The Atatürk Dam project in south-east Turkey: changes in objectives and planning over time

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Abstract

The Atatürk Dam was constructed on the Euphrates River in Turkey in the 1980s as the central component of a large-scale regional development project for the South-eastern Anatolia region, known as GAP. Since the first development plan for the region was presented in 1970, the objectives for regional development have changed significantly.

This article aims to analyze how the functions, design, and capacities of the Atatürk Dam project have been modified since 1970, paralleling changes in the regional development objectives and ambitions, and to identify accomplishments and constraints in the realization of the dam project.

Since 1970, ambitions to develop the region have grown significantly, resulting in major changes to the original project plans. The most important change occurred in 1978, when the design for the Middle Karababa Dam, recommended in 1970, was abandoned and the Atatürk Dam design was adopted. This change considerably increased the storage and power generation capacities of the dam. Yet, the sparse rainfall throughout the catchment in recent years has hampered full utilization of the dam’s storage and generation capacities and increased the need for tradeoffs between conflicting demands for water use.

Keywords: Atatürk Dam; Regional development; Euphrates River; Planning; Southeastern Anatolia Project

1. Introduction

Large dam projects are implemented for various reasons, for example to store water for irrigation, industrial, and municipal uses and to generate hydroelectricity. In developing countries, multipurpose dams are often also planned as central components of regional development projects.

The objectives and ambitions for regional development may change considerably over time. Changes to the overall development plan could be driven, for example, by increased national demands, improved financial and technological capabilities, greater expectations of possible outcomes, or by the adoption of new principles for development. Reformulation of the development plan may, in turn, promote changes to the character of the involved infrastructural projects, both during the planning phase and after construction.

A dam project may not necessarily reflect changes in the political objectives and ambitions of regional development through, for example, adjustments to its design, functions, or operational schedule. Also, unforeseen factors may constrain the realization of the intended functions of a dam project, such as unfavourable hydroclimatic conditions in the river catchment, increased demands from competing water uses, or the need to consider the water demands of downstream riparian states.

The Atatürk Dam project in the semi-arid south-east Turkey is an example of a large multipurpose dam project that has been implemented as part of a large-scale regional development plan. The regional development project is known as the South-eastern Anatolia Project or GAP1 and encompasses the South-eastern Anatolia region in the upper part of the Euphrates-Tigris river basin (see Fig. 1). The Atatürk Dam is the most important component of GAP. It was constructed on the mainstream of the Euphrates River between 1983 and 1990 (GAP-RDA, 1997b), primarily for water storage and hydropower generation. The Atatürk Dam has an important role to play in the development process anticipated for the region. Also, it constitutes a significant national energy source, with the greatest power generation capacity of all hydropower dams in Turkey (Harmancioglu et al., 1990). The dam has a height of 169m and a total storage capacity of 48.7 million m\(^3\), which make it the 20th largest reservoir in the world (Gleick, 1993).

1 GAP is the Turkish acronym for Güneydoğu Anadolu Projesi.
The first detailed plans for development of hydropower and irrigated agriculture in the South-eastern Anatolia region were presented in 1970 by the Turkish State Hydraulic Works (DSI). The plans encompassed a series of four dams on the lower reaches of the Turkish Euphrates River and irrigation schemes for the surrounding plains (DSI, 1970d). Between 1970 and 1995, the ambitions and consequently the plans for the region gradually expanded. Since 1990, GAP encompasses plans for the construction of 22 dams, 19 hydropower plants, and an extensive irrigation network to cover almost 1.7 million ha of agricultural land, as well as projects in the health, education, finance, and transportation sectors (SPO, 1990b). The ultimate aim is to transform the region from a traditional agrarian society to a modernized society based on large-scale irrigated agriculture and export oriented agro-industries (PMU/SPO, 1988a).

Over the same thirty year span, significant changes have also been made to the planned hydropower and irrigation projects for the region. Not least the Atatürk Dam project has been revised in terms of design and functions. Since it was first proposed in 1970, then called the Karababa Dam (with three alternative designs), the role of the Atatürk Dam project in GAP and Turkey has also changed noticeably.

The literature and international dam debate has tended to focus on adverse social and environmental impacts of large dam projects (e.g. World Commission on Dams, 2000; Rosenberg et al., 1997). Meanwhile, relatively little attention has so far been given to the fact that large dam projects may undergo significant changes over time, for example in response to changes in regional development plans. Similarly, the possibility that unforeseen future events may constrain the ability to utilize the dam for its intended functions has not been seriously debated either. With the emergence of new issues on the international agenda, such as the principles of sustainable development, decision makers and planners are faced with new possibilities as well as challenges. However, the way, and the extent to which, dam projects are adjusted to match new development ambitions depends on many factors and tends to reflect the priorities of the decision makers.

