The role of dams in development

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Abstract Dams are a major issue in sustainable management of finite water resources; they have also become the subject of vigorous public debate. This article considers them in the light of the report of the World Commission on Dams and using the example of Turkey. It is argued that economic development and population growth, particularly in arid and semi-arid regions, make plain the need for dams for hydropower and irrigation. Environmental impact assessment is essential, as are effective programmes for resettlement to avoid the impoverishment of displaced people.

Keywords Dams; development; environmental impact; hydropower; irrigation; resettlement; World Commission on Dams

Introduction

Although the amounts of water resources are enough for the entire world, the distribution of them in time and space shows uneven patterns. The water need is increasing with heavy industrial and agricultural requirements, while available water in the world remains as a fixed source. Economic growth, socio-cultural, and environmental developments are being realized following these changes. In order to achieve sustainable management of water resources, these changes have to be taken into consideration in water-related development projects.

Particularly in recent decades, rapid population growth in the world, enhancing the extension of irrigated agriculture and industrial development, has been forcing the balance of nature in terms of quality and quantity. Owing to increasing demand for different kinds of natural resources, it has begun to be realized that man can no longer follow a “use and discard” philosophy. Understanding of sustainable development of water resources covers determination and planning of demands for water resources, rational water use, comprehensive observation and assessment, effective supervision and provision of the necessary conditions for protection of related structure. Taking these into account, emphasis is given to supply water in sufficient quantity and quality at the right time and place, reallocating water according to certain priorities among sectors, conjunctive use of surface and groundwater resources and environmental factors.

Demand for water is steadily increasing throughout the world, even though the fresh water resources are limited and unevenly distributed; during the past three centuries, the amount of water withdrawn from fresh water resources has increased by a factor of 35, whereas world population has increased by a factor 8.

The engineering of dams, which provides regular water from reservoirs of dams to be used in case of demand pattern, is a vital part of the civilization. Dams have played a key role in the development since the third millennium BC when the first great civilizations evolved on major rivers, such as Tigris-Euphrates, the Nile and the Indus. From these early times dams were built for flood control, water supply, irrigation and navigation. Dams also have been built to produce power and electricity since the industrial revolution. Development priorities changed, experience accumulated with the construction and operation of dams. Although the importance of water is well known in the human life and civilization around the world, still various groups argue that expected economic benefits
are not being produced and that major environmental, economic and social costs are not being taken into account.

A dam is a structure built across a stream, river or estuary to retain water. Its purposes are to meet demands for water for human consumption, irrigation, or industry; to reduce peak discharge of flood water, to increase available water stored for generating hydroelectric power, to increase the depth of water in a river so as to improve navigation. Dams are considered as an important issue in the sustainable management of the finite water resources. Those resources are subject to increasingly competitive demands as global population growth creates tensions over the water needed to produce energy and to ensure food security. Dams store water in the reservoir during times of excess flow, so that water can be released from the reservoir during the times that natural flows are inadequate to meet the needs of water users. Dams are important because they help people have water to drink and provide water for industry, water for irrigation, water for fishing and recreation, water for hydroelectric power production, water for navigation in rivers, and other needs. Dams also serve people by reducing or preventing floods.

Environmental consequences should be recognized in a dam project and should be considered in project selection, planning and design. This means a significant advance of human development on a basis that is economically viable, socially equitable, and environmentally sustainable. Any kind of human development activities to transform the natural environment, especially large-scale infrastructure projects, require land and other immovable assets and so the involuntary displacement of peoples who are living in the project areas. For that reason “Resettlement Action Plans” should include sound rehabilitation programs for those whose assets are subject to inundation.

The WCD study states that “Dams have made a significant contribution to human development, and the benefits derived from them have been considerable.” (WCD, 2000). The last century showed a rapid increase in large dam building. According to the ICOLD (1999) definition, by 1949 about 5,000 large dams had been constructed worldwide, three quarters of them in industrialized countries. By the end of the 20th century, there were 45,000 large dams in over 150 countries. According to the same classification there are 625 large dams in Turkey. All over the world, 50% of the large dams were built mainly for irrigation. It is estimated that dams contribute to 12–16% of world food production. Almost all major dams are built for hydropower. Hydropower currently provides 19% of the world’s total electricity supply and is used in over 150 countries. Approximately 12% of large dams are designated as domestic water supply dams.

