hanley et al. 1998; Bateman et al. 2003).

[10] This method is most reliable when the original site and the study site are very similar in terms of factors such as quality, location, and population characteristics; when the environmental change is very similar for the two sites; and when the original valuation study was carefully conducted and used sound valuation techniques (www.ecosystemvaluation.com).

In recent years, in the context of Turkey's EU candidacy, there have been increased efforts to understand the role of water in economic development and to integrate water valuation into river basin management processes. As an example, in 2012, WWF-Turkey, in cooperation with the MoFWA, prepared a report which assesses Turkey's water footprint with a specific focus on the relationships between water, trade, and production.[11]

The ***Sectoral Water Allocation Plan in Seyhan Basin Project*** implemented by DGWM conducted an economic analysis of water resources. The project aims to prepare a pilot sectoral water allocation plan for the Seyhan Basin by making hydrological, environmental, economic and social analyses in light of surface and groundwater resources, their usage, and potential future demands in the basin. As part of the project, the TEV generated by water resources in Seyhan Basin is estimated. In addition, a WTP study to estimate the value of the environmental flows of Seyhan River is currently ongoing. It is expected to be finalized by September 2016.

Finally, an Instrument for Pre-Accession (IPA) Project named ***Technical Assistance on Economic Analyses within River Basin Management Plans and Water Efficiency Aspects in three Pilot River Basins in Turkey*** is another important step towards economic analysis of water resources at the river basin level. The project was developed by DGWM and aims to carry out an economic analysis of water uses in selected basins and to assess current levels of the cost-recovery of water services including environmental and resource costs in the light of EU-WFD. Yeşilırmak, Akarçay, and Western Mediterranean Basins have been identified as pilot river basins within the Project, which will start by early 2017.

In addition to the efforts carried out by the government, some academic studies have been conducted to estimate different water values. Their findings are summarized below, and described in greater detail in Table 3.

- ***Water for irrigation, urban use and hydropower generation***

A few studies estimate these values. Some authors focus on valuing individual benefits, primarily water for irrigation. For example, Tsur (2004) used a demand function to estimate the net value of water for irrigating the main crops grown in the Harran Plain (Table 3). More recently, Aydogdu (2016) conducted a CV survey to estimate farmers' WTP for irrigation in the same region, and concluded that the WTP was substantially higher than the existing water price. In addition, Bilgic et al. (2008) estimated the WTP for treating potable water in Southeastern Turkey. They combined averting behavior data (i.e. use of spring water instead of water from the municipal water network) and stated preference data (i.e. CVM to estimate WTP to be able to drink tap water without purchasing spring water) in a model to determine residents' WTP for improved tap water quality.

Other authors estimate the combined value of water for several uses. For example, Tilmant et al. (2008) used a production function approach to analyze the value of water for hydropower generation and irrigated crops in several irrigation-hydroelectric reservoirs in Turkey and Syria.

[11] It shows that the water footprint of consumption, 140 billion m^3, is almost equal to the water footprint of production, 139.6 billion m^3. Similarly the virtual water that enters the country through imports approximately equals the export of virtual water, which indicates that Turkey's virtual water budget is in balance. (WWF-Turkey, 2014a)

Gürlük and Ward (2009) estimated the economic value of water for agriculture, urban use, and recreation in the Nilüfer basin (Bursa province).

- ***Water-based recreation***

This is the aspect best covered in the available studies. Valuation focuses on a variety of contexts (nature parks, protected areas, coastal zones) and sometimes considers different types of visitors (local, foreigners). Some authors apply the TCM to estimate the recreational benefit, for example related to Kursunlu Waterfall Nature Park in Antalya province (Ortaçeşme, 2001), Great Meander Delta National Park, on the Aegean coast (Başar, 2007), Lake Manyas of Kuşcenneti National Park (Gürlük and Rehber, 2008), and Tuz Lake Protection Area, located within the borders of Ankara, Konya and Aksaray (Demir, 2014). Other authors use CVM, for example in relation to beaches near Mersin, on the eastern Mediterranean coast (Birdir et al., 2013). Yet, others combine the two techniques to estimate the local and foreigners' WTP for visiting Olu Deniz beach (Blakemore et al., 2002; Blakemore and Williams, 2008).

- ***Improved water quality***

A few studies attempt to estimate the value of improvements to water quality, coastal, and marine biodiversity. They generally use CVM to estimate the WTP to improve water quality of different lakes: Manyas Lake, one of the country's Ramsar sites (Gürlük and Rehber, 2006), Beyşehir Lake, the largest freshwater lake in Turkey (Özdemir and Baycan-Levent, 2010), and Izmit Bay, a coastal area affected by decreasing water quality due to increased nutrient loads (Tolun et al., 2012). Only one study was found to apply CEM to value the local residents' WTP to improve water quality and restore marine ecosystems, in Göcek Bay (Can and Alp, 2012).

Table 3. Overview of water valuation studies conducted in Turkey

Study	Location	Type of value	Valuation method used	Description of results
		Water for irrigation, urban use and hydropower generation		
Tsur et al. (2004)	Harran plain, southeastern Turkey	Water for irrigation	Production function (based on linear programming)	The economic value of water was estimated at TL12 mil. – TL16 mil.
Aygodgu (2016)	Harran plain, in the Southern Anatolian Project (GAP)	Water for irrigation	CVM	WTP was estimated at TL 235/ha, while the price paid was TL137/ha (2011)
Tilmant et al. (2008)	Euphrates river basin, 5 reservoirs in Turkey (Keban, Karakaya, Ataturk, Birecik, Karkamis) and 2 in Syria (Tishreen, Tabqa)	Water for irrigation and hydropower	Production function (based on stochastic programming)	Marginal water values were estimated at US\$0.034 – 0.046/m^3 for Keban, US\$0.026 – 0.039/m^3 for Karakaya, US\$0.019 – 0.027/m^3 for Ataturk, US\$0.007 – 0.014/m^3 for Birecik reservoirs (2003)
Gürlük and Ward (2009)	Nilüfer basin, located in Bursa province	Water for agriculture, urban and recreation (fishing, scenic view, picnicking, bird watching)	Derived demand function (based on optimization model)	The average water values were estimated at TL31/m^3 for urban use (city of Bursa), and TL3.9-4.6/m^3 for irrigated agriculture (Nilufer, Misi and Cayirova irrigation districts) (2003).
Bilgic et al. (2008)	Southern Anatolian Region (GAP)	Improved quality of potable water	Avertive expenditures and CVM	The WTP is NTL6.43 /household/month (2007)
		Water-based recreation		
Ortaçeşme (2001)	Kursunlu Waterfall Nature Park in Antalya province	Recreational value	TCM	The total recreational use value is estimated at US\$50,000 (1999).
Blakemore et al. (2002)	Beaches at St George's Bay (Malta), Mamaia (Romania) and Olu Deniz (Turkey)	Recreational value	TCM and CVM	The average WTP per visit was estimated at £0.64 for St George's bay, £0.32 for Mamaia and £0.94 for Olu Deniz. In addition, the consumer surplus (CS) was estimated at £0.62 per visit for British users, £0.46 per visit for Turkish users and £0.69 for Romanian users. (2000)
Blakemore and Williams (2008)	Olu Deniz beach	Recreational value	TCM and CVM	The WTP of British tourists is £0.9/visit for adults (2004)
Başar (2007)	Dilek Peninsula - Great Meander Delta National Park, located on Aegean coast of Turkey	Recreational value	TCM	The total WTP was estimated at NTL 42 million (2006)
Gürlük and Rehber (2008)	Kuşcenneti National Park at Lake Manyas	Recreational value (bird watching)	TCM	The CS of the park was about US\$103 million annually, or US\$3.75/visitor (2004)
Birdir et al. (2013)	Kizkalesi, Yemiskumu and Susanoglu beaches located near Mersin, on the country's eastern Mediterranean coast	Improved beach quality	CVM	The average WTP was Euro 2.33/visitor for Kizkalesi, Euro 2.22 for Yemiskumu and Euro 1.77 for Susanoglu beaches (2011).
Demir (2014)	Tuz Lake Protection Area, located within the borders of Ankara, Konya and Aksaray of the Central Anatolia Region	Recreational use value	TCM	Using TCM, the average WTP = US\$24/visitor, leading to a total recreational benefit of US\$5 million (2013).

