COMPREHENSIVE WATER RESOURCES MANAGEMENT: AN ANALYSIS OF TURKISH EXPERIENCE

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Turkey's socioeconomic structure is characterized by a transition from an agriculture- to an industry-oriented economy, shifting outward and inducing a changing public sector role—from leading economic growth to supporting private sector development. The country has abundant, though unevenly distributed, water resources. Its major water sector strategies are to decrease agricultural production's dependence on climate by introducing modernized irrigation techniques and to shift energy policy from imported oil dependence to indigenous resource development, including hydropower. This paper emphasizes that allocation of water resources cannot be separated from economic considerations. Allocation policy should also be flexible to adapt to new demands. The regulation of consumption through demand management tools, such as appropriate pricing policies, has recently received greater attention in Turkey. The paper also discusses the establishment of development objectives and the identification of constraints. In the coming decades, greater emphasis will be given to water pollution control and water resources conservation, recognizing that measures to increase water use efficiency are as important as finding additional sources of water.

Water Resources Development

Socioeconomic Factors

The nation's socioeconomic structure is characterized by a transition from an agriculture- to an industry-oriented economy. The share of agriculture in total output declined from 27.6 percent in 1977 to 18.1 percent in 1990; conversely, the share of the industrial sector increased from 19.8 to 29.2 percent during that period. Turkey is also experiencing a rapid increase in urban population. The overall population growth rate is 2.4 percent, whereas the rate of urbanization is 3.6 percent and is expected to continue at that level. In response to poor economic growth in the late 1970s, the government implemented several reforms, including shifting the orientation of the economy outward and changing the role of the public sector from leading economic growth to supporting private sector development, a policy that currently encourages private investment and decentralization to regional authorities.

Water Resources

The country, with a total area of 779,452 km^2, has a continental climate, characterized by cold, rainy winters and dry summers. Average annual rainfall is 643 mm. Although Turkey has an abundance of water, it is not evenly distributed over time and space. Precipitation varies from less than 400 mm in the inland areas of central Anatolia to over 2,500 mm on the eastern Black Sea coast, where rainfall occurs throughout the year. Of an average annual runoff of 186 km^3 and a safe groundwater yield of 10 km^3, an estimated 95 km^3 and 9 km^3 of water resources, respectively, could be developed for

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consumption. Currently, total annual consumption of groundwater is 5.4 km^3; actual consumption of surface water is 25.2 km^3, about 30 percent of the potential.

Sectoral Water Use

IRRIGATION. In the 1990/94 five-year development plan, the strategy is to decrease the dependence of agricultural production on climate by introducing modernized irrigation techniques. To achieve its objectives with respect to food security and exports, Turkish agriculture needs to grow at 4 percent annually. Irrigation infrastructure is indispensable because of the uneven temporal distribution of rainfall. About 8.5 million ha of land are estimated to be economically irrigable; 1.6 million ha have already been developed, and irrigation construction is underway for another 1.3 million ha (see table 1 for present and future sectoral water use).

HYDROPOWER. Hydropower is regarded as a major national energy resource, and its development is supported. Following the oil shocks of the 1970s, the Turkish government shifted its energy strategy from dependence on imported oil to indigenous resource development, including hydropower. The share of hydropower in total energy supply has increased substantially, from 30 percent at the beginning of the 1970s to more than 40 percent recently. Turkey has substantial hydropower resources, and the General Directorate of State Hydraulic Works (DSI) and the General Directorate of Electrical Survey Administration estimate the economically viable hydropower potential at about 35,618 megawatts. Only 20 percent of this potential has been developed so far, but this figure will rise to 33 percent within the next five years after construction of large projects at Ataturk, Batman, Catalan, Gezende, and Ozluce.

WATER SUPPLY AND SEWERAGE. Turkey plans to supply sufficient, safe water to all settlements by the end of 1993 and to make significant progress in sewerage and sanitation systems. Increase in drinking water access, comparing 1980 and 1990, is shown in table 2. By the end of 1989, 56 percent of the urban population was connected to modern sewerage systems. The construction of sewage treatment plants and marine disposal units has also been initiated to prevent environmental pollution.