Controversy over large dams

Large dams have often been seen as an effective way of meeting water and energy needs. However, global review has emphasized the wide range of problems associated with them. Dams can provide hydropower, irrigation and flood control. These are benefits concerning development, but there are also costs to be paid in social, environmental and economic terms. Public debate has been going on between dam advocates and opponents. The breakdown in constructive dialogue between interested parties in the dam debate has had ramifications in areas ranging from the achievement of civil society consensus on sustainable development, to the availability of financing for dams and their alternatives.

• Dam reservoirs cause water losses. This is believed as mainly a result of considerable amounts of evaporation losses from the huge sizes of surface areas of reservoirs.

• Large dams are generally justified by regional and/or national macro-economic benefits while their physical impacts are locally concentrated, mostly affecting those within the confines of the river valley and along the river reaches.

• The livelihoods of many millions of people also suffer because of the downstream
effects of dams: the loss of fisheries, contaminated water, decreased amount of water, and a reduction in the fertility of farmlands and forests due to the loss of natural fertilizers and irrigation in seasonal floods. Dams also spread waterborne diseases such as malaria, leishmaniasis, and schistosomiasis.

• According to the study conducted by Ron Corso, Mead & Hunt, Inc. (1997) dams can stop regular annual floods but often fail to hold back exceptionally large floods. Because dams lead people to believe that floods are controlled, they lead to increased development of flood plains. When a large flood does come, damages caused are often greater than they would have been without the dam.

• Some scientists do not consider hydropower as clean power because of the destruction of river ecosystems and its many social impacts. Internationally, private investors in power projects are largely avoiding large dams and prefer to invest in cheaper and less risky gas-fired power plants.

However, it is a fact that developing nations are mostly located in arid and semi-arid areas. Water shortage, drought and occasional floods have regularly created serious problems for those countries. Rapidly increasing populations have forced those countries to give a top priority to the development of water resources. But, the green movement flourished in developed countries, which had completed water resources development processes, and launched some campaigns.

An example in this regard, could be given for Africa where the development of known exploitable hydroelectric potential is estimated as 1,600,000 MW. However the present total installed capacity in Africa is only 1.2 percent; 54 African countries produce a total of 53 billion kWh. By comparison, Switzerland produces 37 billion kWh and USA 310 billion kWh, which is six times more than Africa. On the other hand, by 1975, all western nations had exploited most of their river basins for hydroelectricity generation.

Furthermore, alternatives to large dams recommended in some studies as “near term solutions” are qualitatively interesting but are not realistic on an adequate scale to meet the needs of an extra 3 billion people by the year 2050. In addition to this, the social and ecological impact of these suggested alternatives are not clearly discussed for comparison.

### Need for the dams

Growing population and rising level of economic activities increase human demand for water on related services. Development, technological change and income distribution affect the level of water demand. Moreover, life-styles are changing all over the world and a direct impact of this trend is a very significant increase in water use. For these reasons, demand for water is steadily increasing throughout the world. However, freshwater resources are limited and unevenly distributed both in time and place. In addition to this, seasonal variations and climatic irregularities in flow lead to the inefficient use of river runoff, with floods and droughts causing problems at catastrophic proportions. Distribution of fresh water throughout the world is given in Figure 1.

From the beginning of human history, for almost 5,000 years, dams have served to ensure an adequate supply of water by storing water in times of surplus and releasing it in times of scarcity, thus also preventing or mitigating floods and making a significant contribution to the efficient management of finite water resources that are unevenly distributed and subject to large seasonal fluctuations. In the other words, the construction of dams in the concept of water resources management has always been considered as a basic requirement to harmonize the natural hydrological regime with the human needs for water and water related services.

Purposes to be served by such a project usually include water supply, irrigation, flood control, hydropower generation, navigation, recreation, pollution abatement, industrial
use, fish and wildlife conservation and other environmental considerations, salinity and sediment control, and recharge of groundwater. To meet these purposes, a number of dams are constructed to control and regulate the natural flows. This regulation function is obviously the main reason for creating reservoirs by constructing dams.

Water storage facilities are being constructed in Turkey as in any other country in the world, in order to utilize water resources which are not regular in terms of time and space, being aware of the fact that the total amount may be enough in any given year or long term period. Water storage facilities are also being constructed in order to prevent flood and other water damages. Dams and the reservoirs create protection for growing populations from the unpredictability and violence of river seasons. In warm regions stored floodwaters can supply enough irrigation for a year-round growing season.