Improved water quality, biodiversity, and other values				
Gürlük (2006)	Lake Manyas National Park	Improved environmental quality	CVM	The average WTP = 60 New Turkish Liras (NTL)/year, and the aggregate benefit to residents of the Lake was NTL 4.8 million/year (2004).
Gürlük (2010)	Lake Uluabat, one of the Ramsar Sites of Turkey located in southern Marmara region	TEV	CVM	The TEV of benefits generated by Uluabat Lake Wetland Management Plan = US$80.8 per capita per year (2004).
Özdemir and Baycan-Levent (2010)	Beyşehir Lake Basin, located in Konya Closed Basin	Improved water quality	CVM	The WTP for improved water quality = TL18/household, with a total value of TL2 million per year (2010).
Can and Alp (2012)	Göcek Bay, located in Fethiye-Göcek region	Improved water quality and marine life	CEM	The WTP is TL18/month/person for improvements in water quality, and TL14.8/month/person for improvements in marine life (2010).
Tolun et al. (2012)	Izmit Bay, at the east of the Marmara Sea	Improved water quality	CVM, HPM	Based on CVM, the average WTP = EUR18.7 per person. In addition, the HPM indicated that an increase in water clarity from 2 to 3 m would increase the price of the average apartment (ca. 450 EUR/m^2) by EUR 6.0/m^2 (2009)

Note: The results presented in the last column are as given in the studies cited.

Summary of the applicable methods to estimate water values

While a wide range of techniques are available for valuing water benefits (Table 4), it is important to note that the choice of specific valuation method depends on several factors: type of values to be estimated (i.e. while use values can be estimated through most available techniques, non-use values can only be estimated through stated preference methods); purpose of valuation (i.e. certain purposes require valuation techniques based on the estimation of marginal values, while others require valuation of total or average values); data availability (i.e. existence of data from secondary resources); resources and time available (i.e. the various techniques can differ greatly in terms of the resources and time required to undertake a study). The next chapter (Chapter V) selects the appropriate valuation methods for which data are available, to demonstrate their applicability in relation to Beyşehir basin in Turkey.

Table 4. Components of TEV and commonly-used valuation methods

TEV	Type of benefit	Economic valuation methods *
Direct use values	Water for irrigation	RM, PF, MP, DD, ACM, CVM
	Water for municipal use	PF, DD, RM, MP, CVM
	Water for industrial use [a]	PF, DD, ACM
	Recreation[b]	HP, TCM, CVM, CEM
	Wildlife and plant harvesting[c]	MP
Indirect use values	Nutrient retention	RC, COI
	Pollution abatement	RC, COI
	Flood control	RC, MP
	Micro-climatic stabilization	PF
Option values	Potential future uses of direct and indirect uses	CVM, CEM
	Future value of information of biodiversity	CVM, CEM
Non-use values	Biodiversity conservation	CVM, CEM
	Cultural heritage	CVM, CEM
	Potential uses for future generations and for contemporaries of the current generation	CVM, CEM

Source: adapted from Birol et al. (2006) and Brouwer et al. (2009).

Notes: [a] refers to production processes that can be consumptive (such as beverage and food industries) and non-consumptive (such as hydro-power, cooling, navigation). [b] benefits associated with leisure activities such as swimming, diving, and recreational fishing. [c] benefits from tangible goods extracted from water, either for consumptive uses (e.g. commercial fishing, algae, reeds) or non-consumptive uses (shells for decoration). *Acronyms refer to production function (PF), residual method (RM), replacement cost (RC), market prices (MP), cost-of-illness (COI), travel cost method (TCM), hedonic pricing method (HP), contingent valuation method (CVM), and choice experiment method (CEM), alternative cost method (ACM), and derived demand (DD).

V. Valuation Applications in Beyşehir Lake Subcatchment

Objectives and profile of the case study area

This chapter attempts to quickly apply the methodology presented above to a river basin in Turkey, demonstrate economic valuation as a useful tool to improve water resources management, and promote the future applications of water valuation in Turkey's WRM decision-making. The Beyşehir Lake subcatchment was selected for a quick case study for several reasons: (i) it is highly important in terms of water availability, being the country's largest freshwater lake; (ii) it is a protected area, with high conservation value; (iii) it provides water to multiple users, thus encountering problems from competing uses; (iv) data availability and the size of subcatchment allowed a quick economic valuation to be conducted.

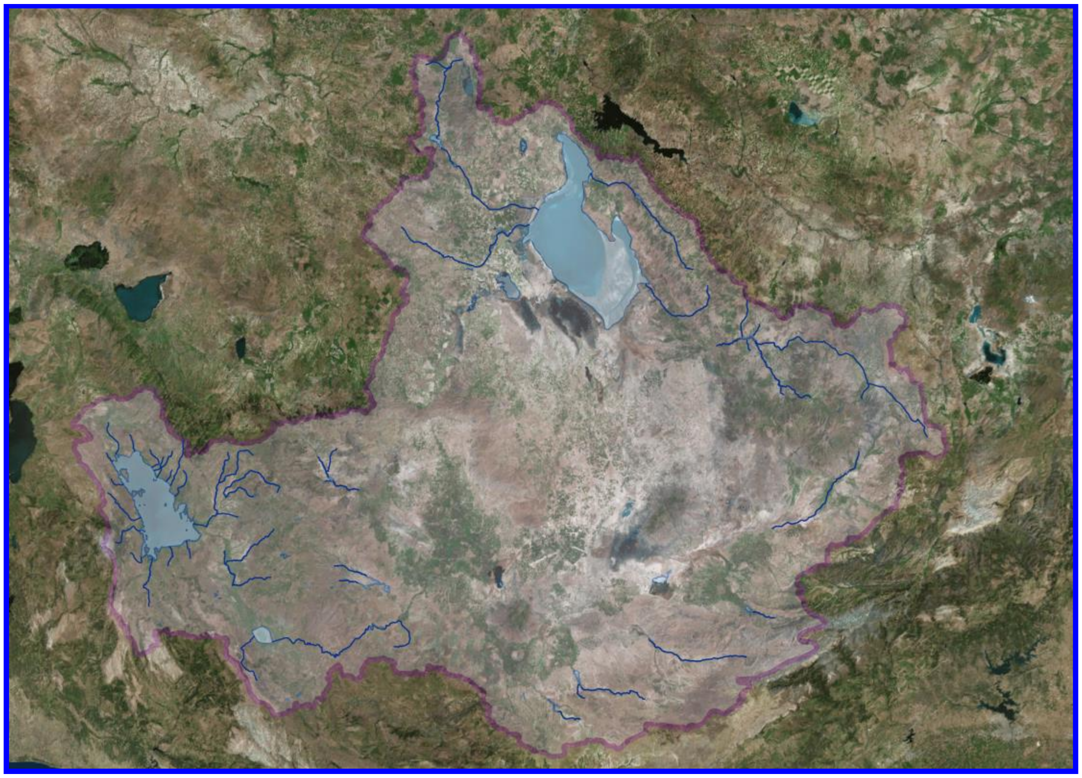
Data collection was quickly undertaken through desk review and interviews of a few local government officials in charge of water management. Based on data availability, a few valuation methods were employed to assign economic values to water in the subcatchment. Some preliminary valuation results were presented and discussed.

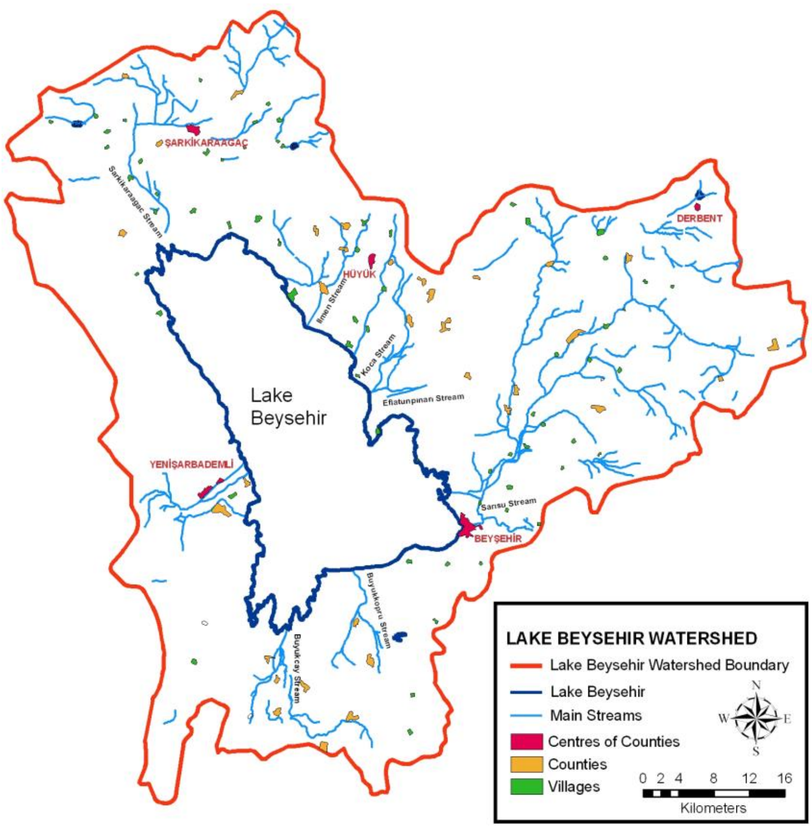
Beyşehir Lake is located in the southwest corner of Konya Closed Basin, which is in the Central Anatolian Plateau covering an area of 53,000 km^2, roughly 7% of Turkey's total surface area (Figure 3). The Basin has semi-arid climate conditions and an annual average precipitation of around 300-350 mm, almost half of Turkey's average. Beyşehir Lake is the main surface water resource for Konya Closed Basin.