The purpose of this article is to analyze how the functions, design, and capacity of the Karababa/Atatürk Dam project have been modified since 1970, paralleling changes in the overall development objectives and ambitions for the region. The article will also identify accomplishments and constraints towards the realization of the dam project. The study is based mainly on Turkish official documents, archive material, interviews, and field observations made in 1998 and 1999.
2. Change in regional development objectives over time

2.1 Recognition of development potentials in the Euphrates River basin

The potential to develop the Euphrates and Tigris river basins for hydroelectricity generation was recognized in the 1920s by Mustafa Kemal Atatürk, the founder of the modern Turkish Republic. Modernizing Turkey required increased supply of electricity (GAP-RDA, 1997a). Following a number of surveys initiated in 1958, two detailed reconnaissance reports were presented in the mid-1960s on the potential for irrigation and energy production in the Euphrates River basin (GAP-RDA, 1997a).

At the end of the 1960s, the Government of Turkey saw the possibility of making use of the water and land resources in the South-eastern Anatolia region on a grander scale. Based on a contract signed in 1968 between the DSI and a joint venture of consulting firms (DSI, 1970b), a study was undertaken for the development of the water resources of the lower Euphrates basin to generate hydroelectricity and irrigate arable lands. The study covered the river segment between the present sites of the Kebar and Atatürk dams (DSI, 1970e).

In 1969, an interim report was submitted to the DSI by the joint venture (DSI, 1970c), evaluating 22 different combinations of four mainstream dams of alternative heights and various irrigation schemes. The consultants recommended a scheme consisting of Karakaya, Low Gökköy, and Middle Karababa dams and power stations, the Bedir Dam on a tributary river, and two pumping plants for irrigation diversions from the Middle Karababa reservoir. The final report, submitted in 1970, presented the recommended scheme for the lower Euphrates River, called the Lower Firat (Euphrates) Project. This was the only detailed plan for the development of the South-eastern Anatolia region in existence at the time.

2.2 The Lower Firat Project

The Lower Firat Project was planned as a multipurpose project for irrigation and hydropower development (DSI, 1970d). The project was justified on the basis of five national concerns (DSI, 1970d, f).

Firstly, the project was planned as a means to meet Turkey’s future requirements for agricultural production. Production was projected to increase by more than 4%/year for the foreseeable future (DSI, 1970d). Because essentially all arable rain-fed land in Turkey was already under cultivation, any production increase would have to be achieved through modern technology and irrigation. At the time, the lower Euphrates basin was the largest non-irrigated agricultural area in Turkey, encompassing about 20% of all potentially irrigable land in the country. The planned irrigation schemes were supposed to make possible a 30-fold increase in agricultural productivity (DSI, 1970a).

Secondly, the project would make the region contribute materially to national economic growth (DSI, 1970d). At the time, other economically more developed regions in Turkey heavily subsidized the region both directly and indirectly. Irrigation development would transform the region from an unproductive frontier region into an important wealth-producing national asset (DSI, 1970d). Irrigation was expected to generate more indirect benefits than any other kind of development in the region. Also, developing irrigation would exploit “the only significant resources of the region — land, water, climate, and people”. Water use for irrigation would therefore be given first priority (DSI, 1970d).

Thirdly, construction of mainstream dams exclusively for irrigation purposes was expected to be difficult to justify (DSI, 1970d). Therefore, the dam projects would also “create attractive opportunities for developing low-cost hydroelectric energy” (DSI, 1970d). The hydropower plants would enable an extension of the interconnected energy system in Turkey and thereby add to national energy supplies (DSI, 1970e). The national need for electricity was high: as much as 60% of the Turkish population was without electricity and national per capita consumption was approximately one-tenth of that of Western Europe. About 86% of the national electricity demand came from the more populated and industrialized western part of the country. Whereas in the south-western and northern Turkish provinces, water resources were relatively restricted and partly exploited, in the eastern provinces, they were much more abundant, especially in the Euphrates River basin. The Lower Firat Project would involve the transmission of large amounts of power from the eastern to the western parts of the country, mainly to Istanbul, Ankara, and Izmir (DSI, 1970e).

Fourthly, the project would enable Turkey to claim its riparian rights to the flow of the Euphrates for beneficial uses, i.e. large-scale irrigation. At the time, no water treaty existed among the riparian countries that could regulate the use of the river. According to DSI (1970d), “In the absence of a water treaty among riparian interests, precedence of beneficial use becomes an important criterion in the adjudication of water rights”.

