

Interbasin Water Transfer Practices in Turkey

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Abstract

Since some watersheds do not have the potential to meet growing and conflicting water demands of socio-economic systems in Turkey, various inter-basin water transfer schemes are currently operated or under construction to meet water requirements for drinking, irrigation, industrial use, and hydroelectric power production. Transfer of water, one of the interconnected components of an ecosystem, from a given watershed to another brings along the need for a sound analysis and evaluation of environmental, social and economic issues. This opinion article explores environmental and socio-economic implications of inter-basin water transfers for sustainability of water resources as well as solutions to issues being faced in Turkey.

Keywords: Environmental implications; Socio-economic implications; Sustainability of water resources; Water demands; Water transfer

Introduction

Achieving sustainable management of water resources towards the long-term health of both ecological and economic systems of a watershed area will be the most crucial issue of the present and coming century. Finite capacity of world water resources cannot meet growing demands of global socio-economic systems (SES) without a strategy of sustainability. One of the most common solutions to the problem applied in many countries is water transfer from a water resources-rich watershed to a water resources-poor one that is rich in socio-economic infrastructure [1,2].

Inter or intrabasin water transfers can be defined as transfer of water by a ditch, canal, tunnel or pipeline from its basin of origin for use in another, or from one river to another in order to eliminate water deficit [3-6]. Water transfers can take many forms such as permanent transfer, contingent transfer/dry year options, spot market transfers, water banks, water wheeling or water exchanges, and transfer of reclaimed, conserved and surplus water. Water transfers must be integrated with both supply-side and demand-side management approaches.

The existing total volume of interbasin water transfer is about 490 km³ yr⁻¹ with 155 schemes in 26 countries. Almost half of the existing schemes (82) are located in the Americas with a total capacity of 179 km³ yr⁻¹, including 138 km³ yr⁻¹ in Canada, and 38 km³ yr⁻¹ in the USA. Asia has about 22 schemes with an existing total capacity of 181 km³ yr⁻¹, including 100 km³ yr⁻¹ in Pakistan and 38 km³ yr⁻¹ in India. Europe has 30 schemes with a total existing capacity of about 120 km³ yr⁻¹. Africa has 20 schemes with a total existing capacity of about 5 km³ yr⁻¹. In Oceania, there is only one single scheme with a limited existing capacity of 1.13 km³ yr⁻¹ [7].

Water transfer from one basin to another has various environmental and socioeconomic implications that should be analyzed and assessed carefully [8-10]. Some operational benefits of using transferred water include meeting demand directly, improving reliability and responsiveness of water systems in case of drought or flood, improving water quality, and satisfying environmental constraints [11]. Several interbasin water transfer schemes were put into practice in Turkey to meet urban, industrial and agricultural water requirements. This study explores environmental and socioeconomic implications of interbasin water transfers for sustainability of water resources as well as solutions to issues being faced in Turkey.

Quality and Quantity of Water Resources and Water Use in Turkey

Turkey has a land area of 779 452 km², with an average population density of 87 people km⁻². In Turkey, the total length of rivers is about 177 714 km, and natural and man-made lakes have the total surface areas of 203 599 ha and 179 920 ha, respectively [12]. The three seas surrounding Turkey, high mountain ranges mostly extending parallel to the coasts, and rapid variations in altitude all contribute to spatial and temporal variability of climate across Turkey. Mean annual precipitation varies from 250 mm to 2500 mm, with a long-term mean annual precipitation of 650 mm (Figure 1). This is equivalent to 501 km³ of water yr⁻¹, while annual water loss by evapotranspiration is about 274 km³ yr⁻¹. Mean annual surface runoff is about 186 km³ yr⁻¹, whereas economically and technically usable potential of surface water is 95 km³ yr⁻¹. Seepage down into groundwater is, on average, 41 km³ yr⁻¹. Out of 41 km³ yr⁻¹, 14 km³ yr⁻¹ constitutes the economically and technically usable portion. Contributions of internationally emergent rivers to surface water and its viable use potentials in Turkey are 7 km³ yr⁻¹, and 3 km³ yr⁻¹, respectively. Gross and net renewable water potentials of Turkey are 240 km³ yr⁻¹ and 112 km³ yr⁻¹, respectively [13]. Gross freshwater potential per capita in Turkey is given in Figure 2.