The Beyşehir Lake subcatchment has an area of about 414,000 ha, and the lake itself, the largest freshwater body in Turkey, has a water surface area of about 73,000 ha, with a mean and a max depth of 5m and 9m, respectively. The Lake's southern and northern shores are shallow and mostly covered with swamp and reedbeds. The Lake is bordered by forested mountains in the west and south, with lower parts of the maquis-covered slopes occupied by small areas of arable land and orchards. North of the Lake is the indigenous *Cedrus* forest of Kızıldağ, whereas the eastern side is flat, and mainly used for crop cultivation.

The lake is fed by 27 streams from the Dedegöl Mountains to the west, and by underground springs coming from Sultan Mountains to the east. According to hydrogeological surveys conducted by DSİ, due to the Lake's karstic ground characteristics water is leaking through the holes into the Manavgat Basin and connecting to the Mediterranean Sea, meaning that the Lake is either charged or discharged by these groundwater flows. Depending on the season and year, the Lake's water level fluctuates often, and there are significant relationships between temperature, precipitation, evaporation and the Lake's water inflow and withdraw.

Figure 3. Konya Closed Basin and Beyşehir Lake Subcatchment





Source: MoEF 2010 for Konya Closed Basin, Nas, B., et al., 2010 for Beyşehir Lake Subcatchment

Beyşehir Lake is surrounded by two National Parks—Beyşehir and Kızıldağ. The Lake is the source of drinking water (reservoir) and a designated natural reserve area, it is also important for large numbers of wintering waterfowl including Red-crested Pochard (*Netta rufina*), common pochard (*Aythya ferina*) and common coot (*Fulica atra*). The following fish species were reported in Beyşehir Lake: carp (*Cyprinus carpio*), pikeperch (*Sander lucioperca*), silver crucian carp (*Carassius gibelio*), tench (*Tinca tinca*), big-scale sand smelt (*Atherina boyeri*), chub (*Leuciscus lepidus anatolicus*) and rubb (*Chondrostoma Beyşehirense*) (Alaş, A., et al., 2010).

Beyşehir Lake lies within the administrative boundaries of Isparta and Konya provinces. There are five major settlements located in the Lake Basin, namely the Beyşehir, Hüyük, and Derbent districts of Konya and Yenişarbademli, Şarkikarağaç districts of Isparta. According to TurkStat, the total population of the five major settlements in Beyşehir Lake Basin was about 120,000 in 2014. Of the five settlements, Beyşehir district has the largest population with 71,366 inhabitants (TurkStat, 2014c).

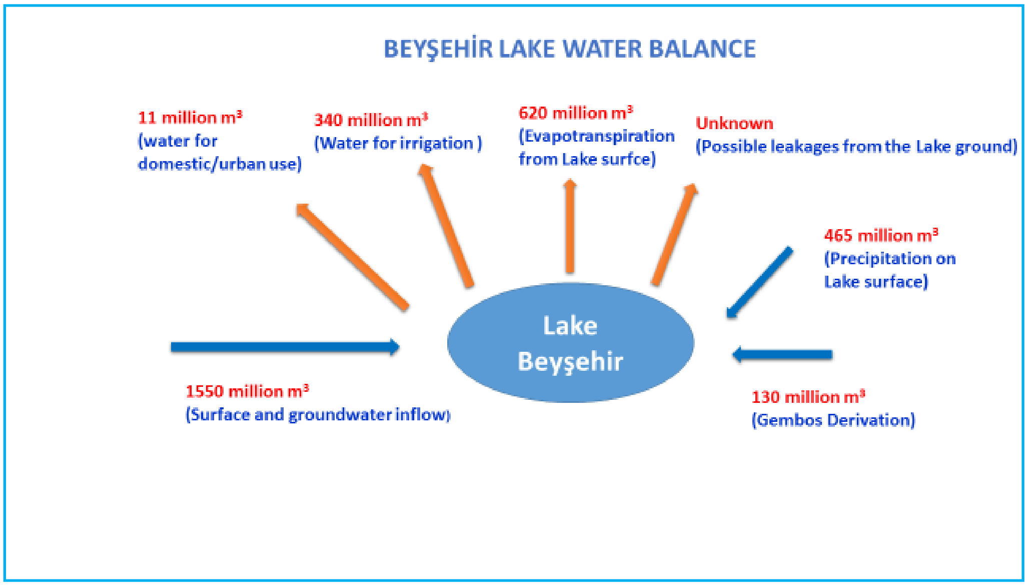
Agriculture (crop production and livestock), fisheries, and tourism are the main economic sectors in the subcatchment. Of these, agriculture is the most important, and consists of both irrigated agriculture and dry land arable farming. Cereals (wheat and barley), chick peas, maize, sugarbeet, fodder crops, potato, vegetables and fruits are the main crops cultivated in the subcatchment. Also, Şarkikaraağaç and Hüyük are remarkable for apple and strawberry production

The Lake has been operated since the early 1900s for irrigation of the Konya Plain, and the historical regulator facility (Stone Bridge) located in the Lake's southeastern coast was constructed in 1913. Today, the DSI's 4th Regional Directorate is the main authority responsible for management of the Lake. Within the Konya Plain Project (referred to by DSİ as KOP Project), Çarşamba and Beyşehir Streams were turned into an artificial channel (BSA Channel-Beyşehir-Suğla-Apa Channel) to transfer the Lake's water to Konya Plain for irrigation. Out of irrigation season, water is being stored in Suğla Lake and Apa Dam; during the irrigation period it is diverted to Çumra Plain. Each year, about 330-340 million m^3 of water from the Lake is used for irrigation. This includes approximately 320-330 million m^3 for the irrigation of Konya Plain, and the remaining for the Şarkikarağaç and Kıreli irrigation projects developed by DSİ. Apart from the planned irrigation schemes developed by DSİ, farmers also supply water to their farmlands independently either through pumping directly from the Lake and streams flowing to it, or from groundwater wells. According to DSİ, 1361 groundwater wells operate in the subcatchment (361 licensed, and 1000 illegal).

In addition to this, in 2008 as part of the KOP Project, DSİ constructed a water diversion scheme from a neighboring catchment to increase the water level of Beyşehir Lake, called the Gembos Derivation Scheme. Today, an average of 130 million m^3 of water is diverted annually to the Lake via Gembos (from the interview with DSİ 4th Regional Directorate).

Beyşehir Lake also provides drinking water for the Beyşehir District and some surrounding small towns, and some villages also use the streams and creeks feeding the Lake to supply their drinking water. According to the 7th Regional Directorate of the Konya Water and Sewerage Authority (KOSKİ) in Beyşehir, about 11 million m^3 of water is used annually from Beyşehir Lake for domestic/urban purposes (Interview with local expert in KOSKİ), providing water for 42,671 subscribers (KOSKİ, 2014). Figure 4 shows the water balance of Beyşehir Lake, based on literature and interviews with local experts.

Figure 4. Beyşehir Lake water balance



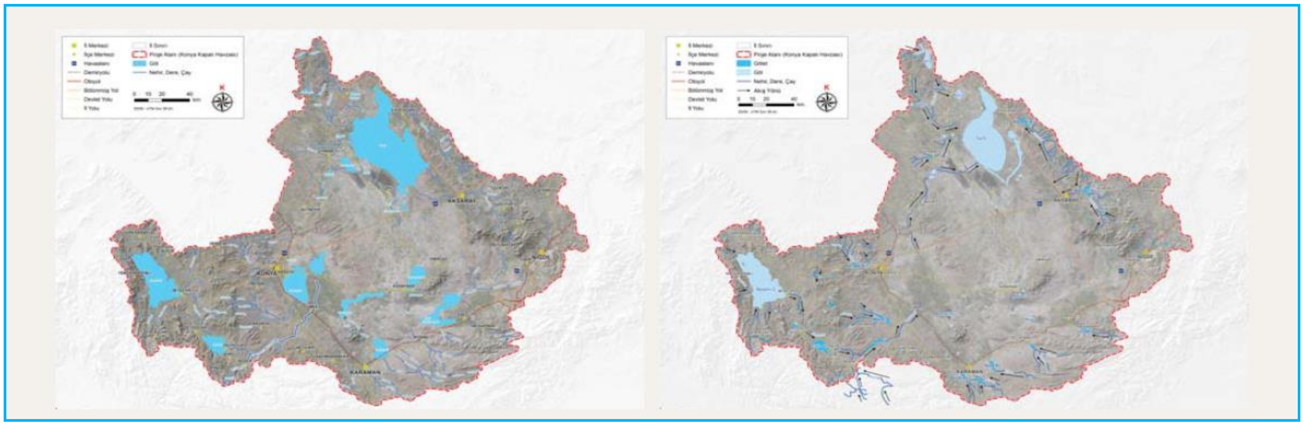
Source: Interview with local experts

The Beyşehir District's wastewater treatment plant was constructed in 2005. However, due to high operation and maintenance costs, the treatment plant has not functioned since 2008, and urban wastewaters remain untreated and are directly discharged out of the subcatchment to a small stream. Of the four other major settlements—Şarkikarağaç, Hüyük, Derbent and Yenişarbademli—none have wastewater treatment plants, and discharge their untreated wastewater to the streams flowing into the Lake except for Yenişarbademli, which discharges into a doline near to the town.