Lastly, the project would also benefit the region’s economy. The regional economy, almost entirely based on agriculture, was “stagnant and deteriorating”, because population growth in the region absorbed any small increases in agricultural productivity that were achieved (DSI, 1970d).

2.3 GAP as a water and land resources project

In 1977, the decision was taken to merge the Lower Firat Project with other plans for hydropower and agricultural development in the basins of the Euphrates and Tigris rivers into an overall package, named Gineydogu Anadolu Projesi or GAP (GAP-RDA, n.d.). In 1980, GAP was presented as a package of 13 related projects for hydropower

Underlying the formulation of GAP was the Turkish Government’s ambition to make maximum use of the great potential for hydropower and irrigated agriculture in the South-eastern Anatolia region recognized in the early 1970s. Since 1975, the national electricity supply had fallen short of meeting domestic demand, which had increased, particularly in western Turkey, as a result of rapidly growing industries and expanding urban areas (SPO, 1988b). Moreover, the leap in world petroleum prices during the 1970s promoted a revision of the initial energy and pumping projects in Turkey (Kolars and Mitchell, 1991). The region was perceived to provide favourable locations for additional hydropower plants.

2.4 Turning GAP into an integrated multi-sectoral development project

In the 1980s, Turkey decided to reformulate the GAP concept into “an integrated multi-sectoral development project” (Unver, 1997). Development of the region would involve not only irrigated agriculture and hydropower generation but also related sectors, including industry, infrastructure, transportation, education, health, and social sectors.

An important reason for revising the GAP plans was the long-standing political ambition to reduce prevailing interregional socio-economic disparities in Turkey (Weiker, 1981). At the end of the 1970s, these imbalances had been increasingly debated (Weiker, 1981). The Fourth Five Year Development Plan for 1978–83 identified certain “priority provinces in development”, mainly in the eastern and south-eastern regions of Turkey, which were significantly less developed and making slow progress. It was decided that national resources would be allocated specifically to these, for the development of infrastructure, industries, and service sectors (GAP-RDA, UNDP, 1997). Also, these regional imbalances caused large-scale internal migration from the eastern provinces to the urban areas in the west (Weiker, 1981). This not only created problems in the west but also drained the eastern provinces of their younger and more educated groups. In addition, the growing consciousness among the eastern residents of the prevailing inter-regional inequalities created a risk for political unrest and uprising in many eastern provinces (Weiker, 1981).

A multi-sectoral development approach would also ensure a more rapid socio-economic development process (GAP-RDA, n.d.). By simultaneously developing the region’s infrastructure, service sectors, and general working conditions for the construction workers, the dam projects could be implemented in a more timely and cost-effective manner. Also, integration of the physical, economic, and socio-cultural aspects of GAP would better justify the high cost of the physical investments and would maximize the contribution of GAP to national development, according to PMU/SPO (1988b).

2.5 Regional development objectives according to the GAP Master Plan

In 1987, the GAP Master Plan study was initiated with the purpose of formulating the new objectives, strategies, and timetables of GAP (SPO, 1990a). The study was completed in 1989 (the English version in 1990), preceded by a series of working papers.

The Master Plan officially recognized a number of development problems in the South-eastern Anatolia region (SPO, 1990b). The region was seen to experience low levels of education, income, and health services, and high migration rates from rural areas to larger cities within and outside the region. The Plan also recognized a distortion of land distribution and ownership, lack of proper planning and management for resource utilization, unfavourable climatic and topographic conditions, and low soil productivity. Against this background, the Master Plan has formulated the development objectives and strategies of GAP (SPO, 1990a,b). The Plan has formed the basis for GAP implementation during the 1990s and will be used until the completion of a revised and updated Plan in late 2001, referred to as the GAP Regional Development Plan (Anadolu Agency, 2001). In the Master Plan, four main objectives and strategies for regional development can be discerned:

Firstly, GAP aims to reduce socio-economic disparities between the region and the rest of Turkey (SPO, 1990b). Improvements in regional socio-economic conditions and social welfare fundamentally depend on the development of agriculture and related industries. The traditional agricultural system will be modernized through the adoption of modern irrigation technologies, mechanized farming practices, and a diversified crop pattern oriented towards cash crops. Agro-related industries will be established to process the agricultural products and to supply agricultural inputs. The Master Plan also envisages an expansion of the livestock, fishery and forestry sectors, and the development of various industries and service sectors, such as the manufacturing industry and the engineering, trade, banking, and finance sectors. These developments, in turn, are expected to lead to improved employment opportunities in high-paying jobs, increased average income levels, and the immigration of outside technical and administrative staff to the region, thus stimulating further socio-economic development (SPO, 1990b).