Institutional Arrangements

Water rights are key to institutional arrangements. Legislation and organization and the relation between them are basic components of the institutional framework: organizations function well only if empowered by legislation, which is effective only if properly implemented by appropriate organizations.

Table 1. *Water Demand, 1990-2000*
(km^3)

Use	*1990*	*1995*	*2000*
Drinking and utility	5.9	7.4	9.0
Irrigation	32.3	37.0	41.8
Industry	5.1	6.2	7.3
Total	43.3	50.6	58.1

Source: General Directorate of State Hydraulic Works.

Table 2. *Percentage of Population with Access to Drinking Water, 1980, 1990*

	1980		*1990*	
	Urban	*Rural*	*Urban*	*Rural*
Home connection	64.2	62.0	97.7	85.0
Other means	21.8	20.0	1.8	12.0
No access to water	14.0	18.0	0.5	3.0

Water Rights and Ownership

A series of water laws and legislation has been established, such as the law establishing the DSI, the Groundwater Law, Drinking Water Supply Law, Provincial Bank Law, Rural Water Supply Law, and Law of Environment. Special laws for sectoral water uses have also been issued by introducing the prior-authorization system.

The basic principle governing surface water use is that it is a public good subject to rights of prior use. According to the Turkish constitution, all surface and groundwater, except privately owned springs, belong to the government. The development of water resources, therefore, is considered the responsibility of the state. Legislation regarding groundwater use is more comprehensive than that for surface water. Generally, the DSI needs to approve both the use and extraction rate of water for different activities. Water rights can be neither sold nor transferred. If any conflicts arise among users, various customary rules and local regulations apply. If these do not help in resolving the matter, rights are settled by court decision. When a prospective user intends to divert water, however, court adjudication can be rendered almost impossible because of the difficulty in identifying prior existing rights within provincial and district jurisdictions. New laws on water rights are therefore required. With water use for hydropower and thermal energy production, special legislation has been enacted requiring prior authorization for water use.

Water Sector Organizations

The organizational structure of the water sector in Turkey is not complex because of the limited number of authorities involved. The responsibility for water resources management and nationwide water planning is centralized within the DSI, which was established under the Ministry of Public Works in 1954. Based on economic factors and emergency situations identified by the Council of Ministers, the DSI establishes priorities for development and implementation of irrigation, power generation, flood control, and river training. The responsibility for drinking water supplies in rural areas was originally given to the DSI, but was later transferred to the General Directorate of Rural Services. The DSI is the only legal authority responsible for the exploitation, use, and allocation of groundwater.

At the national level, the DSI coordinates water use in cooperation with other agencies, which must obtain prior approval from the DSI for each project they undertake. These agencies include (a) the General Directorate of Rural Services, part of the Ministry of Agriculture, Forestry and Rural Affairs, responsible for carrying out on-farm works for state irrigation schemes, developing small irrigation schemes, and supplying drinking water to rural areas; (b) the General Directorate of the Bank of Provinces (Iller Bank), under the Ministry of Public Works, providing credit to finance and implement urban infrastructure; (c) the General Directorate of Electrical Power Resources Survey, under the Ministry of Energy and Natural Resources, responsible for carrying out hydrological studies, geotechnical investigations, and mapping activities to evaluate national hydroelectric potential and also involved in the planning and design of hydropower projects; and (d) the Turkish Electrical Authority (TEK), under the

Ministry of Energy and Natural Resources, responsible for generation, transmission, and distribution of electricity. Hydropower schemes constructed by the DSI are transferred to the TEK for operation.

Human Resources Training

The current lack of experienced, qualified personnel has tended to increase the cost of projects and to reduce project efficiency. Statistical information concerning human resources training is still not available in Turkey. Policies emphasizing human resources planning and training should be developed. Experience shows that the contribution of private consulting firms to the elaboration of water development projects has been positive: policies should promote an appropriate atmosphere to encourage the creation of such firms.