Although it has protection status (several of them), the Beyşehir Lake has been suffering from a number of problems: decreasing water levels due to excessive abstraction for irrigation; failures in water management policies; lack of coordination between Nature Conservation and Water Management authorities; unsustainable fishing practices; pollution caused from urban and rural wastewaters; and unplanned urbanization. The problems in Beyşehir Lake are complex and strongly interlinked with socio-economic and agricultural development in the entire Konya Closed Basin; they threaten both the sustainability of the Lake ecosystem and the services provided by the Lake.

The Konya Closed Basin is a typical example of a semi-arid region where groundwater resources are under strong anthropogenic pressure (Figure 5). Over the past few decades, the basin has experienced huge non-renewable groundwater abstraction for irrigation, along with groundwater head declines and environmental degradations. Decisions to irrigate land, increase agricultural production, and build reservoirs to expand irrigated land in the basin have resulted in several environmental problems such as the loss of ecologically important wetland habitats (which are also mostly groundwater dependent), decreasing fish stocks in inland waters, loss of reedbeds, etc. By the 1970s nearly half of the basin had already been converted into arable land; today this proportion is even higher. These areas include many former wetland and steppe habitats.

Figure 5. Surface water resources in Konya Closed Basin before water development projects (in early 1900s) and in 2012



Source: WWF-Turkey, 2014b

The over-exploitation of groundwater resources is one of the most important problems in Konya Closed Basin. Based on the observations of the groundwater wells operated by DSİ 4th Regional Directorate, groundwater levels have decreased more than 28 meters across the basin since 1980. (Göçmez, G., 2004) According to an unpublished DSI inventory carried out in 2008, of a total of 94,000 wells in the basin, 68,000 were drilled and operated without permission. Today, the number of illegal wells throughout the basin is estimated to be more than 100,000. Although DSİ has been taking several steps to protect the basin's groundwater resources over the last few years (e.g. preparing master plans and setting up safe yields for groundwater use, developing new monitoring and control mechanisms, training and awareness raising activities for farmers in cooperation with other local authorities), illegal pumping and overexploitation of groundwater resources continue to threaten the sustainability of the basin's water resources.

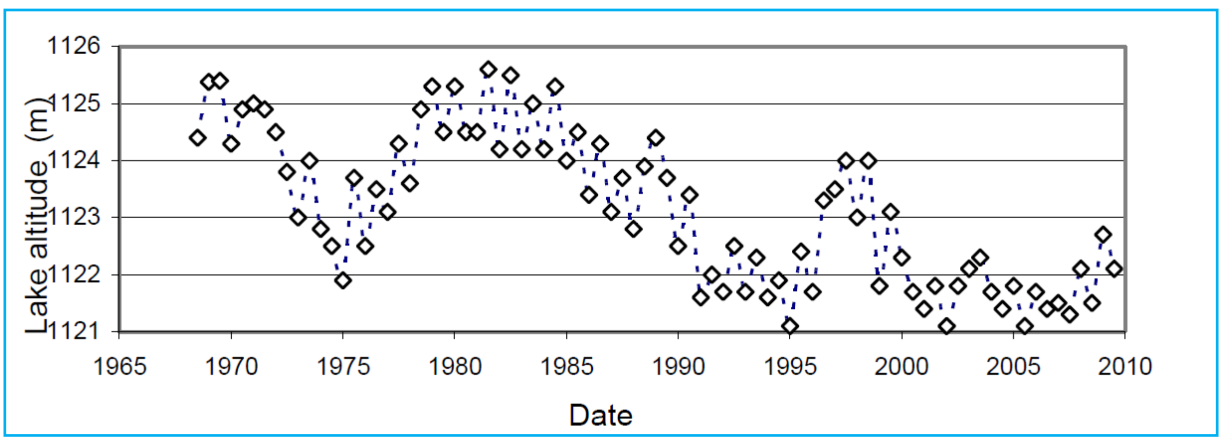
Looking at the available water supply and the water use figures, the basin's total annual utilizable water potential is about 4.3 billion $m^{3,}$ and total annual water use is about 6.5 billion m^3—meaning there is a deficit of over 2 billion m^3 in the basin's water balance sheet annually. The water budget deficit is mostly met through static groundwater reserves, and thus safe groundwater reserves have already been exploited (WWF-Turkey, 2014b).

In addition to these figures, the second largest irrigation project (after South Eastern Anatolia Project) is being implemented in the basin, namely the Konya Plain Projects (KOP). It consists of 18 projects including 14 large- and small-scale irrigation projects, 3 water supply projects, and 1 energy project. The KOP's ultimate goal is to irrigate an area of 617,923 ha across the basin; today almost half of this irrigation target has been realized. According to KOP Authority, the average income generated per hectare of irrigated land across the basin is about TL5500 (KOP Authority, 2014)[12] and the KOP Project will provide a total economic value of US$2.2 billion in irrigation, US$300 million in energy, and US$70 million in drinking water for a total contribution of US$2.57 billion to the national economy as well as generating direct employment opportunities for 100,000 people (DSİ, 2014).

As a part of this Project, 10% of Göksu River's annual flow (414 million m^3/year) is being diverted via an interbasin water transfer project to the Konya Basin to meet the increasing water demand for agriculture. Today, 88% of Basin's water resources are used in agriculture and 61% of water used for irrigation is sourced from groundwater resources (WWF-Turkey, 2010). Spring irrigation and gravity irrigation are commonly applied across the Basin, and according to Union of Konya Irrigation Cooperatives, spring irrigation and drip irrigation only comprise some 30-40% and 10% in the overall irrigation practices in the Basin respectively.

Decreasing water levels due to over-abstraction of water for irrigation is, perhaps, the Lake's most pressing problem. According to long-term statistics, the Lake's water level fluctuates between 1121.03 m and 1125.6 m altitude. However, over the course of years, the Lake's water level has fallen dramatically and today it is sometimes reduced to only 50,000 ha in dry seasons. Since the mid-2000s, relevant national and local stakeholders have been discussing ways to secure a guaranteed minimum water level for the Lake. It's important to note that, while the water level fluctuates naturally with seasonal variations of 0.5-1 m, in recent decades a long-term general trend of declining water levels has been observed due to overexploitation. There is therefore a serious risk that Beyşehir Lake may reach critical water levels in the near future as the increased demand for water and climatic change continues. Figure 6 demonstrates the Lake's changing water levels from 1965 to 2010 (Dursun, 2010).

Figure 6. Water level fluctuations of Beyşehir Lake



Source: Dursun 2010

A recent study conducted by the Department of Biology of the Middle East Technical University shows that future climate conditions will bring major changes to the hydrology and ecology of the Beyşehir Lake. The study revealed that climate models project a considerable decrease in

[12] This represents the farmers' net income from agricultural production; it does not cover direct income payments from agricultural policy.

precipitation for the near future (up to 20% reduction on an annual basis relative to the baseline period of 1981-2010), and according to the hydrological model the total water supply to Beyşehir Lake may be reduced up to 30%. Consequently, nitrogen and phosphorus loads to the Lake are projected to decrease by as much as 36% and 53%, respectively, for the near-future scenarios.[13] The samples collected from the Lake's main tributaries revealed that the highest nutrient concentrations were present in areas that have a relatively high proportion of agriculture (i.e. the northern and eastern parts of the catchment) (Beklioğlu et al., 2014).

Beyşehir Lake provides a very critical freshwater ecosystem which plays an important role in maintaining the area's ecological balance, contributing to the hydrological regime of the basin and preserving biological diversity. In that sense, over-abstraction of water for irrigating the Konya Plain results in shrinking of the Lake, which also means the loss of some of the critical ecosystem services it provides. Due to water fluctuations and decreasing water levels, shoreline vegetation is being destroyed, especially in the southern coast of the Lake and around the islands. Given the fact that wetland vegetation improves shoreline stabilization by reducing the effects erosion as well as providing a nesting and breeding ground for water birds and some fish species, decreasing water levels on Lake Beyşehir have negative impacts on the Lake's composition of birds and fish species in the long run.