Many new dams are planned for this century to address the escalating water crisis in the world, and to provide cheap and renewable energy. Most of the dam projects have not only the purpose of economic benefits, but also in these projects the socio-economic development of the local people is highly considered. In this respect, the dam projects would help prevent migration to the cities, while giving people a higher standard of living in their native areas. Additionally, in countries such as Turkey, where the semi-arid climate is highly dominant, building the reservoirs in order to use water resources in an efficient manner, for the purpose of the economic development of the country, would be highly beneficial.

In order to meet the increasing demand, Turkey, showing a rapid social and economic progress, must produce continuous high quality, reliable and economical electricity while taking into consideration all environmental effects. Development of projects by making use of the energy resources available in Turkey and making necessary investments for this purpose are therefore required. The local energy sources are mainly hydro and lignite, especially in the eastern part of the country. Turkey has a large potential for renewable energy sources. Ataturk dam was constructed on the Euphrates River in 1992. This dam will provide water for 882,000 ha irrigatable land and generate 8,900 GWh/year hydro energy.

For the production of electrical energy, hydroelectric power plants, in comparison with fossil and nuclear fuel thermal, geothermal and natural gas power plants have two significant advantages, as they can be used for peak operation as well as using a renewable resource. In terms of initial investment cost, with the exception of natural gas power plants and in some special cases, hydroelectric power plants are in a position to compete with other thermal and nuclear power plants. They are the most economically operated power plants causing very little damage to the environment.

To conclude, with respect to the regional considerations, the need for dams for development is obvious. The economy is almost entirely oriented to agriculture in most regions. The summer drought, being very long and severe, has a negative effect on the agricultural production and product variety. In order to reduce the burden of the underdeveloped
regions on the national economy, the agricultural production has to be increased. This can only be achieved with the development of the region’s land and water resources, through construction of dams.

**Purpose of large dam building**

According to the ICOLD classification, a large dam is one with a height of 15 m or more from the foundation. If dams are 5 to 15 m high and have a reservoir volume of more than three million cubic metres, they are also classified as large dams. Based on this definition, there are 45,000 large dams around the world (Figure 2). Regional distribution of large dams in the 20th century is given in Figure 3.

There are various demands for water, including irrigation; domestic uses (bathing, watering lawns and gardens, etc.); industrial uses (water used for processing, washing and cooling in facilities that manufacture products); thermoelectric power uses (water used for cooling to condense the steam that drives turbines in the generation of electric power with fossil fuels and nuclear or geothermal energy); and in stream water uses (water used for hydroelectric power generation, navigation, recreation and ecosystems).

The required domestic water supply in developed countries is 4 to 14 times more than developing countries. Freshwater withdrawal for different sectors throughout the world is shown in Figure 4.

Dams are grouped into two categories, single purpose and multipurpose. According to the study of the World Commission on Dams (WCD, 2000) conducted all over the world, most (48% approximately) dams are for irrigation and therefore contribute greatly to food production. A considerable proportion (15% approximately) of single purpose dams serve for domestic and industrial water supply. A substantially smaller number (20% approximately) generate electricity. The same study informs us that other purposes include, in
decreasing order of importance, flood control (8%), recreation (4%), inland navigation and fish farming. Besides, multi-purpose dams account for a large proportion, nearly 30 percent, of the total. It is also added that multi-purpose dams are increasingly important for regional economic development.

Nearly one-fifth of the world’s electricity is generated by dams. Dams also provide flood control, supply water to cities, and can assist river navigation. Many dams are multipurpose, providing two or more of the above benefits. Irrigation comes first in this category also, followed by flood control, hydropower, domestic and industrial water supply and recreation, then fish farming and navigation. Since the groundwater reservoirs presently tapped to provide about half of irrigation, drinking and industrial water supply are already heavily overdrawn in many parts of the world, the only large-scale solution, apart from saving water, is to increase the share of surface water from storage reservoirs.

According to the WCD study, flood control has been a particularly significant motive for dam construction and frequently its primary purpose. It will continue to be so, as long as about 40 percent of all fatalities from natural catastrophes worldwide are caused by flooding.

Compared with the main requirement of irrigation, domestic and industrial water supply, energy production and flood control, the other purposes of dams such as navigation, fisheries and tourism, improvements to the infrastructure, job creation and onsite training, are of generally minor importance, but must nevertheless not be disregarded.