Secondly, GAP aims to increase the region’s contribution to the country’s economic growth and export earnings (SPO, 1990b). The region will be transformed into an open export base from which agricultural and related products will be sent to domestic and international markets. The success of the export industry will depend on agricultural diversification into exportable cash crops, development of related industries and the generation of hydropower.

Thirdly, GAP aims to increase socio-political stability in the region (SPO, 1990b), where the population is mainly of Kurdish origin (TDN, 2001a). Through improved social
welfare, the Government hopes to discourage separatism and to ‘harmonize’ the social and political identity of the region with the rest of Turkey.

Lastly, GAP aims to support urban and industrial development also in other parts of Turkey, mainly in the west (SPO, 1988b, 1990b). The hydroelectricity to be produced in the GAP region is anticipated to far exceed any foreseeable demand by local industries, and most villages in the region were already served with electricity at the end of 1980s.

2.6 Ambitions for sustainable human development

In response to international calls for sustainable development, stemming from the United Nations Conference on Environment and Development (Rio de Janeiro, 1992), the Turkish Government decided to reevaluate GAP against principles of sustainable development. In March 1995, a seminar was held in Ankara with the purpose of defining sustainable development in relation to GAP and the strategies to achieve it (GAP-RDA UNDP, 1995). The seminar paid particular attention to the need for community participation, improved basic education, health and social services, the advancement of women, the creation of more employment opportunities, efficient use of resources, and environmental preservation in the GAP region. The seminar resulted in a joint programme for UNDP and GAP-RDA, named the “Sustainable Development Programme in the GAP Region”, which was put into effect in March 1997 (GAP-RDA, UNDP, 1997). The programme serves as an umbrella project, supporting the implementation of 29 related projects.

Since 1997, principles of sustainable human development have been given a prominent role in GAP. According to Ünver (1997), President of GAP, guarantees of long-term prosperity in the region can be provided “only if development is human oriented, and if it is designed and implemented with a focus on sustainability.” Various proposals and some practical attempts have been made to put the GAP principles of sustainability into practice. The proposed measures cover a wide range of issues from local participation to water management. While the interest in sustainability issues is evident, by 2001 the overall development objectives as articulated in the GAP Master Plan of 1989/90 still applied. In the new GAP Regional Development Plan, however, principles of sustainability will be given a more prominent role in GAP (Anonymous, 2001).

3. Modifications to the Karababa/Atatürk Dam project over time

3.1 The Middle Karababa Dam

In 1970, the Karababa Dam, later renamed the Atatürk Dam, was proposed on the site of the present dam (DSI, 1970c). The Karababa Dam was presented in three alternative designs: the Low, Middle, and High Karababa Dam. These differed significantly in design, with heights of 85, 112, and 169m respectively. The Middle Karababa Dam design was the most highly recommended. The Low Karababa Dam alternative was never seriously considered, and the High Karababa Dam would be more expensive, require high initial investments, face certain leakage problems, be vulnerable to any major flood wave, and have an enormous dead storage volume believed to be far greater than required (DSI, 1970b).

The Middle Karababa Dam was planned as part of the Lower Firat Project, which comprised four dams on the lower reach of the Turkish Euphrates River. These were the Karakaya, Low Gülköy, and Middle Karababa dams on the mainstream, and the Bedir Dam on a tributary river (DSI, 1970d).

The Middle Karababa Dam was planned to serve three main functions. Firstly, it would be the only dam project to provide water to the planned irrigation area of 700,000 ha of the Lower Firat Project (DSI, 1970d). On average, 8600 million m³ of irrigation water per year would be diverted from the reservoir through two separate conveyance systems to the Urfa-Harran, Lower Mardin, Siverek-Hilvan, Upper Mardin, and the Nusaybin-Cizre schemes (DSI, 1970b). Irrigation water would be supplied during the dry season and late summer months in order to prolong the growing season.

Secondly, the Middle Karababa Dam would generate electricity with an installed power capacity of 800 MW. At full irrigation, the average annual energy output would be 3325 GWh (DSI, 1970c). Most of the electricity would be transmitted to other parts of Turkey; only a smaller share would be supplied locally (DSI, 1970h). Thirdly, the dam would benefit downstream users by releasing an almost uniform regulated flow, which would reduce the river’s high annual flow variation and virtually eliminate the floods that occur in April and May of most years. Lastly, it would create opportunities for the transportation of goods, development of fisheries, and “other corollary uses” (DSI, 1970b).