Furthermore, decreasing water levels may also result in changes in the Lake's water quality parameters, such as turbidity, suspended sediment, and chlorophyll-a. According to Turkish Water Pollution and Control Regulation, suspended sediment values should not exceed 5 mg/l to control eutrophication on lakes. A study on the water quality of Beyşehir Lake in 2006 shows that the lake's suspended sediment concentrations were in compliance with this regulation, with a mean suspended sediment concentration of 4.51 mg/l. The study also shows that the highest concentrations of chlorophyll-a correspond to areas that receive untreated domestic wastewater via streams from villages in adjoining areas of the Lake, with a particular emphasis on the streams at the northern and eastern parts of the Lake (Nas et al., 2010).

Valuation context for Beyşehir Lake

Water-related goods and services in Beyşehir Lake subcatchment were identified based on the TEV framework and presented in Table 5. The study estimates the economic value of the gross benefits (annual flows) provided by the Lake during the year of reference 2015.[14]

[13] The study also shows that the concentration of the inorganic forms of nitrogen and phosphorus in Beyşehir Lake is generally very low. The TN:TP mass ratios ranged 3 to 24 in the two-year time series from within the Lake, indicating that primary production in the Lake may be alternating between being phosphorus and nitrogen limited. The sampling period was April 2010- April 2012.
[14] In other words, the study aims at estimating the individuals' total Willingness to Pay (WTP) for the benefits derived by the lake.

Table 5. TEV framework for Beyşehir Lake

Total Economic Value		Type of benefit
Use Values	Direct use values	Water supply for irrigation
		Water supply for municipal use
		Recreation
		Wildlife and plant harvesting Fishing Reed cutting
	Indirect use values	Nutrient retention
		Pollution abatement
		Flood control
		Micro-climatic stabilization
	Option values	Potential future uses of direct and indirect uses
		Future value of information of biodiversity
Non-use Values	Existence values	Biodiversity conservation
	Altruistic values	Cultural heritage
	Bequest values	Potential uses for future generations and for contemporaries of current generation

Source: the authors

Data collection was based on interviews with local authorities during field visits conducted in April-May 2016, complemented by secondary information gathered from scientific articles. Locally available information relates mostly to tangible goods, e.g. areas, yields, and local prices. However, a detailed valuation study could not be conducted due to limited time and resources for the study, which, inevitably, create a degree of uncertainty. Data, especially related to ecosystem services, is scarce and has not been collected at the catchment level. Furthermore, some data for quantifying indirect use values does not exist, and future field surveys and analyses will be needed. In these cases, some benefits were estimated by transferring unit values from other similar contexts, while others could not be estimated at all. Thus, valuation results should be considered only as ***orders of magnitude*** that underestimate the real value of these benefits.

Valuation results

This section presents the valuation methods and the results for Beyşehir Lake subcatchment. It estimates the direct use values, indirect use values and non-use values related to the Lake.

Direct use values

Water supply for irrigation. Water from Beyşehir subcatchment is largely used for irrigated agriculture. In 2015, about 347 million m^3 of water[15] has been used to irrigate 64,490 ha of agricultural land (Table 6). Around 56% of the irrigated area is located in Beyşehir subcatchment, and the rest in Çumra region.

[15] About 320 million m^3 originated from Beyşehir Lake and 27 million m^3 from the groundwater of Beyşehir sub-catchment. However, it is not possible to distinguish between the type of crops according to the irrigation source; therefore, the present valuation considers all crops irrigated with water from both the lake and groundwater from Beyşehir sub-catchment.

Table 6. Irrigated crops with water from Beyşehir Lake (2015)

Crops	Area (ha)	Yields (t/ha)	Price (TL/kg)	Agricultural revenue (TL/ha)	Net water use (m^3/ha)	Total water used (million m^3)	Water tariff (TL/ha)
	(a)	(b)	(c)	= (b) * (c)	(d)	= (a) * (d)	
Beyşehir							
Wheat	7,620	4.7	0.9	4,000	4,500	34.3	120
Barley	17,710	3.0	0.9	1,950	4,000	70.8	120
Sugarbeet	3,740	59.5	0.7	11,300	8,000	29.9	220
Fruit trees	940	31.3	0.8	24,400	6,000	5.6	360
Strawberries	470	35.6	0.8	26,700	5,000	2.4	360
Sub-total Beyşehir	***30,480***	***n.a.***	***n.a.***	***4,700***	***4,700***	***143.0***	***143***
Çumra area							
Wheat	8,250	4.9	0.9	4,200	4,500	37.1	120
Barley	7,160	4.1	0.7	2,700	4,000	28.6	120
Maize	7,750	9.6	0.6	6,100	7,000	54.2	220
Sugarbeet	9,250	77.4	0.2	14,700	8,000	74.0	220
Sunflower	1,600	4.5	0.9	3,900	6,000	9.6	140
Sub-total Çumra	***34,010***	***n.a.***	***n.a.***	***7,160***	***5,990***	***203.6***	***171***
Total	**64,490**	**n.a.**	**n.a.**	**5,990**	**5,380**	**346.6**	**158**

Sources: Turkstat, 2015 Crop Production Statistics for area and yields; 2015 Konya Commodity Exchange for crop prices; communication with Konya agricultural directorate for the net water use; communication with the Regional Directorate of DSI for water tariff; n.a. = not applicable. Note: the results may not add up exactly due to rounding.

This section estimates the economic value of water used in the two regions. Valuation is based on the residual method, also called "maximum ability to pay".[16] For each region, we estimate the costs of production unrelated to water (e.g. fertilizers, soil preparation, planting, pesticides, maintenance, rent, etc); then we subtract these costs from the agricultural revenue and ascribe the difference to the value of water. These data, obtained from simple farm budgets, are summarized in Table 7.[17] Accordingly, the economic value of water is estimated at ***TL186 million***.

Table 7. Estimated economic value of water for agriculture (million TL, 2015)

Estimated values	Beyşehir	Çumra	Total
Agricultural revenue (1)	143	243	386
Cost of production	83	150	233
- water-related costs	4	29	33
- other costs (2)	78	122	200
Economic value of water for irrigation (1 – 2)	**65**	**121**	**186**

Sources: Farm budgets per crop of irrigated lands for Çumra (Konya Provincial Directorate of Agriculture, 2015) and communication with agricultural officer of the Konya Provincial Directorate of Agriculture.

[16] An alternative way to estimate this benefit is by ascribing the difference between the unit value of irrigated and non-irrigated land to the value of water. However, applying this method could be problematic for this area, because irrigated land is covered by several crops (wheat, barley, sugarbeet, strawberries, fruit trees, etc.), while non-irrigated land is cultivated only with wheat. In this case, the difference between the revenue of an average hectare covered by several high-value added crops and that of a hectare covered by rainfed wheat could not be attributed solely to the input of water (much of the difference results from other production inputs). At the same time, the difference between the revenue of a hectare cultivated with irrigated and non-irrigated wheat would underestimate the benefit of water used for other high value crops. Because of the above limitations, this section uses the residual method to estimate the value of water for irrigated agriculture.

[17] Based on Konya Provincial Directorate of Agriculture, these farm budgets relate to the year 2015 and refer to irrigated wheat (33 farms, 2540 ha), rainfed wheat (33 farms, 2404 ha), irrigated barley (47 farms, 4767 ha), sunflower (24 farms, 1736 ha), maize (20 farms, 2058 ha) and sugar beet (56 farms, 2734 ha). The main cost items cover soil preparation, planting, fertilizers, pesticides, irrigation, maintenance, harvesting, land rent and other fixed costs.

Water supply for municipal use. Beyşehir Lake provides 11 million m^3 of water for municipal use (communication with the 7th Regional Directorate of KOSKİ). It serves 71,400 people, distributed through 42,700 subscribers; about 80% of them are households (i.e. 34,100) and the remaining are commercial establishments (i.e. 8,600). According to 7th Regional Directorate of KOSKİ in Beyşehir, water consumption is about 18 m^3/month per household. Consequently, water consumption is estimated at 7.4 million m^3 for households and 3.6 million m^3 for commercial establishments.

The tariff for municipal water is TL2.3/m^3 for households and TL3.5/m^3 for commercial establishments. However, since these are nominal values, they do not represent the society's WTP for tap water. No study estimating the economic value of municipal water has been found for the pilot area. However, the WTP for municipal water was estimated to be 85% higher than the actual water tariff in Greater Baku, Azerbaijan (AZN15.1 vs. AZN8.3/m^3) (Scandizzo and Abbasov, 2012) and about twice as much as in Bursa, Turkey (TL32 vs. TL16/m^3) (Gürlük and Ward, 2009). Assuming that the economic value for municipal water in Beyşehir is only 85% higher than its nominal value (as in Baku), it is estimated at TL4.3/m^3 for households and TL6.5/m^3 for commercial households.[18] Applying these values to the total consumption of municipal water in Beyşehir subcatchment, the economic value reaches ***TL55 million***.