Major benefits of dams
According to the study conducted by the United States Committee on Large Dams (USCOLD, 1997), living conditions of billions of people today are certainly improved by the construction of dams. Besides the essential need for potable water, industrial water supply, production of food through irrigation, energy and power production, flood control, and provision of recreational facilities are among the major benefits of dams.

The World Bank report (1998), namely “The World Bank’s Experience With Large Dams: A Preliminary Review of Impacts”, states that: “… without the exploitation of rivers, the world would be a much different place, such as a cycle of drought, floods and famines. The rivers would support fewer viable human settlements for many people in the great rivers and basins of the world.” Large dam construction around the world is given in Table 1.

Dams and hydropower generation
Almost all major dams in the world were built for hydropower. The first use of dams for hydropower was around 1890. By 1900, hundreds of large dams had been commissioned around the world. According to WCD (2000), hydropower presently provides 19% of the total electricity supply and is used in over 150 countries. It represents more than 90% of the total national electricity supply in 24 countries and over 50% in 63 countries. About a third of the countries in the world currently rely on hydropower for more than half of their electricity need. Five countries – Canada, United States, Brazil, China and Russia – account for more than half of the world’s hydropower generation.
As we are all well aware, one of the major benefits of dams is the production of hydroelectric energy. Generating clean energy of hydropower, dams contribute significantly to reduce air pollution. Hydropower is the most plentiful and most efficient renewable energy resource, contributing a considerable percentage of all renewable electric energy produced all over the world. According to study by USCOLD, the efficiency of a modern hydroelectric plant exceeds 90 percent, which is more than twice the efficiency of a thermal plant.

It is a well known fact that energy is one of the most important commodities for the satisfaction of physical needs and for providing economic development of modern society. Meanwhile energy needs are continuously growing. The demand for electric power continues to grow rapidly. The world energy market, up to date, has depended almost entirely upon the non-renewable, but low cost, fossil fuels. According to the report by the International Energy Agency, released in March 1999, energy produced by hydroelectric installations throughout the world provides approximately one-fifth of the world’s total electrical energy. Recently, new problems have evolved with the large growth of electrical energy demands. However, these are the issues of water supply for energy production and the impact of energy developments on climate and the global environment.

Hydropower is solar energy in a naturally and ideally concentrated form that can be utilized with the help of a mature and familiar technology with unsurpassed rates of efficiency and without depriving future generations in any way of raw materials or burdening them with pollutants or wastes. According to the study prepared for the Water and Sustainable Development International Conference, in March 1998, with a total annual generation of 2.1 million GWh, hydropower accounts today for 20 percent of electricity production and about 7 percent of total energy production worldwide; even at a conservative estimate, the total exploitable hydro-potential in the world amounts to at least six times as much.

Given the foreseeable depletion of fossil fuels, which presently are used to satisfy three quarters of primary energy requirements worldwide, plus the problem of the greenhouse effect and global warming, there is an urgent need to gradually replace them with methods of energy production which do not release carbon dioxide, (or airborne mercury from coal-fired plants) into the atmosphere and which draw on renewable sources of energy. In the short and medium term, however, the predominant sources of renewable energy that will permit large-scale exploitation will be biomass and hydropower, before new sources like the direct harnessing of the sun’s energy by photovoltaic cells will be ready to make a contribution of the same order of magnitude. Conventional electricity supply options include thermal (coal, oil and gas), nuclear and hydropower of different scales. These technologies currently dominate global electricity generation (thermal 62%, hydro 20%, nuclear 17% and all other 10%); use of cogeneration particularly, and geothermal and wind generation both for isolated supply and small to medium scale grid feeding applications is small but increasing on a global level.

Hydropower has a long list of positive characteristics that explain its strong support and

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of dams</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Varies from 695 to 960 depending on the source of information</td>
<td>Irrigation, multipurpose</td>
</tr>
<tr>
<td>China</td>
<td>280</td>
<td>Flood control, irrigation, hydropower including pumped storage</td>
</tr>
<tr>
<td>Turkey</td>
<td>209</td>
<td>Irrigation, hydropower, water supply</td>
</tr>
<tr>
<td>South Korea</td>
<td>132</td>
<td>Irrigation, hydropower, flood management, water supply</td>
</tr>
<tr>
<td>Japan</td>
<td>90</td>
<td>Mainly flood control</td>
</tr>
<tr>
<td>Iran</td>
<td>48 (above 60 m)</td>
<td>Irrigation, multipurpose</td>
</tr>
</tbody>
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promotion. For one thing, it is highly efficient. In addition to the power generated, the advantages of hydropower are many such as flood protection (commonly undervalued), flow regulation, multiple use and fossil fuel avoidance. The other major beneficial aspects of hydropower can be listed as following.