Environmental Issues

Legislation and Executing Bodies

Legislation was passed in 1983 on initiating environmental impact assessment (EIA) through the Environment Act, followed by detailed regulations in 1988. The legislation has provisions concerning the establishment, location, and operation of industrial and other activities. Operating permits will be denied to those enterprises that do not have, either individually or collectively, the required waste treatment facilities. Another policy related to environmental protection is the aggregation of industries in certain areas where the impact of their activities on the environment can be minimized. Several cities have started implementing this policy through the relocation of polluting industries.

The Ministry of Environment (MOE) is the main coordinating body for environmental management, responsible for formulating environmental policies and legal arrangements. It also coordinates all environmentally related national and international activities. Central and provincial environmental commissions have also been organized and are attached to the MOE. Nine regional directorates have been established.

Key Issues in Environmental Impact Assessment

INVOLUNTARY RESETTLEMENT. Two options are available for the resettlement of people displaced as a result of land submergence by a reservoir: resettlement through government arrangements or cost compensation for property lost (in which case people are free to settle wherever they like). In both cases, the major concerns are that (a) coordination among project-implementing agencies be arranged during an early project phase; (b) there be adequate information concerning compensation for affected groups; (c) resettlement sites be carefully selected; and (d) resettlement plans be implemented by expert teams.

WATERBORNE DISEASES. These are associated particularly with irrigation projects. Proper operation and maintenance (O&M) should be carried out to prevent development of swampy areas where water is permanently spilled via broken, prefabricated flume-type canals.

ECOLOGICAL IMPACT. The preservation of low-lying delta has ecological significance. This objective often conflicts, however, with the needs of land management, such as low water tables and drainage, salinity, and alkalinity control. Reclamation for agriculture and irrigation development put pressure on these ecologically sensitive areas. For example, in the deltas of the Menderes and Gediz rivers, irrigation development reduced the flow to marshes and endangered the life of wild birds, and drainage discharge threatened marine life.

Water Quality Management

Water quality management is reflected in the Water Pollution Control Regulation of 1988. This regulation identifies four water quality classes and specifies their uses. Classification was based on extensive water quality monitoring by the DSI. The regulation also identifies protection zones around reservoirs and lakes to prevent pollution. Industrial wastewater discharges are subject to different effluent standards, depending on industry type.

The following actions need to be considered in planning: water quality networks should be expanded; an accurate inventory of pollution sources should be compiled; technical and financial support should be available for industries to establish suitable treatment facilities; and environmental legislation, including penalties, must be enforced.

Water Allocation and Pricing

Intersectoral Allocation

Intersectoral water allocation involves allocation and reallocation of water among different users, such as irrigation, hydropower, urban supply, and in-stream recreation. Water resources allocation cannot be separated from economic considerations because transfer of water from one use to another indicates adjustment in sectoral economic activities. For example, transfer of water from hydropower to irrigation will increase income in the agricultural sector; hydropower generation, however, contributes to the entire economy.

The general approach to dealing with alternative uses of water requires the identification of the objectives of all interested parties and exploration of viable alternatives. Actions can then be determined on the basis of an evaluation of gains and losses, both economic and noneconomic, for each party. For example, in the Southeastern Anatolia Project three alternatives were presented representing different development schemes in different sectors. Criteria such as incremental capital output ratio, gross regional production, foreign currency requirements, and total public investment were selected as macroindexes for comparison.

Allocation policy should also be flexible to adjust to new demands. In the Gediz and Menderes river basins, water was overallocated to irrigation. Because no provisions were made in the original allocation plan for transfer of water rights from agriculture to higher-value uses, urban development in the region led to the exploitation of marginal water resources at a high cost.

Interbasin Transfers

Interbasin water transfer is being implemented on a large scale in Turkey. For example, 1.2 billion m^3 of water will be transferred annually from the Great Melen River to Istanbul to meet the growing water demand in the capital, at a cost of US$2.8 billion (US$2.3/m^3). Such large-scale transfers will affect the social and economic conditions of the population. It is therefore important to assess all the economic, social, and ecological consequences of such diversions.