Water supply for industrial use. Several small- and medium-scale industries exist in Beyşehir subcatchment related to food and fish processing, weapons and ammunition production, textile and chrome processing. The towns Huğlu and Üzümlü are well known for their rifle factories, which export 80% of Turkey's shotgun products to more than 50 countries around the world (interview with local experts). However, as no data is available related to the use of water for these industries, no estimate can be provided at this stage.

Recreation. Natural and landscape characteristics of Beyşehir Lake and the neighboring national parks (Beyşehir and Kızıldağ) provide several activities for recreation and tourism, such as bird watching, swimming, sports fishing, and water surfing. In addition, cultural and historical heritage sites make Beyşehir Lake a popular weekend destination for people living in Konya and other nearby settlements. Overall, there are about 327,900 visitors annually to Beyşehir Lake (Table 8). According to data gathered from national park management units, about 102,900 visitors have been recorded paying entrance fees in different areas. The remaining 225,000 visitors are enjoying the lake free of charge. The recreational benefit is estimated below, for both types of visitors.

Table 8. Number of visitors in different areas of Beyşehir Lake (2015)

Visitors	Karaburun beach[a]	Yakamanastır Nature Park[a]	Kızıldağ National Park	Total
- paying entrance fees	42,300	42,200	18,400	102,900
- free of charge	200,000		25,000	225,000
Total	**284,500**		**43,400**	**327,900**

Note: [a] Part of Beyşehir Lake National Park.
Source: Communications with Beyşehir Lake National Park and Kızıldağ National Park management units

[18] This is in the same range as the total WTP for potable water found in Southeastern Turkey, of TL6.4 /m3 (Bilgic et al., 2008).

(i) *Benefits for visitors paying entrance fees*. These benefits include the actual payments made by these individuals to visit the park, and the consumer surplus they enjoy on top of their actual payment. These benefits are estimated as follows:

- *Actual payments*. Considering an entrance fee of TL3/visit according to Beyşehir Lake National Park management unit, the total amount paid at the entrance is estimated at TL308,600. In addition, there are three sightseeing cruise boats in the Lake, transporting about 100 passengers/day each from mid April–mid October who have paid TL7.5/person. The revenues collected from boating activities are estimated at TL405,000. Consequently, revenues collected from entrance fees and boating amount to TL713,600.

- *Consumer surplus*. The value associated with these benefits has not been estimated for Beyşehir Lake. However, several studies have been conducted in relation to other lakes in Turkey. Examples include Kursunlu Waterfall Nature Park in Antalya province (Ortaçeşme, 2001), Great Meander Delta National Park, on the Aegean coast (Başar 2007), Lake Manyas of Kuşcenneti National Park (Gürlük and Rehber, 2008) and Tuz Lake Specially Protected Area, located within the borders of Konya Closed Basin (Demir, 2014). Among these areas, Lake Manyas of Kuşcenneti National Park provides the most similar context to that of Beyşehir Lake, as both are large inland freshwater lakes. Based on this study, the consumer surplus is estimated at about TL17.8/visit (in 2015 prices). [19] Applying this value to the number of visitors paying entrance fees (102,900), the consumer surplus is estimated at TL1.8 million.

Based on the above calculations, the recreational benefit of visitors paying entrance fees totals *TL2.5 million (1)*.

(ii) Benefits for visitors that come free of charge. Though these visitors do not pay any fees to the park, they benefit from several services such as landscape views, free picknicking and swimming. These benefits have not been estimated for Beyşehir Lake; in lack of information, we assume that they are similar with the consumer surplus estimated for the visitors that pay entrance fees, i.e. TL17.8/visit. Accordingly, the recreational benefit for visitors arriving free of charge (225,000 people) is estimated at *TL4 million (2)*.

Adding up the estimates obtained for all visitors (1 + 2), the total recreational benefit is estimated at ***TL6.5 million*** in 2015.

Fishing. Fishing is the main source of income for several settlements located around the Lake. During 2000-2015, this activity declined significantly from 2,000 licensed fishermen with a total catch of 1,400–1,600 tons (Babaoğlu, 2007) to only 680 licensed fishermen with 256 tons catch. The Lake is divided into two fishing zones: Sarkikaraagac fishing zone, located in Isparta province, and Beyşehir fishing zone, situated in Konya province. Based on data gathered from the experts at

[19] The authors applied Travel Cost Method (TCM), based on zonal approach, and conducted 300 face-to-face interviews during June-August 2004. The area was divided in 14 zones. The consumer surplus obtained for each zone has been aggregated to arrive at the total consumer surplus for the area.

Konya Provincial Directorate of Agriculture, the most common fish caught in 2015 was pikepearch (135 tons), followed by carp (105 tons) and silver crucian carp (16 tons). Local market prices are TL14/kg of pikepearch, TL12/kg of carp and TL1/kg of silver crucian carp. Accordingly, the value of fish catch is estimated at TL3.1 million. In addition, an interview with experts at Şarkikaraağaç District Directorate of Agriculture indicated that in reality the illegal (unlicensed) fish catch is at least twice the quantity of fish caught legally. Accordingly, the real value of fishing is estimated at ***TL9 million.***[20]

Reed cutting. Reed cutting was a source of income in the pilot area until 2010.[21] However, decreasing water levels and shrinking of the Lake led wild boars to infest the lands and destroy the reed beds. Nowadays, the quality of reeds does not meet the required standard for export and local people harvest them only for traditional uses such as roofing.[22] No information is available to estimate the local value of reeds extracted from around the Lake.

Indirect use values

Pollution abatement. The Lake is believed to be important in performing water purification functions. According to local water authorities, the settlements of Derbent (4,600 people), Hüyük (16,300 people), and Şarkikaraağaç (25,800 people) do not benefit from operational wastewater treatment plants, so their residents' discharge untreated wastewater in the streams flowing into Beyşehir Lake. The average discharge quantity is about 90 liters/capita/day in the region.[23] Based on the above, the total quantity of municipal wastewater discharged from these settlements amounts to 1.5 million m^3.

The pollution abatement function is estimated through the replacement cost method, assuming the cost of wastewater treatment in the area. The annual cost of advanced wastewater treatment is estimated at TL1.8/m^3 of wastewater, based on information from KOSKİ.[24] Applying this cost to the quantity of untreated municipal water discharged in streams flowing in Beyşehir, the total replacement cost is estimated as ***TL2.8 million***. Other indirect use values such as nutrient retention, flood control[25] and micro-climatic stabilization could not be estimated, due to the non-market nature of these benefits and data scarcity.

Non-use values

[20] No estimate of consumer surplus for fishing has been found. Therefore, the result underestimates the total WTP for fishing in the lake.
[21] About 150-200 people were involved in reed cutting with an average of 400,000-500,000 ties harvested annually (WWF-Turkey, 2006) in mid 2000s and almost all of them were exported to Germany, Netherlands and Belgium through intermediate sellers.
[22] General Directorate of Nature Conservation and National Parks is in charge of providing reed-cutting permission in accordance with the Wetlands Regulation, based on an interview with local experts.
[23] Communication with KOSKİ- Konya Water and Sewerage Authority
[24] This cost includes: (i) the annual O&M cost, varying from TL0.5 to TL2.5/m^3, with an average of TL1.5/m^3 (a); (ii) the annualized investment cost, estimated at TL0.3/m^3 (based on a total capital cost of TL145/capita, discharged quantity of 90 liters/capita/day, and lifetime of treatment plant of 20 years) (b). Adding up (a) and (b), the total annual cost of treatment is TL1.8/m^3.
[25] However, while the Lake's capacity to control floods was an important function in the past, it is not believed to be a significant benefit anymore: decreasing water levels and precipitation over time mean that floods are not a hazard in the pilot area.

This section estimates the value of biodiversity as a non-use value. In other words, this is the value that individuals place on the conservation of the Lake's biodiversity, even though they may never use it directly.

No CVM or CE study has been found for Beyşehir Lake estimating this value. However, Birol et al. (2006) valued non-users' WTP to conserve biodiversity in Cheimaditia Lake, a freshwater lake and Ramsar site in Greece. The authors used the CEM to account for people's preferences for biodiversity under different management scenarios. They estimated the non-users' WTP at 15.5 euro per person (2005 prices). Adjusting this estimate for Beyşehir Lake, a WTP for biodiversity is TL5/person for 2015. [26]

Beyşehir Lake is found at the border between the Konya and Isparta regions, whose population is 2.5 million people (Turkstat, 2015). By deducting the number of visitors to Beyşehir (327,900 people—see "recreation" section), the total population of "non-users" that live in close proximity to the Lake is estimated at 2.2 million. Assuming that they are willing to pay TL5/person for biodiversity conservation of Beyşehir Lake, the associated non-use values linked to biodiversity are estimated at ***TL11 million***. It should be stressed that this estimate has only indicative meaning, being based on values and assumptions from studies conducted in another country (Greece), due to a lack of specific data for the Lake.