About 41 km³ of the net renewable water potential is being used annually. Allocation of the water use capacity is as follows: 74% agricultural irrigation, 16% for drinking and municipal uses, and 10% for industrial uses. By 2030, the amount of water used is projected to reach 72 km³ for agricultural irrigation, 18 km³ for drinking and municipal uses, and 22 km³ for industrial uses [14]. Currently, Turkey uses 36% of its net freshwater potential and is ranked in the medium-to-high water-scarce countries. By 2030, Turkey is estimated to use its full potential of freshwater and become one of the high water-scarce countries. In

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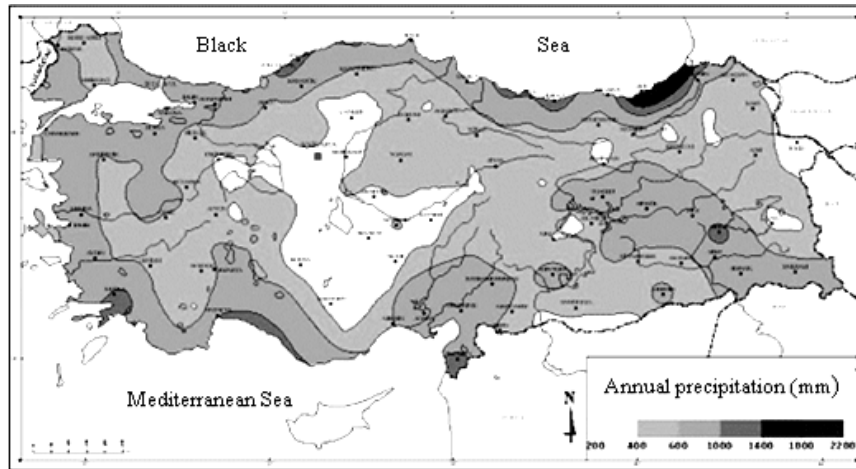


Figure 1: Geographical distributions of long-term mean annual precipitation over Turkey.

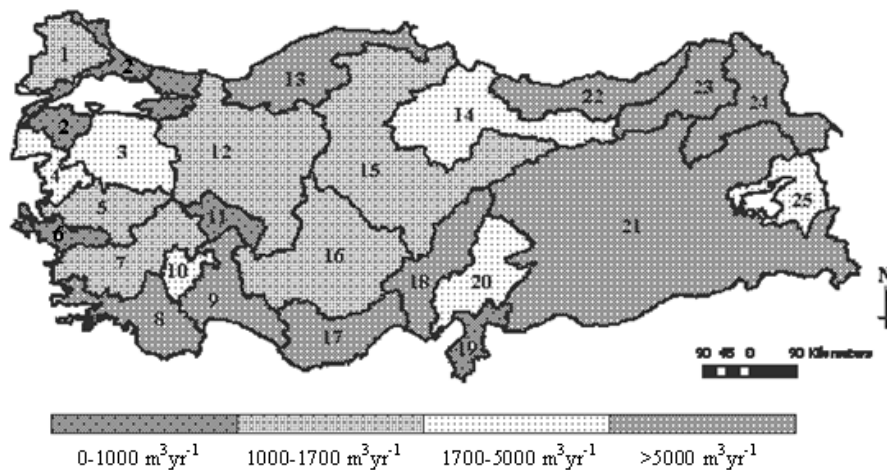


Figure 2: Gross freshwater potential per capita for the following main river basins of Turkey: 1 Meric; 2 Marmara; 3 Susurluk; 4 North Aegean; 5 Gediz; 6 Little Menderes; 7 Big Menderes; 8 West Mediterranean; 9 Antalya; 10 Burdur; 11 Akarcay; 12 Sakarya; 13 West Black Sea; 14 Yesilirmak; 15 Kizilirmak; 16 Konya; 17 South Mediterranean; 18 Seyhan; 19 Asi; 20 Ceyhan; 21 Euphrates-Tigris; 22 South Black Sea; 23 Coruh; 24 Aras; 25 Van Lake.

the calculation of per capita freshwater use potential in Turkey, only water quantity has been taken into account without any consideration of water quality. Unfortunately, municipal and industrial waste water discharges, and runoff laden with pollutants from agricultural lands cause pollution of water resources significantly at unprecedented rates, thus are restricting their current and future uses of water resources. Per capita annual water use will further decline when water quality is considered in the calculations.