- Because hydropower is a domestic resource, governments and utilities in developing countries often prefer hydro generation to electricity produced from fossil fuels, which must be imported or, if the nation has its own, are valuable sources of export revenues.
- In addition, the relatively low maintenance cost and simplicity of operation associated with hydro projects are significant advantages for countries where the more complex maintenance and operating logistics of thermal plants pose serious problems.
- Although water is one of the two essential components in the production of hydroelectric energy, this is essentially a non-consumptive use as well as a non-polluting one. For example, in the production of thermal-electric energy, water is required in practically all technical stages from the boring of test wells in oil and gas exploration to the transformation of fossil and nuclear fuels into electrical energy at thermal power stations; uses which are largely consumptive and/or polluting.

**Dams and irrigation**

Dams have played a key role in the development since the third millennium BC when the first great civilizations evolved on the major rivers. Initially, only small dams were built for water supply and for irrigation. According to WCD (2000), half of the world’s large dams were built exclusively or primarily for irrigation and an estimated 30–40% of the 271 million hectares of irrigated lands worldwide rely on dams. Dams are estimated to contribute 12–16% of world food production. About 1 billion people depend on food produced by reservoir related irrigation. There is no alternative to how this food is produced.

Most dam projects not only have the objective of economic benefits, but also address the overall socio-economic development of the people in the region. The major irrigation projects, which are dependent on dam construction, often help prevent migration of rural people to the cities, giving them a higher standard of living in their native areas. Without irrigation projects, it is impossible to grow any kind of crop on most of the land in the world.

The need of food for the growing population of the world was strongly determined in the sector vision on “Water for Food and Rural Development”, at the 2nd World Water Forum which has been held in The Hague, The Netherlands, in 2000. According to this vision, it is expected that during the coming 25 years, duplication in food production will have to be achieved to feed the world’s still growing population. Most of the increase in food production will have to be realized in the developing countries. The increase in food production is expected to imply an increase in withdrawals for irrigation of 15–20% under the assumption of significant increase in water use efficiency.

Water scarcity affects many countries of the world. Thousands of dams have still to be built to store water and make it available, during the first half of this century, on a worldwide basis, especially in the developing countries.

The increasing demands of growing population, the pace of urbanization and the urgent need to improve the standard and quality of life of the rural population is forcing the countries to develop their water resources to meet their growing food demand. While the developed world has thousands of dams, some developing countries have only a few of them. Developed countries have completed building their dams almost two decades ago. Some developing countries have built a large number of dams but are considering the need to build additional dams, because their populations, and hence the needs, are still growing and because they could not build them in the past with the requisite speed due to relatively weak economies and population pressure.
Social and environmental considerations

Social and environmental issues have, for the last two decades, been among the concerns in dam-related decision-making activities. Following the United Nations Conference on the Human Environment held in Stockholm in 1972, the World Bank adopted its first dam-related policy in 1977 (on dam safety). During the 1980s the Bank developed policies and guidelines that focused on the social and environmental dimensions of dams and water resources. Environmental Impact Assessment (EIA) was adopted and formalized in many countries during the 1980s, although many developing countries only approved EIA legislation in the 1990s. EIA has become the major tool for addressing social and environmental impacts.

The 1992 Earth Summit in Rio de Janeiro, Brazil established the critical link for all countries between a healthy environment and economic development. Subsequently, 177 countries in the world have accepted and approved the Biodiversity Convention.

Understanding, protecting and restoring ecosystems at river basin level is essential for faster equitable human development and the welfare of all species. Option assessment and decision-making around river development gives high priority to the avoidance of impacts, followed by the minimization and mitigation of harm to the health and integrity of the river system. Avoiding impacts through good site selection and project design is a priority. Releasing tailor-made environmental flows can help maintain downstream ecosystems and the communities that depend on them.