Summary and discussion

Based on the above estimates, the TEV of Beyşehir Lake reaches TL271 million in 2015 (Table 9). Although a conservative number, it represents 13% of Beyşehir subcatchment's GDP in the same year.[27] In other words, every year the Lake provides economic benefits in the order of TL2,300 per capita in the pilot area. [28]

[26] The adjustment was done in two steps: (i) annualizing this value at a 3% discount rate; (ii) applying benefits transfer procedure, considering the GDP/capita ratio between the two countries and the consumer price index to reflect price differences between 2005 and 2015.

[27] The estimation was conducted as follows: the gross value added per capita in Konya-Karaman region was TL11,935 in 2011 (Turkstat 2015). Based on the total population of Beyşehir sub-catchment (120,000 people), the GDP of this area is estimated at TL1.43 billion in 2011. This represents 0.11% of Turkey's GDP of the same year. Considering the same ratio in the country's GDP for 2015, and knowing that Turkey's GDP is TL1,953 billion in 2015 (Turkstat 2016), the GDP of Beyşehir sub-catchment was estimated at TL2.16 billion in 2015.

[28] Obtained by dividing TL271 million by the 120,000 residents of Beyşehir sub-catchment.

Table 9. TEV components of Beyşehir Lake

TEV	Valuation method	Economic value (million TL)	Financial value [a] (million TL)
Direct use values			
Water supply for irrigation	Residual method	186	10
Water supply for municipal use	Benefits transfer (of CVM results)	55	30
Recreation	Market price and benefits transfer (of TCM results)	7	0.7
Wildlife and plant harvesting (fishing)	Market price	9	0.04
Indirect use values			
Nutrient retention		n.e.	0
Pollution abatement	Replacement cost	3	0
Flood control		n.e.	0
Micro-climatic stabilization		n.e.	0
Option values		n.e.	0
Non-use values	Benefits transfer (of CVM results)	11	0
Total		**271**	**41**
Total (% of Beyşehir's GDP)		**13%**	**2%**

Source: the authors. Notes: n.e. = not estimated; [a] estimated as actual revenues derived from water tariffs (for water supply in agriculture and municipal uses); fees collected from visitors and sales of fishing licenses.

Needless to mention that the existing estimates for Beyşehir Lake could be refined when additional data become available and additional field surveys or studies are carried out. For example, the value of water for agriculture could be improved by using results of more complex farm budgets that account not only for marketed inputs (e.g. fertilizers, harvest), but also for non-priced ones (e.g. opportunity cost of time, as is the case of unpaid labor). Estimates of other benefits could be also improved, by conducting primary surveys in the Lake's area. This is the case of the value of water for municipal use (e.g. by conducting CVM to derive the users' WTP for municipal water), the value of recreation (e.g. by performing TCM or CVM surveys that estimate the visitors' demand for recreation) and the non-use value of biodiversity (e.g. by conducting CVM or CEM, aiming at estimating non-users' WTP for the lake's biodiversity).

Despite being preliminary, the results of the quick water valuation in Beyşehir subcatchment, however, are useful to policy analysis. In absolute terms, water supply for agriculture appears to be the most important component, followed by water for municipal uses. However, this is because the quantity of water supplied for agriculture (347 million m^3) is much higher than that for municipal use (11 million m^3); in fact, the unit economic value of water allocated for municipal use[29] (TL5/m^3) is considerably greater than that for irrigation[30] (TL0.5/m^3). This result has important implications for policy in the basin.

In addition, the economic value of the Lake appears particularly significant when compared to its financial value—the latter provided by actual revenues derived from goods provided by the Lake. The gap between the two values is largely explained by the difference between the economic value of the water supply for different uses (irrigation, municipal) and its financial value. In this light, the analysis demonstrates that the economic value of water is much higher than its financial value for both municipal (TL5/m^3 vs. TL2.7/m^3 on average) and agricultural uses (TL0.5/m^3 vs. TL0.03/m^3). This result indicates that increasing tariffs could be potentially useful for water conservation in the subcatchment.

[29] Obtained by dividing the economic value of water for municipal uses (TL55 million) by the quantity supplied (11 million m^3).
[30] Obtained by dividing the economic value of water for agriculture (TL186 million) by the quantity supplied (347 million m^3).

VI. Conclusions and Recommendations

As presented in the diagnostic note of natural capital accounting prepared by the World Bank in 2014, the Turkish government is considering a set of policy issues related to WRM, ranging from assessing water's economic contribution to national growth, to tradeoffs among competing users in managing water resources, to water pricing and cost recovery, to planning and prioritizing investments to compensate or offset the loss of water due to depletion. The need for water-related policy analysis and decision-making are a strong motivation for the development and application of water valuation and accounting tools.

The economic valuation of water is a basic step in making well-informed decisions across the water sector. Government agencies, such as the MoD, TurkStat and the MoFWA, are intent on conducting valuation to better understand water resources' economic contribution to the economy, improve water accounting, and integrate water valuation in WRM processes at the river basin level.

Valuation, in particular, is a powerful tool that can be used in many ways, such as: 1) to estimate the cost of environmental degradation related to water resources in different river basins, thus helping to identify and prioritize the most important challenges related to water; 2) to estimate the costs and benefits related to alternative options for improvement, thus helping to make the best choice of investments for allocating limited water availability among different sectors; 3) to assess the benefits of different water-related ecosystems (water bodies or wetlands), thus contributing to a better understanding of their importance and the need for their conservation.

To respond to the Turkish government's interest in water policy analysis, the present study addressed the issue of the economic valuation of water by: 1) providing a comprehensive overview of methods that can be used to value water by type of use; 2) reviewing existing efforts to estimate water values at the international and national levels; and 3) demonstrating the application of some valuation methods through a case study in Turkey. The study identified the need for the following actions:

- **Nurture the political will and institutional arrangements to support the incorporation of valuation into decision-making**. High-level political will and commitment, particularly from the National Government, are fundamental to ensure that valuation is integrated into decision-making processes. Other measures are equally important, such as helping promote the coordination among stakeholders—by forming an Expert Advisory Group under the coordination of MoD comprised of experts and officials from relevant government agencies (TurkStat, MoFWA, MoEU), academia and civil society organizations, for example—in order to ensure that NCA efforts are effectively carried out inter- ministerially. The Expert Advisory Group would also explore new developments related to NCA studies at the global scale; would pioneer discussions in the country; and would help to harmonize different approaches and methodologies for Turkey.

- **Adopt NCA and valuation as supporting tools in implementing the 2030 Agenda and delivering the Sustainable Development Goals (SDGs).** The 2030 Agenda for Sustainable Development with 17 SDGs require better and more integrated information on how the economy, environment and society interact. In that sense, NCA and the SDGs are highly compatible. Both recognize the need for understanding the interactions and trade-offs between the economic, environmental and social dimensions of sustainable development. NCA can help deliver the SDGs by making explicit the links between the economy and the environment, enabling sustainable policy decisions and actions. Furthermore, NCA can also support the process of monitoring and reporting the progress on the SDGs. Turkey, one of the successful implementers of Millennium Development Goals (MDGs), is keen on implementing SDGs and improving its performance on sustainable development. MoD, as the overall coordinator of the 2030 Agenda in Turkey, is in the preparation stages of the 11th Development Plan and is updating the country's long-term vision aligned with the 2030 Agenda and SDGs. In this context, it is curical to integrate NCA and valuation efforts into Turkey's SDGs implementation roadmap and adopt these tools for delivering SDGs.

- **Carry out in-depth valuation studies, covering a wider range of water values and river basins**. In Turkey, water valuation efforts have been uneven, concentrating mostly on valuing recreation and to a lesser degree on the purification function of water bodies. Little work has been found on the value of water for irrigation and municipal use, and none on indirect use values (e.g. flood control, pollution abatement) or the costs of water degradation (i.e. impacts of water pollution and overexploitation). Moreover, the existing studies have been concentrated in a few river basins. To better understand the importance of water resources and water-related ecosystems, and to be able to prioritize and design interventions aimed at reducing problems, there is a need for a more comprehensive set of studies that would cover both **a *wider range of values*** and a ***wider range of river basins***.