Pricing and Cost Recovery Policies

In the past, water resources development policy was almost totally dominated by supply management. The regulation of consumption through demand management tools, such as appropriate pricing policies, has recently received greater attention. The pricing approaches selected affect the distribution of income, resource allocation, and level of investment.

IRRIGATION. In Turkey, irrigation water charges reflect the cost of operating and maintaining irrigation facilities plus an amount required for the recovery of capital costs, amortized over a period not exceeding 50 years. No interest is charged. Since 1989, O&M charges have been set to recover 100 percent of the actual costs incurred in the previous year. Over the past three years, however, collections have only amounted to about 37 percent of total assessments, due to inadequate penalties for late payment. Recent legislation has proposed an increase in the penalty from a flat rate of 10 percent to a monthly charge of 7 percent for delays.

Agricultural water use is heavily subsidized, with government irrigation schemes financed by the national budget. This represents a redistribution of income from urban taxpayers to farmers. This method of transferring income from the "richer" to the "poorer" regions contributes little to equitable income distribution, because at the scheme level flat rates apply to all farmers regardless of farm size, and charges are levied on a crop area basis with different rates for different crops. This system does not lead to more efficient water use. A volumetric charging system and participation of farmers in investment decisions regarding irrigation projects should be introduced to motivate water conservation.

WATER SUPPLY. Municipal water supply charges are determined by municipal assemblies, taking into account O&M and amortization of capital costs over 30 years, and constitute part of municipal budgetary incomes. Drinking water is charged in two ways: a fixed amount regardless of consumption and a variable amount depending on consumption. Additional water charges are also made in some large cities, such as Istanbul, Ankara, and Izmir, to cover sewage disposal costs.

Comprehensive Water Resources Planning

Two major components of comprehensive water resources planning are the establishment of development objectives and the identification of constraints.

Establishment of Development Objectives

Comprehensive water resources planning should first examine national development objectives. The main objectives of the sixth five-year development plan (1990/94) are to improve income distribution under sustainable development policies, to reduce unemployment, and to eliminate interregional differences in the level of development. In addition, strategies for the water sector include developing backward areas; avoiding water pollution; and preserving historical, cultural, and archaeological areas.

Identification of Constraints

There are three basic obstacles in water resources planning and development: population growth and urbanization, financial constraints, and environmental concerns.

POPULATION GROWTH AND URBANIZATION. The growth of urban areas and the creation of an urban middle class have changed household structures and social preferences, resulting in a rapid rise in per capita water consumption. Until 1950, Turkey was predominantly an agricultural country with about 75 percent of the population living in rural areas. Since then, modern technologies and marketing have been introduced in agriculture, resulting in a massive rural migration to urban areas. Sixty percent of the population lives in urban areas, and this figure is expected to increase to 70 percent in the year 2000. In rural areas, water consumption for domestic purposes is less than 50 liters/day, whereas it has reached 200 liters/day in urban areas. This rapid growth in demand has strained water resources and has also resulted in increased water pollution from sewage.

One of the most important concerns regarding population growth is meeting present and future needs for food and fiber. The options are an increase in the cropped area, an increase in yields, or a combination of both. The response in Turkey has been an expansion in irrigated agriculture.

FINANCIAL CONSTRAINTS. Financial management of the water sector (irrigation, hydropower, water supply, and sewerage) is fundamental to the integrated management structure, with financial policies playing an important role in achieving social and resource allocation objectives. Investment in the water sector ranks third, after transportation and energy, and from 1980 to 1991 accounted on average for 11.7 percent of total public investment.