Examples of water transfers schemes in Turkey

Turkey has 25 main watersheds with distinct characteristics of water potential, economy, culture, and demography (Figure 2). Since some watersheds do not have the potential to meet growing and conflicting water demands of socioeconomic systems, interbasin water transfer projects have been planned and implemented (Figure 3 and Table 1) recently for supply of water to watersheds where big cities, industries, and agricultural activities are intensely located.

Water transfer projects for Istanbul

Large-scale water transfer projects were put into practice to meet

increasing water demand in Istanbul (Figure 4). Transferring water supplies from other basins is projected to meet 70% of water demands in Istanbul whose urban population is expected to rise to over 19 million by 2040. Currently, 45% of water requirements in Istanbul are met by interbasin water transfers.

Project name	Volume of transferred (10 ⁶ m ³ /year)	Distance (km)	Purpose
Istranca Project	365	-	Domestic, Industrial
Yesilcay Project	335	60	Domestic, Industrial
Great Melen Project Total	1180	185	Domestic, Industrial
Anamur- Dragon Project	75	81	Irrigation, Domestic
Manavgat Stream Project	180	-	Irrigation, Domestic
Konya Plain Project	414	17	Irrigation, domestic
Gerede Project	230	30	Domestic, Industrial
Kizilirmak Project	300	125	Domestic, Industrial
Gembos Project	130	4	Irrigation

Table 1: Some properties of interbasin water transfer schemes in Turkey.

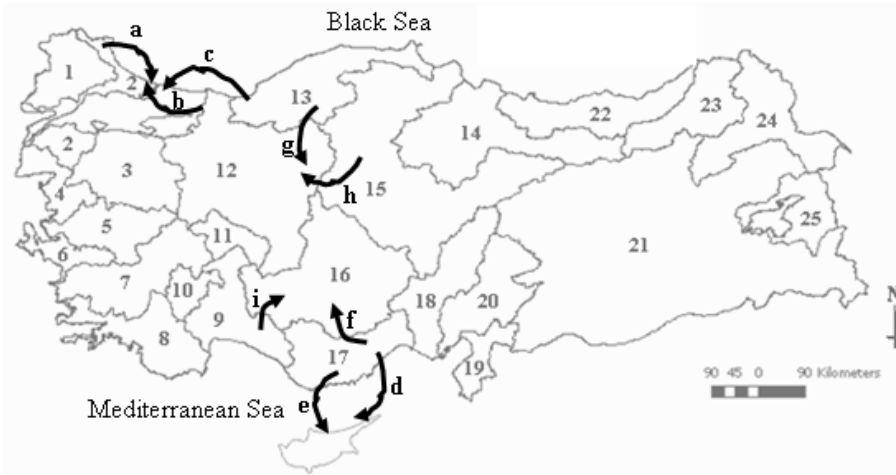


Figure 3: The major extant and planned interbasin water transfer projects schemes in Turkey. a. Istranca project; b. Yesilcay project; c. Great Melen project; d. Anamur-Dragon project; e. Manavgat stream project; f. Konya plain project; g. Gerede project; h. Kizilirmak project; i. Gembos project.