- **Improve the valuation of water benefits in Beyşehir Lake subcatchment through extended data collection and site-specific studies concerning the economic value of water uses (i.e. agricultural, municipal, recreational, and biodiversity).** The TEV of Beyşehir Lake was estimated to be about TL271 million, or 13% of the Beyşehir subcatchment's GDP in 2015, with the greatest value being generated by water supply for agriculture, followed by water for municipal uses. However, the unit value of water allocated for irrigation (TL0.5/m^3) is estimated to be considerably lower than that for municipal use (TL5/m^3), even though water use by agriculture is much higher than that for municipal use. The analysis thus suggests that water allocation is inefficient. To confirm this conclusion and improve allocation, a more comprehensive assessment of the economic benefits of water resources - focusing particularly on the value of *water for irrigation, municipal use, recreation and biodiversity* - and of the trade-off between water uses and food security as well as rural development is required. A better understanding of the value of water in its various uses will help design systems that improve the total benefits of water use by improving its allocation; the allocation experiences of other countries can provide a useful starting point for such efforts.

- **Develop *national guidelines* on water valuation and accounting to facilitate future studies and scale/implement existing efforts nationwide**. These guidelines should propose a stepwise approach for practitioners at all levels and have a general context of "ecosystem valuation" with differentiated aspects of forest, water, and marine valuation. Prior to that, national circumstances (e.g., data limitations, government priorities, institutional capacity, etc.) have to be properly analyzed.

- **Establish a national water accounting system**. The fragmented structure of water management and administrative units in Turkey makes the establishment of water accounting a *challenge*. Furthermore, earlier efforts to develop water accounts remained as "pilot projects" and have not yet result in proper institutionalization. In that sense, Turkey still needs to gain experience and conduct further studies to improve its existing water accounting framework in a standardized and consistent way. Existing physical water accounts can be improved with new modules, and data should be collected beyond the current administrative boundaries, and standardized across all river basin levels. Data quality frameworks should be developed and the quality of existing water statistics should be assessed. Extra effort is needed for additional data compilation in water-related economic sectors like fisheries, energy, forestry, tourism and agriculture. Monetary accounts need to be based on the economic value of water in terms of its exploitation, depletion, and contribution to the national economy. In the end, physical and monetary water accounts will be incorporated into a national water accounting system.

- **Integrate water valuation into RBMPs**. Turkey is making concerted efforts to prepare RBMPs for 25 river basins aligned with the EU-WFD, with the main goal of reconciling economic development and ecosystem maintenance. In particular, the Turkish government prioritizes water allocation planning in some river basins where increasing conflicts exist between competing water uses. Water valuation could provide valuable knowledge in terms of the benefits from actual and alternative uses as well as the costs of degradation, thus helping to prioritize problems and find solutions for improved water management. Water valuation could also provide useful insights in designing economic instruments (subsidies, taxes, and pricing mechanisms) to increase water efficiency particularly in water stressed regions like Konya Closed Basin and in western basins where water quality is low.

In Turkey, it is particularly important to conserve water and improve its allocation among different uses. This study has demonstrated that water valuation is an important tool for improving water management at both the river basin and national levels. However, to better understand the valuation results and their policy implications in the implementation of the polluter pays principle, pricing, and full cost recovery, as well as the efficient allocation of water resources by sector (and more) further studies and consultations with stakeholders are needed.

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Annex Table

Summary of economic valuation techniques and their applicability to different water uses

Valuation method	Description	Applicability to different types of value			Examples of applications
		Direct	Indirect	Option, bequest and existence	
INDIRECT TECHNIQUES					
Residual method	Calculates the value of water as the net income after all other relevant costs are accounted for.	√			To estimate the value of water for ***irrigation*** in Jordan (Tabieh et al. 2015), China (World Bank 2007) and South Africa (Speelman et al. 2008).
Production function approach	Estimates the change in output from a unit increase in water input in a given sector.	√	√		To estimate the value of water for ***irrigation*** in **Turkey** (Tsur 2004; Gürlük and Ward 2009) and China (Liu 2007); for ***irrigation*** and ***hydro-power generation*** in **Turkey** and **Syria** (Tilmant et al. 2008); for ***irrigation***, ***municipal and environmental uses*** in **Turkey** (Gürlük and Ward 2009); for ***industrial*** uses in Poland (Stone and Whittington 1984).
Hedonic price method	Derives the value of water based on price differential paid for land with water resources	√	√		To estimate the value of water for ***irrigation*** in the United States (Petrie and Taylor 2007; Mukherjee and Schwabe 2012), **Greece** (Latinopoulos et al. 2004; Mallios et al. 2009), Iran (Esmaeili and Shahsavari 2011; Kakhki et al. 2010). To estimate the value of ***municipal water*** in Philippines (North and Griffin 1993). To estimate the impact of ***water quality*** on real estate value in Izmit Bay, **Turkey**. (Tolun et al. 2012). To estimate the ***flood risk reduction*** benefits of floodplains in the United States (Harrison et al. 2001; Schultz and Fridgen 2001)
Travel cost method	Estimates the costs incurred in reaching a recreation site as a proxy for the value of recreation.	√	√		To estimate the ***recreational value*** of wetlands in the United States (Fleming and Cook 2008; China (Chen et al. 2008); India (Nandagiri 2015), **Turkey** (Gürlük and Rehber 2008; Demir 2014; Blakemore and Williams 2008); **Romania**, Malta and **Turkey** (Blakemore et al. 2002).
Avertive expenditures	Costs incurred to prevent the effects of reduced water quality	√	√		To estimate the benefits of improved ***drinking water quality*** in Espirito State, Brazil (McConnel and Rosado 2000), South Korea (Um et al. 2002) and **Turkey** (Bilgic et al. 2008). To estimate the costs associated to groundwater contamination in the United States (Abdalla 1994) and Lebanon (Sarraf et al. 2004).

Cost of illness	Values an environmental change through its impact on illness (e.g. medicine, doctor, hospital bills)	√			To estimate the cost of ***treatment of water-borne diseases*** such as diarrhea and malnutrition in Morocco (World Bank 2016) and **Iraq** (World Bank 2012).
Alternative cost method	Estimates the cost savings from using an alternative to water (e.g. use of thermal energy instead of water to generate electricity)				To estimate the value of water for ***irrigation*** in the US (Holland and Moore 2003); for ***hydro-power*** generation in the United States (Harpman 2006) and for ***navigation*** in the United States (Gibbons 1986). Sahin et al. (2009) estimated the cost of alternative forms of transportation (road, railway, sea) in **Turkey**.
Replacement cost	Potential expenditures incurred in replacing restoring the function that is lost.		√		To estimate the value of flood plains as ***nutrient sinks*** in Germany (Dehnhardt 2015).
Market-based transactions	Derives the value of water based on transactions of water rights.	√			To estimate the value of water for ***irrigation*** based on transactions of water rights in the United States (Loomis 1992; Bunch 2004; Brown 2006) and Australia (Grafton et al. 2011). To derive the value of ***municipal water*** in the United States (Hansen et al. 2012), Australia (Grafton et al. 2011b) and Chile (Anderson et al. 2012).
DIRECT TECHNIQUES					
Contingent valuation method	It involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services.	√	√	√	To estimate the use value of ***recycled wastewater in agriculture*** in **Cyprus** (Birol et al. 2008a) and of ***irrigation water*** in Chalkidiki rural area in **Greece** (Mallios and Latinopoulos, 2001) and to value ***residential*** water use in Perth, Australia (Thomas and Syme 1988). In **Turkey**, it was used to estimate the WTP for ***irrigation water*** in Harran plain (Aydogdu 2016); for ***improved water quality*** of Beyşehir lake (Ozdemir and Baycan-Levent 2010); for ***improved water clarity in*** Izmit Bay (Tolun et al. 2012); for conservation of forest and ***river ecosystem*** in Misi area (Gürlük 2005); for estimating the ***recreational benefit*** of coastal beach near Mersin (Birdir et al. 2013), and for estimating the ***TEV of benefits*** produced by an environmental management plan for Uluabat Lake (Gürlük 2010). It has been used to estimate also non-use values, such as biodiversity conservation in wetlands in **Cyprus** (Birol et al. 2008b) and Lake Sevan in **Armenia** (Wang et al. 2004).
Choice Experiments	It asks people to make choices based on a hypothetical scenario; values are inferred from the hypothetical choices or tradeoffs that people make.	√	√	√	To estimate the WTP for different ***wetland functions***, such as flood risk reduction, biodiversity conservation and improved recreational access in Poland (Birol et al. 2009), ***biodiversity conservation*** in **Greece** (Birol et al. 2006); improved ***water quality, quantity and biodiversity conservation*** in **Cyprus** (Birol et al. 2010); WTP for improved ***electricity*** service in **North Cyprus** (Ozbafli and Jenkins 2013); and the WTP of local residents and tourists to improve ***water quality and marine life*** in Göcek Bay, **Turkey** (Can and Alp 2013).