3.2 Adoption of the High Karababa Dam

The formulation of GAP in 1977 necessitated a revision of the original Lower Firat Project. By excluding the Low Gülköy Dam of 500 MW and adding two turbines and 57 m to the Karababa Dam height, the generation capacity of the Karababa Dam increased from 800 to 2100 MW (DSI, 1978). Moreover, the total planned irrigation area was to be extended to 800,000 ha, by revising and complementing the Lower Firat irrigation scheme with two new irrigation schemes, namely the Adiyaman-Katha and Baziki-Suruc schemes (DSI, 1978). The expected high cost of this expansion motivated the adoption of the High Karababa Dam, which was now considered more economic than the Low Gülköy and Middle Karababa dams together (Ertunc, 1999).
As a result, the Middle Karababa Dam was rejected in favour of the High Karababa Dam alternative. The proposed Low Gölköy Dam was no longer needed (see Fig. 2), and the Bedir Dam and pumping plant were also excluded (Bagis, 1989). Instead, a new dam downstream of the High Karababa Dam was proposed, the Birecik Dam. In total, the Euphrates River would be impounded by three mainstream dams below the existing Keban Dam: the Karakaya, High Karababa, and Birecik Dams (DSI, 1978). A number of smaller tributary dams were also proposed. The High Karababa Dam was planned to irrigate the total planned 800,000 ha in the Euphrates River basin within the region, through three separate tunnels (DSI, 1978).

### 3.3 Modification of the High Karababa Dam

In late 1978, the number of turbines at the High Karababa Dam power plant was increased from seven to eight (DSI, 1978). The generation capacity of the Karababa Dam hereby rose from 2100 MW to 2400 MW. Modifications were also made to the dam design, which increased its useful storage capacity from 5440 to 19,300 million m³.

As a result, the importance of the High Karababa Dam for Turkey was recognized and it was renamed ‘Atatürk Dam’, after the founder of the modern Turkish Republic (Altinbilek, personal comm., 2001). The name Karababa had been taken from the town Karababa, near the proposed dam site.

### 3.4 The Atatürk Dam in 1989/90

With the preparation of the GAP Master Plan from 1987 to 1989, the development plans of the Euphrates River basin in Turkey were further modified. A fourth mainstream dam was proposed downstream of the Keban Dam, named the Karkamis Dam, and the power generation capacity of the Karakaya Dam was upgraded from 1400 to 1800 MW (SPO, 1990b).

Construction on the Atatürk Dam, which had started in 1983, was completed in 1990 (GAP-RDA, 1997b). Together with its associated irrigation schemes, it was now referred to as the most important structure of the Southeast Anatolia Project (PMU/SPO, 1988a). According to the Master Plan (SPO, 1990b), the Atatürk Dam is planned to serve five main functions, of which irrigation is of the highest priority (SPO, 1989).

The Atatürk reservoir was intended to supply irrigation water to 882,380 ha of agricultural land, which corresponded to about 54% of the total GAP irrigation area (SPO, 1989) (see Fig. 3). The irrigation system encompassed six irrigation schemes: the Siverek-Hilvan scheme (160,105 ha); the Bozova pumped scheme (69,702 ha); the Suruc-Baziki scheme (146,500 ha); the Mardin-Ceylanpinar scheme (334,939 ha); and the Urfa-Harran scheme (141,535 ha). The last two were regarded as the most important (SPO, 1990b).

The associated irrigation area was to be dominated by summer crops, such as cotton, maize, sesame seeds, and soybeans (SPO, 1989). Cultivation of summer crops in the region is totally dependent on irrigation, due to the low rainfall levels from June to September (see Fig. 4). Winter crops, mainly wheat and barley, and perennial crops, such as fruits, were also planned. However, these would demand little or no irrigation (SPO, 1989).

There is a possibility that the final irrigation area of the dam project may not become as large as proposed in 1989. In 1990, the GAP Master Plan recommended that only certain priority irrigation and hydropower schemes of GAP should be implemented, in view of the large public investments required and the uncertainties involved. This would mean that irrigation associated to the Atatürk Dam becomes limited to the Urfa-Harran plains and the first stage of the Mardin-Ceylanpinar scheme, i.e. an area of 371,665 ha corresponding to only 42% of the area proposed in 1989 (SPO, 1990b).