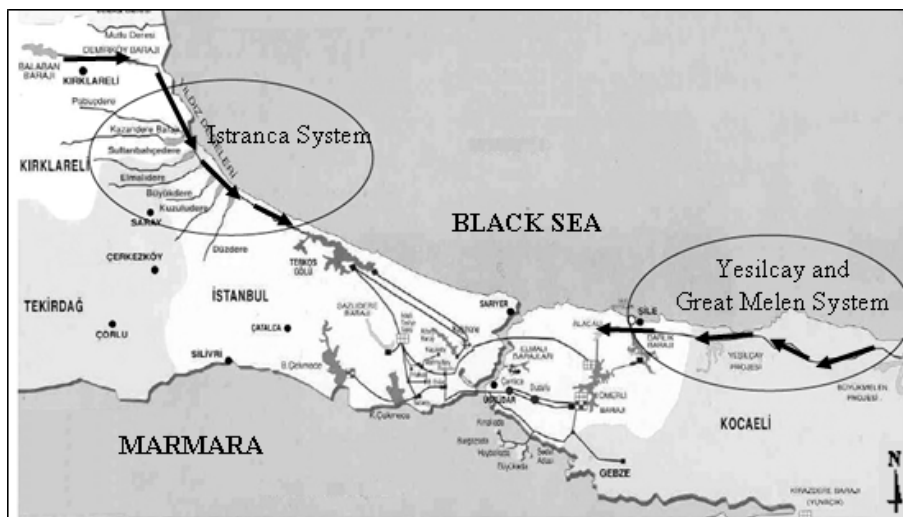


Figure 4: Interbasin water transfer schemes for Istanbul.

Istranca project: The aim of the Istranca Project is to meet water demand of Istanbul partly from Istranca streams discharged into the Black Sea. The project consisting of four stages whose first two stages are in operation will be able to transfer 280 million $m^3 yr^{-1}$ to Istanbul when fully completed [15].

Yesilcay project: In the first phase of the project, 145 million $m^3 yr^{-1}$ of water from Yesilcay stream is projected to be transferred to the supply system of drinking water for Istanbul. Total cost of the first phase is about USD 270 million. In the second phase, additional 190 million $m^3 yr^{-1}$ of water will be transferred to Istanbul through the construction of Isakoy and Sungurlu dams. When the project is fully operated, 335 million $m^3 yr^{-1}$ water will be transferred. The project will supply drinking and municipal water for an additional population of ca. 1.5 million people in Istanbul [16].

Great Melen Project: The project will transfer 268 million $m^3 yr^{-1}$ in its first stage and 1.180 billion $m^3 yr^{-1}$ in its final stage to Istanbul. The Great Melen Project will provide additional 268 million $m^3 yr^{-1}$ of drinking and municipal water by transfer line of 185 km of which 25

km is tunnel for Istanbul. The first stage of the Great Melen Project will meet drinking and municipal water demand of population of additional 2.75 million. Water diversion from Melen stream was initiated in October of 2007 due to prolonged droughts although the completion of the first stage of the project was planned by 2010. Total cost of the project is about USD 1.181 billion.

Anamur-dragon project: The aim of the Project is to transfer 75 million m^3 of water from Dragon stream in Anamur to Cyprus by a 78 km-long pipe line. 15 million m^3 of water out of the water transfer will be used for drinking, with the remaining to be used for irrigation of Meserya plain. The USD 250 million-worth project is expected to be completed in five years.

Manavgat stream project: The project was begun in April of 1992 and completed in September of 1999, with a total cost of USD 150 million. It is planned to transfer 180 million $m^3 yr^{-1}$ of water half of which will be delivered to the Middle East countries, particularly, to Israel, and partly to domestic market and the Turkish Republic of Cyprus. However, there have existed no large-scale water demands

from national and international users due to the high cost of water transfer. For example, Israel demanded 50 million $\text{m}^3 \text{yr}^{-1}$ of water and later declined its demand due to its high cost.

Konya plain project: The project is expected to transfer 414 million $\text{m}^3 \text{yr}^{-1}$ of water of the upper Goksu watershed discharging into the Mediterranean Sea to Konya watershed through three dams and a 17-km long tunnel to be built. Water to be transferred will be used for the purposes of drinking and agricultural irrigation.

Gerede project: With the aim of providing drinking water for the capital city of Ankara, the project will transfer 230 million $\text{m}^3 \text{yr}^{-1}$ of water to Camlidere dam where water will be distributed to the city through the building of Işıklı dam on Gerede stream discharging into the Black sea and a 30-km line. The project was started in 2008.