The expansion of water sector investment could be achieved by introducing private sector participation and by selling revenue-sharing bonds to the public. In the hydropower sector, the government now encourages private sector participation in electricity generation through the removal of all legal constraints. The most extensive application model of this kind is the recent "Build, Operate and Turnover" scheme, under which private investors are encouraged to finance, build, and operate a given facility for a certain period, and then to transfer it to the government. Revenue-sharing bonds and the use of the proceeds to finance other projects with revenue potential have been successfully implemented in the hydropower sector since 1984. The impact of this policy is reflected in higher rates of hydropower investment.

There is a growing need to develop a rational financial plan to support development programs. The plan should address priority investments in the water subsectors; multiyear-based investment strategies; improvement of the investment data base; and improvement of investment-planning skills.

ENVIRONMENTAL CONCERNS. Recently, serious water pollution problems have arisen in certain areas of Turkey. Major factors contributing to pollution are the lack of adequate sewage treatment and industrial waste treatment facilities, and agricultural intensification. The reuse of polluted water resources will require high expenditure and advanced technical facilities.

Technological Aspects

A series of technological development activities has been initiated, including development of a flood forecasting and warning system for all watershed areas, a research project on introducing new irrigation techniques, and a study program on increasing irrigation system efficiency. The DSI controls all files and archives for hydrometric and meteorological information. It recently inaugurated a modern, computerized data base system for meteorological and stream flow measurement. Coordination with other organizations on water resources inventory data is encouraged by the DSI to establish compatible data banks. An autonomous institute could be set up to collect, store, and process these data.

International Water Issues and Cooperation

Nearly 22 percent (608 km) of Turkey's international borders with the former Soviet Union, Greece, Syria, Bulgaria, Iraq, and Iran are formed by rivers. Several agreements have been signed between Turkey and neighboring countries concerning border watercourses. A joint boundary water commission was established with the then-Soviet Union under the terms of the 1927 treaty on the beneficial uses of boundary waters. The commission consists of four government representatives, two from each country. Another agreement was reached in 1973, in which the commission prepared a plan for the redemarcation of the west boundary of the Aras River. Also in 1973 agreement was reached on joint construction of the Arpacay Dam and the equitable allocation of regulated river flows. Since 1986, the dam has been operated by a joint technical commission.

Table 3. *Population and Water Availability Projections*

Year	*Population (millions)*	*Water (m^3/cap/year)*
1990	56.5	3,471
1995	63.3	3,096
2000	69.8	2,808
2005	76.5	2,562
2010	83.4	2,350

The Meric basin is shared by Turkey, Bulgaria, and Greece. The upstream area is located in Bulgaria. In 1950, the Turkish and Greek governments jointly authorized a master plan to develop the basin's downstream areas, without considering the activities in the upstream areas. Several flood control facilities have been implemented along the river. Lack of control over river segments located upstream in Bulgaria, however, has affected downstream activities adversely.

In 1946, Turkey and Iraq signed a protocol for the control of the waters of the Tigris and Euphrates rivers and their tributaries. A joint technical committee for the regional waters was established according to another protocol between Turkey and Iraq in 1980. Syria joined the committee in 1983. Cooperation in hydrological data exchange has been beneficial to the three riparians. Through the committee's studies, technical rules will be further developed for reasonable and equitable utilization of water resources in the Tigris-Euphrates basin.

Future Outlook

Estimates of future population growth and water availability per capita are shown in table 3. Generally, countries with annual water availability between 1,000 and 3,000 m^3 per capita have major problems during drought years. As seen from the table, water conflicts in Turkey will become increasingly acute.

Recent estimates have suggested that in the Middle East average temperatures will rise by about four degrees centigrade as a result of the greenhouse effect. This would result in greater rates of evapotranspiration and increased irrigation needs. Consequently, drought management will become more important. Measures that increase water use efficiency are as important as finding additional sources of water. Irrigation water use per hectare could be decreased by almost 30 percent by improving water management at the farm level. Sprinkler irrigation at the farm level has been introduced in Turkey and is expected to grow as a result of financial incentives. In addition, quality may become more important than quantity in determining water availability in some river basins. In the coming decades, more emphasis should be placed on water pollution control and water resources conservation.