The Atatürk Dam and power plant are planned to generate large amounts of hydroelectricity of high importance to Turkey’s national economic growth (SPO, 1988b). The installed power generation capacity of the dam project is 2400 MW, corresponding to 32% of the total planned capacity of GAP. At full irrigation development, the average annual generation rate would be 5300 GWh (SPO, 1990b).

The Atatürk Dam project is also expected to facilitate the generation of hydropower at the downstream dams of Birecik and Karkamis (SPO, 1989), by releasing regulated runoff over the year.

In addition, the Atatürk Reservoir is planned to support a large share of the fish production in Turkey’s dam reservoirs (SPO, 1988a). Because the river naturally does not provide much fish, fishing has traditionally been of small-scale and limited to local private consumption (GAP-RDA, 1996a). However, an increased regional consumption and production of freshwater fish is expected.
Figure 3. Location of planned irrigation schemes of GAP. Areas marked with any stripes will be irrigated by water from the Atatürk Reservoir. Areas marked with dots will be irrigated by water from other sources.

Lastly, the area surrounding the Atatürk Dam is expected to provide favourable conditions for recreation and tourism (SPO, 1990b).

3.5 The Atatürk Dam project after construction

Since construction work on the Atatürk Dam and power plant was completed in 1992, a number of additional water uses and reservoir-related activities have been proposed for the dam.

Most importantly, the irrigation area associated with the Atatürk reservoir has been extended from 882,380 ha in the early 1990s (SPO, 1990b) to 975,000 ha in June 2001 (Tasdelen, 2001, personal comm.), despite the recommendations in the GAP Master Plan.

Moreover, in 1995, an agreement was signed between concerned energy ministers for an interconnected electricity network that would transmit part of the electricity produced at the Atatürk Dam to the Syrian border and onto Iraq, Jordan, and Egypt (Anonymous, 1995). This would generate important export revenues for Turkey. The first power line transmitting electricity from the dam to the Syrian border was completed in August 1998. Construction work on the Syrian line has been delayed, however (WNC, 1998).

Water from the reservoir will also be used for other purposes than irrigation, such as household, municipal, and industrial uses (Tasdelen, 1999, personal comm.). Since the mid-1990s, people in the Sanliurfa province have retrieved household water from local groundwater wells or from nearby tertiary irrigation canals (Tasdelen, 1999, personal comm.).

The hatchery station by the Atatürk Dam, which in 1999 was operated on a small pilot scale, is expected to grow and be commercialized in response to increased demand from the private sector (Yaman, 1999, personal comm.). In the future, annual fish production is expected to reach 10,000 tons for the reservoir and 20,000 tons for the whole GAP region (Arslan, 1999, personal comm.).

Measures have also been proposed and partly implemented to improve the design, management, and operation of the irrigation schemes associated with the Atatürk Dam (Altinbilek and Akcakoca, 1997). Since 1992, DSI has considered the possibility to reuse drainage water on the Urfa-Harran plain, which would reduce the water diversion rate from the reservoir and the salt load to be transferred downstream (Altinbilek and Akcakoca, 1997). In 1996, an Atatürk Dam/Reservoir Subregional Development Plan was completed, proposing a set of environmental policies to control hillside and shoreline erosion and reservoir sedimentation, to prevent degradation of the reservoir water quality, and to monitor the affected groundwater table (GAP-RDA, 1996a). However, in 2001, no measures had yet been presented that would adjust the design or operation of the Atatürk Dam to minimize potential adverse effects on the river ecology downstream of the dam.

Table 1 summarizes the stepwise changes that have occurred to the design, capacities, and main functions of the Karababa/Atatürk Dam project since 1970. The intended combination of functions of the dam project has also been modified since 1970. Figure 5 illustrates how the regional development ambitions and the proposed set of dam project functions have evolved over the last thirty years.

4. Accomplishments and constraints in realizing the project

4.1 Progress in realizing dam functions

Since irrigation was initiated on the Urfa-Harran plain in April 1995 (GAP-RDA, n.d), the area under irrigation grew to 95,405 ha in 1999 (DSI, 2000) and to 130,000 ha in June 2001 (Tasdelen, 2001, personal comm.). In other words, six years after initiation, the completed irrigation area corresponds to only about 13% of the planned 975,000 ha. The relatively slow pace of irrigation development has been caused mainly by initial difficulties to deliver farming services, lack of funding, low irrigation experiences among farmers (Ağız et al., 1997), and the tribal organization that has dominated the farming system in the past (Erhan, 1997).
Table 1. Changes to the planned design, capacities, and main functions of the Karababa/Atatürk Dam project over time