The underlying intent of the Environmental Impact Assessment (EIA) process is to produce better decisions by ensuring informed decisions. During the development of the projects, EIA studies should be done early in the planning process. Project planners should consider environmental impacts along with economic and engineering criteria when making choices among alternatives, and decision-makers can do the same when deciding which projects to implement. Consultants and agencies involved in planning should focus on ecosystem, social and health issues at the same time that economic and technical studies for options assessment begin. Planning teams should explicitly incorporate ecosystem, health, social and economic findings in the final choice of project through multi-criteria analysis.

The EIA process identifies ways of improving projects environmentally, by preventing, minimizing, mitigating, or compensating for adverse impacts. EIA allows project designers to address environmental issues in a timely and cost effective fashion. Means to avoid or minimize impacts can be incorporated into project design, or alternatives to the proposed project can be considered. Identifying and resolving environmental issues in the planning stage can reduce project cost by avoiding delays in implementation due to unanticipated environmental problems. The EIA process also provides a mechanism for interagency coordination on environmental issues and for addressing the concerns of affected groups and non-governmental organizations. The EIA regulation was issued in 1993 in Turkey. In this regulation, the purpose of the EIA process is stated as:

• To determine and evaluate positive and negative environmental impacts of proposed public and private activities;
• To find out the environmentally sound alternatives and,
• To mitigate adverse impacts from the environmental and social point of view.

EIA reports have been prepared for dam projects since that EIA regulation was enacted in 1993. Additionally, with financial support from the United Nations Food and Agriculture Organization (FAO) “Environmental Impact Assessment Guidelines For Water Development Projects in Turkey” was prepared by national and international experts in 1994.

Resettlement and expropriation

The rapidly growing world population, rising level of economic activities, and a steady change in life-style have a direct impact on a very significant increase in water demand. The
economic activities in the world have grown five times since 1950 at a rate of about 4% per year. So, the governments of the developing world are under enormous pressure to develop their water resources potential by constructing dams on rivers and their tributaries.

Many people have benefited from the services of large dams, while their construction and operation have led to some negative social and human impacts. The adversely affected population includes directly displaced families and host communities where families are resettled. It is denoted by Professor Michael M. Cornea (Senior Sociologist Adviser, The World Bank, Washington DC) that the “Resettlement plan should support the settlers’ social and cultural institutions and rely on them as much as possible, while the initiative of settlers for self help should be encouraged through incentive programs.” According to the world wide experience of Professor Cornea, impoverishment of displaced people is the central risk in involuntary population resettlement caused by development projects. To counter this central risk, protecting and reconstructing displaced peoples’ livelihoods is the central requirement for equitable resettlement programs.

Resettlement action plans should include all the families affected by the project construction because planning provides many benefits. New settlements can be created without destroying the environment. The human considerations are usually the most important, and these considerations involve not only the resettled population but also the host population.

According to WCD (2000), the findings and lessons with regard to social performance of large dams show that 40–80 million people were physically displaced by dams, while 60% of the world’s rivers have been affected by dams and diversions. Many of the displaced were not recognized and therefore were not resettled or compensated, and the compensation provided was inadequate.

In the case of Turkey, involuntary resettlement is regulated by two main laws:

1. The Expropriation Law,
2. The Resettlement Law.

The public agency that executes expropriation carries full responsibility for the task, and expropriation is solely undertaken for public benefit. It is necessary to create satisfactory policies and procedures in order to eliminate the adverse effects of relocation and resettlement both on people and the national economy. These effects are not only economic, but social, cultural, psychological and environmental as well. For this reason the approach to resettlement concepts should deal with these issues in an integrated manner. To ensure that resettlement takes place in a well planned way, and to minimize its adverse affects, it is necessary for people, NGOs and institutions who run the country and make decisions to define their goals, policies and strategies for resettlement and rehabilitation.

From the experience obtained by the previous projects, it has been found that around 25% of the affected families choose government-assisted resettlement. The remaining 75% of affected families prefer self-resettlement rather than government resettlement because they receive sufficient expropriation compensation to afford their own resettlement cost.

The contribution of dams to Turkey’s economy

Water resources development
Owing to considerable variation observed in the runoff in terms of seasons, years, and regions, it is absolutely necessary to have water storage on the major rivers in Turkey in order to ensure the use of the water when it is necessary. Consequently, for these reasons, priority has always been given to the construction of water storage facilities; significant progress was registered in the construction of dams throughout the 47 years elapsed since the establishment of the State Hydraulic Works (DSI).