Kızılırmak project: Though planned to be implemented in 2030, Kızılırmak project is scheduled to be completed earlier than planned in 2008 due to a severe drought that took place in 2007. The project aims at meeting drinking water requirement of Ankara by transferring, on average, 167 million $\text{m}^3 \text{yr}^{-1}$ of water from Kesikköprü dam on Kızılırmak River with a 125-km pipe line. The unanticipated start of the project in 2007 without properly-conducted preliminary planning and survey has been publicly scrutinized. It was argued that water quality to be transferred was not good enough even under the possibility of its treatment by the available water treatment plant. In order for water transferred to be used, a new treatment plant is required, thus increasing the cost of water supply. Furthermore, water transfer from Kızılırmak to Ankara is claimed to decrease generation capacity of hydroelectric power by Kesikkopru dam.

Gembos project: For the purpose of meeting agricultural irrigation demand of Konya plain, water of Gembos stream discharging into the Mediterranean Sea is planned to be diverted to Lake Beyşehir, with a 4-km tunnel. With the project, water transfer was initiated in 2007, and 130 million $\text{m}^3 \text{yr}^{-1}$ of water will be, on average, transferred to Lake Beyşehir where water will be distributed to Konya plain for agricultural irrigation.

Interbasin Water Transfer-Related Issues in Turkey

Transfer of water, one of the interconnected components of an ecosystem, from a given watershed to another brings along the need for a sound analysis and evaluation of environmental, social and economic issues. Issues concerning interbasin water transfers in Turkey can be grouped under four considerations. The first two considerations involve the lack of evaluation of impacts of water transfer projects on the environmental and socioeconomic systems. The third consideration is related to the inadequate assessment of alternative technologies and resources such as recycling and reuse of municipal waste water, desalination, demand-side management, and harvest of precipitation. The last but not least important issue is the issue of water rights.

Environmental issues

The Istranca and Konya plain projects are two significant ones that illustrate the magnitude and severity of environmental issues in the face of water transfer in Turkey. The Istranca project threatens Igneada longos forest, one of the internationally significant wetlands [17]. Streams to be diverted to Istanbul in the phases III and IV of the Istranca project feed the Igneada longos forest. The Igneada Longos accommodates such ecosystem mosaics as Longos forest, calcareous peat bog and wetlands, freshwater and saltwater lakes, and sand dunes as well as such endemic and rare species as *Centaurea arenaria*, *Aurinia uechritziana*, *Salvinia*

natans, *Silene sangaria*, *Trapa natans*, and *Verbascum degenii*, also listed in Annex I of the Bern Agreement. The area is an ecologically significant habitat owing to its biodiversity, sand dune vegetation, and rich wetland flora and fauna [18]. The region is a sanctuary for 17 reptile species, 46 mammal species, 194 bird species, 28 fish species, 544 plant species, and 18 tree species.

The Konya plain project with water transfer to the Konya watershed threatens the Goksu delta, one of the internationally significant nature conservation areas listed in the Ramsar Agreement. The Goksu delta consists of many lakes and lagoons of various sizes surrounded extensively by sedgy and reedy lands, grasslands, steppes, agricultural lands, and sand dunes. The delta contains six endemic plant species and 38 endangered plant species. In the delta, 332 bird species have been identified so far. Agricultural activities and fisheries continued in the delta contribute a great deal to the well-being of the region. The delta forms a buffer zone between the sea and the agricultural lands, thus preventing the destruction of the habitats.

Socio-economic issues

With the implementation of water transfer projects, water is generally transferred from rural areas to urban areas. Socio-economic issues to be encountered due to water transfers from rural areas whose economic well-being depends on irrigated agriculture, fishery, and recreational tourism have not been investigated thoroughly. Another important consideration is the legal restrictions to human activities in the watersheds for the protection of water resources for drinking and municipal uses. Water transfers for the use of drinking alter land use and land cover in the recipient watershed, thus resulting in new economic losses or gains.