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<tr>
<td>Height of dam (m)</td>
<td>112</td>
<td>169</td>
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<tr>
<td>Reservoir surface area (million m^2)</td>
<td>369</td>
<td>817</td>
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<td>Total storage capacity (million m^3)</td>
<td>16,090</td>
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<td>Useful storage capacity (million m^3)</td>
<td>3,430</td>
<td>5,440</td>
<td>19,300</td>
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<tr>
<td>Number of turbines</td>
<td>5</td>
<td>7</td>
<td>8</td>
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<td>Installed power generation capacity (MW)</td>
<td>800</td>
<td>2,100</td>
<td>2,400</td>
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<td>Planned irrigation area (ha)</td>
<td>700,000</td>
<td>800,000</td>
<td>n.d.</td>
<td>882,380</td>
<td>975,000</td>
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<td>Average annual energy output at full irrigation development (GWh)</td>
<td>3,325</td>
<td>n.d.</td>
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<td>882,380</td>
<td>975,000</td>
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Notes: * At maximum water level; a 371,665 ha was recommended by the Master Plan (SPO, 1990b).

Figure 5. Changes in regional development objectives and proposed functions of the Karababa/Atatürk Dam project over time
Since 1998, water has been diverted from the outlet point of the Sanlıurfa tunnels for municipal use in Sanlıurfa (Tasdelen, 2001, personal comm.). However, this water is not being treated at present, as the proposed treatment plant has not yet been constructed. Also, untreated water from irrigation canals is currently being used by households. The water in the Euphrates River is however still relatively clean and safe (Tasdelen, 2001, personal comm.).

Realization of planned activities connected to the reservoir lake has been more successful, and a number of such activities have been initiated since the mid-1990s. Since October 1995, an annual water sport festival is held on the reservoir lake in autumn each year to promote tourism and sport activities and “to publicize the versatile character of GAP” (GAP-RDA, 2000). In 1996, a hatchery station was established in connection to the reservoir by the 16th regional directorate of DSI (Yaman, 1999, personal comm.). In 1999, the hatchery was operated as a pilot study on a rather small scale, producing 850 tons of fish per year, being carp, eel, red freshwater fish, and certain other species for local fishing. As of November 2001, the reservoir was still being used only for local fish production, but plans for the expansion of the hatchery are under way. The reservoir also serves for transportation by ferry at some locations (Tasdelen, 2001, personal comm.).

Since July 1992, when the first hydropower unit became operational (GAP-RDA, 1997b), the Atatürk Dam has become a major producer of hydroelectricity in Turkey. The electricity is distributed all over the country through the national interconnected electricity grid system (Arslan 1999, personal comm.). Between 1992 and 1997, annual electricity generation increased steadily from 1,719 GWh to 10,600 GWh (GAP-RDA, 1997b; WNC, 1999). From 1997, however, it has varied considerably, reaching 11,000 GWh in 1998 but only 7,500 GWh in 1999 (WNC, 2000). This variation is primarily due to the prevailing hydroclimate in the catchment area and the flow regime of the Euphrates River.

### 4.2 Implications of unfavourable hydroclimatic conditions

The natural flow regime of the Euphrates River displays high variations in monthly flow over the year with highest flows from March to June. The flow regime is also characterized by high inter-annual fluctuations and recurrent periods of critically low flows lasting several years. Between 1937 and 1984, the average annual flow at the Atatürk Dam site was 26.78 billion m³ (or 850 m³/s) (SPO, 1989). Within the same time span, two periods of critically low flows occurred, i.e. from 1957 to 1963 and 1970 to 1975 (SPO, 1989). Average annual flow for the years 1961 and 1973 measured only 13.8 and 15.6 billion m³, respectively (DSI, 1970b; SPO, 1989).

Since 1998, the Euphrates River basin has experienced the most severe meteorological drought in 20 years (WNC, 2000). The paucity of precipitation in the upper Euphrates catchment has reduced the annual average inflow into the Atatürk reservoir (TDN, 2001c). These conditions have significantly constrained the potential of the dam project to provide a steady supply of electricity. For continuous production, the reservoir must maintain a minimum operational water level of 525 m. In October 2000, the water level dropped to only 526.59 m (TDN, 2000), and in the spring of 2001, it was still hovering very close to the minimum.

The low inflow into the reservoir has also decreased the amount of water that can be released to Syria downstream. In 1987, Turkey promised Syria an annual average flow of at least 500 m³/s across the Turkish/Syrian border, and committed itself to compensate for a flow below 500 m³/s in any one month by raising the flow the following month (MFA, 1997). In September 2000, the amount of water reaching Syria was only 75 m³/s (TDN, 2001b). It has been questioned whether Turkey will be able to maintain an average flow of 500 m³/s once the GAP irrigation schemes in the Euphrates River basin are fully developed. In 1989, SPO (1989) stated that a minimum maintenance flow of “about 400 m³/s” below Karkamış (close to the Syrian border) could be ensured at full irrigation development.