With the project developed primarily by DSI and other institutions engaged in water resources development, actual water consumption in Turkey as of the year 2000 reached
39.3 km³, which corresponds to only 36% of the economically exploitable water potential, of which 29.3 km³ (75%) has been for irrigation, 5.8 km³ (15%) for domestic uses, and 4.2 km³ (10%) for industrial uses (Figure 5).

In 2001 fiscal year, 26% of the Government’s investment budget, which amounts to 690 million US$, was allocated to DSI. In order to determine its long term objective and revise its action plan to be performed till 2010, DSI has developed “The Long Term DSI’s Strategies and 2010 Action Plan”. In this plan, full development of the water potential of Turkey is aimed at by 2030. In order to achieve this goal it has been determined that a total of 60 billion US$ investment is needed.

**Contribution of irrigation to the economy**

As of 2000, the total irrigation area developed mainly by DSI and other related organizations reached 4.8 million hectares corresponding to 56% of the total 8.5 million hectares economically irrigatable area.

Irrigation contributes to Turkey’s socio-economic development to a great extent. Increase in yield under irrigated conditions is more than three times under dry conditions. The Gross Value Added (GVA) of 1 m³ water supplied to irrigation corresponds to 0.21 US$. So, the total water amount of 29.3 km³, supplied to irrigation in the year 2000, provided the GVA of 6.15 billion US$ for the economy. It has the maximum share in employment. So, irrigation provides direct and/or indirect job opportunities extensively. Roughly one third of the total population of the country still lives in the villages and irrigation is the unique job creation option for more than 22 million farmers. It also gives acceleration to industry which is based on agricultural products.

**Contribution of hydroelectric generation to the economy**

In parallel with economic development and industrialization in Turkey, a considerable rise is observed in the use of electricity. Use of electrical energy rose from 23,275 GWh in 1980 to 116,440 GWh in 2000, indicating an increase of 500% in 20 years. Despite this increase; per capita electricity consumption is 1,735 kWh, which is far less than the average consumption of 5,000 kWh for the developed countries. So far in Turkey, for the purpose of hydroelectric energy generation, 546 HPP’s (Hydro-Electric Power Plants) have been developed at various levels. As of the year 2000, 125 HPP’s have been taken into the operation, 36 HPP’s are under construction, and the other 385 HPP’s are considered at the various project stages.

According to studies carried out until 2001, the exploitable hydroelectric energy of Turkey has been determined as 125,328 GWh/year. As of 2000 hydroelectric energy generation is 42,216 GWh /year. This figure indicates that only 34% of the exploitable hydroelectric energy has been developed.

During the determination of the contribution of hydroelectric energy to the economy, it
has to be taken into consideration that hydropower has an important technical characteristic in absolute flexibility which enables it to adapt in a continuous form to variations in demand. HPP’s are arranging the frequency and power at the same time and providing the rolling load necessary that compensates for the defects that could occur in other power stations of the system.

Taking into account the above mentioned issues, it is estimated that the productivity of hydroelectric energy per kWh is about 0.09 US$. So, the contribution of hydro energy to the economy amounts to 3.80 billion US$ per year. When 60% of this economic value is accepted as GVA, the contribution provided by hydroelectric to the GVA amounts to 2.28 billion US$ per year.

**Contribution of domestic and industrial water uses to the economy**

DSI is responsible for the development of domestic and industrial water supply projects for cities having a population of more than 100,000. So far, DSI has developed water supply projects for 15 cities and provided 1.931 km³/year of domestic water. With projects under construction for another 22 cities, 0.854 km³ water will also be provided in the near future.

The unit price of domestic water varies between 0.50 to 1.25 US$ for various parts of the country and in some cities. So, it can be estimated that the price for domestic water supply is 0.75 US$/m³, the economic amount of 5.8 km³/year is to say some 4.35 billion US$ per year. When 70% of this benefit is taken as GVA, the contribution provided from domestic water is determined as 3.05 billion US$.

The actual utilization of industrial water, as of 2000, reached 4.2 km³/year. Values of the productivity of water in several industrial sectors differs from 1.00 to 2.0 US$/m³. It can be estimated that the unit price for industrial water is 1.50 US$/m³ for 4.2 km³/year, that is to say some 6.30 billion US$. When 70% of this economic value is accepted as GVA, the contribution provided from industrial water is determined as 4.41 billion US$.

Total gross value added by sectors is given in Figure 6.

**References**


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