Issues concerning uses of alternative technologies and resources

Viable alternatives to water transfer in Turkey such as recycling and reuse of municipal waste water, desalination, harvest of precipitation, and demand-side management have not been explored in a detailed way. For this reason, water transfer projects have been scrutinized publicly as well as by the scientific community, particularly with demand-side management practices such as conservation, protection, and efficient use of water resources being in the center of the arguments against water transfer projects. In this context, water savings by rehabilitation of water distribution systems, and campaigns increasing public awareness about water conservation have been suggested to be put into practice first. Given the water losses from the municipal distribution systems of 550 000 $\text{m}^3 \text{day}^{-1}$ in Istanbul and 750 000 $\text{m}^3 \text{day}^{-1}$ in Ankara, objections against water transfer projects are justified. Also, campaigns about water savings and conservation with the slogan "let's not waste our water and future" conducted due to a severe drought in 2007 resulted in, on average, water savings of 250 000 $\text{m}^3 \text{day}^{-1}$ in Istanbul. Similarly, campaigns in Izmir with the slogan "Water is invaluable, so let it not flow away" led to, on average, water savings of 2 million $\text{m}^3 \text{month}^{-1}$.

The first grand-scale project of recycling and reuse of municipal waste water was issued for Istanbul to contractors in 2007, with the aim of reuse through recycling of 500 000 $\text{m}^3 \text{day}^{-1}$ (182 million $\text{m}^3 \text{yr}^{-1}$) municipal waste water for irrigation of recreational parks and gardens, and supply to industrial uses [19]. Big hotels and low-populated municipalities in resort regions tend to obtain drinking and use water from the sea. Avsa Municipality is the first one to implement such a project in 2008 with the construction of a facility to desalinate 10 000 $\text{m}^3 \text{day}^{-1}$ sea water on the island. However, big-scale desalination

projects for big cities have not been realized yet in Turkey due to their high energy costs.

Water right issues

There is no property right for water assigned to private individuals, and water resources are state-owned in Turkey. Central administration and its related institutions and establishments make public decisions about water transfers to the regions in need of water through legal rights. Along with such decisions of water transfers come conflicts and disputes regarding welfare losses and uses of natural resources both between and within the source and recipient watersheds. For example, local inhabitants around Istranca streams regard the water resources as the main attracting source for ecotourism, while Istranca streams are perceived as drinking water resources by the inhabitants of Istanbul. Similarly, the great Melen stream is of great importance to local people for agricultural activities, fishery, and tourism, while it is an important resource for the supply of drinking water for people living in Istanbul. Turkey has to also comply with the commitments made in accordance with the internationally ratified agreements and protocols such as water rights of protected aquatic organisms for survival. However, studies about water rights of endangered aquatic organisms remain to be desired.

Conclusions

With respect to interbasin water transfers, Turkey primarily faces four issues: environmental issues; socio-economic issues; water right issues; and evaluation of alternative water management practices on demand- and supply-sides. Water resources in Turkey are state-owned resources where no one can be excluded from their utilization; however, users' attitudes towards short-term maximization of their profits inevitably result in conflicts about depletion and pollution of water resources in the source basins where water are supplied from. Resulting economic losses in the source basins can be partly met through economic compensations, and/or transfer of wealth associated with use of water resources from the user basins to the source basins. Short- and long-term socio-economic implications of inter-basin water transfers vary for different basins, and integrated scientific assessments and studies are essential to devising and implementing sustainable management strategies of water resources in the process of policy- and decision-making.

Water transfers are practices commonly implemented throughout the world including Turkey. However, alternative methods to transfers (e.g., recycling and re-use of municipal waste water, desalinization, and demand-side management practices) are investigated and developed concurrently prior to making a decision on inter-basin transfers. Diversification and efficient uses of water supplies, legislative regulations, and monitoring of compliance with legislation are all inevitable components of sustainable water resource policies and managements. Recent water transfer practices show the significance of quality- and quantity-related criteria such as environmental/ecosystem water requirements, habitat quality indices for aquatic animals and principles of water use without significant water pollution and depletion of water resources in making decisions on water transfers. There are various approaches developed to quantify habitat and water quality, and ecosystem water requirements in the related literature. Legislative regulations (e.g., environmental impact assessment, wetland management, national parks, and fisheries) are available to prevent environmental issues emerging from surface water transfers (e.g., degradation and destruction of aquatic habitats) in Turkey. However, various problems spring during the implementation of legislations.

For example, although wetland protection legislation states that "water cannot be diverted from natural wetlands in such amounts that adversely change the structure and function of natural wetlands", there is no procedure described in the related legislation to estimate the amount of water than can be diverted or used from a given wetland without adversely affecting its structure and function.

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