### 4.3 Competing uses increase water demand

In the future, allocation of the limited Euphrates waters may become an even greater challenge. As more irrigation schemes are completed, the total water demand for irrigation will increase. Irrigated agriculture constitutes the cornerstone of GAP and an important source of export revenue for Turkey. Reduction in agricultural water demand should therefore be expected primarily as a result of more effective distribution and irrigation practices, unless Turkey modifies the GAP Master Plan and completes only priority irrigation schemes. Future utilization of the Atatürk Reservoir for industrial and more extensive municipal water supply purposes will also increase total water demand.

The Atatürk Dam has also become an important source of domestic electricity supply and national demand is likely to increase in the future, unless Turkey’s current energy crisis can be curbed in other ways. Existing agreements with Syria and other Middle Eastern countries for the sale of electricity from the Atatürk Dam is also likely to influence future dam operations.

### 5. Conclusions

To conclude, the objectives and ambitions driving the development of the Southeastern Anatolia region have changed significantly over the past 30 years. In 1970, the official plans for the region involved only the development of water and land resources primarily to produce food and electricity for the western parts of Turkey and to stimulate national economic growth. In the late 1980s, the project had expanded to a multi-sectoral project, aimed at increasing...
export revenues, reducing regional socio-economic disparities within the country, and enhancing the socio-political stability of the region. Since 1995, the project is officially referred to as a 'sustainable human development project' with the ambition to adhere to principles of sustainable development. 

In the same 30-year period, the design, capacities, and main functions of the Atatürk Dam project have been modified considerably. In terms of dam height, power generation capacity, storage capacity, and planned irrigation area, the most important changes occurred in 1978, when the design from 1970 for the planned Middle Karababa Dam was abandoned in favour of the Atatürk Dam design. During this year, planned dam height was increased from 112 to 169 m, power generation capacity from 800 to 2,400 MW, useful storage capacity from 3,430 to 19,300 million m³, and planned irrigation area from 700,000 to 800,000 ha. In terms of functions, the most important changes occurred in the 1990s, after the dam and power plant had been built. The scope of the dam project now also includes electricity generation for export, water storage for industrial, municipal, and domestic purposes, and commercial production of fish.

During the 1990s, measures have also been proposed and partly implemented with consideration to the environment, partly in response to the ambition to make GAP more environmentally sustainable. However, these measures have mainly been adopted to improve the productivity of the irrigation schemes and to prolong the lifetime of the reservoir. No noticeable adjustments have been made to the dam design, operational schedule, or associated irrigation schemes to reduce potential adverse effects on the downstream ecology of the Euphrates River.

Progress towards realization of the major functions of the dam project has not been as successful as anticipated. The development of irrigation schemes and the rate of hydroelectricity generation have been hampered and constrained, primarily by financial, organizational, educational, infrastructural, and hydroclimatic circumstances. Activities related to the reservoir lake have been less problematic.

Based on the study of the Atatürk Dam project, some general conclusions can be drawn regarding the planning of large dams in the framework of regional development projects in developing countries.

Firstly, changes in the regional development objectives may not translate automatically into adjustments to the dam project. It is likely that the design and functions of a dam are revised during its lifetime to better support current regional development plans. However, adjustments to the dam design and operational schedules that would reduce adverse ecological effects and at the same time compromise certain development objectives should not be expected to be effected instantly nor easily.

Secondly, the character of the dam project may change considerably over time. During the planning phase, the proposed design, estimated capacities, and intended functions of a dam may be significantly revised. Once the dam has been built, new functions may also be added to the project, such as additional water uses and reservoir activities. Whereas increases in the capacity for storage and power generation often reflect growing optimism and expectations, the addition of new functions may be motivated by the desire to maximize the usefulness of the dam and to justify its existence.

Thirdly, hydroclimatic conditions may severely constrain the ability of the dam to live up to its intended water uses. Although a dam project may be gradually revised in order to maximize its technical capabilities, its potential to deliver full benefits upstream and to support overall regional development objectives is fundamentally dictated by the hydroclimate, which cannot be controlled. Low flows may necessitate difficult tradeoffs not only between electricity generation and water diversion for upstream uses (mainly irrigation), but also between the needs of upstream and downstream riparian states.

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