



## What is the Role of Dams in Development ?

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### SUMMARY

Although the amounts of water resources are enough for the entire world, the distribution of them in time and space shows uneven pattern. 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.

Demand for water is steadily increasing through out 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the fresh water resources are limited and unevenly distributed, during the past three centuries, the amount of water withdrawn from fresh water resources has increased by a factor of 35, whereas world population by a factor 8.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 had been built to produce motive 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.

By the end of 20th century, there were 45000 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 world's total electricity supply and is used in over 150 countries. Approximately 12% of large dams are designated as domestic water supply dams.

**Keywords:** Dams, Sustainable development,

## **1. INTRODUCTION**

From the beginning of human history, for almost 5000 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 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.

Many new dams are planned for this century to address the escalating water crisis in the world, and to provide cheap and renewable energy. In Turkey, The General Directorate of State Hydraulic Works (DSI), will continue to work to ensure that these dams will be planned and constructed in an environmentally, socially and economically sound way. Owing to considerable variations observed in the run-offs in terms of seasons and years, it is absolutely necessary on the major rivers in Turkey to have water storage in order to ensure the use of water, when it is necessary. Consequently, for these reasons, priority has always been given to the construction of dams throughout the last decades elapsed since the establishment of DSI.

The 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 the migration to the cities, while giving them a high level of life standards in their native areas. Additionally, in the countries such as Turkey, where the semi-arid climate is highly dominated, it is admitted as a need that building the reservoirs in order to use the water resources in an efficient manner, for the purpose of the economic development of the country, would be highly beneficial.

## **2. PURPOSE OF LARGE DAM BUILDING**

According to ICOLD classification, large dam is one with the height of 15 m or more from the foundation. If dams are 5 to 15m high and have a reservoir volume of more than three million cubic meters, they are also classified as large dams. Based on this definition, there are 45000 large dams around the world.

There are various demands for water, including irrigation; domestic uses (showering, 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 purposes of dams are grouped into the two categories, single purpose and multipurpose.

According to the study of World Commission on Dams (WCD) conducted for all over the world, most (48% approx.) dams are for irrigation and therefore contribute greatly to food production. A considerable proportion (15% approx.) of single purpose dams serve for domestic and industrial water supply. A substantially smaller number (20% approx.) generate electricity. The same study informs 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, with 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.

## **3. MAJOR BENEFITS OF DAMS**

According to the study, conducted by United States Committee on Large Dams (USCOLD), today living conditions of billions of people 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, provision of recreational facilities are among the major benefits of dams.

World Bank Report, 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 support fewer viable human settlements life for many people in the great river and basins of the world."

### **3.1.Dam 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 report, hydropower presently provides 19% of the total electricity supply and is used in over 150 coun-tries. 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 gene-ration.

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 considerable percent of all renewable electric energy produced all over the world. According to the study realized by the USCOLD in the USA, the efficiency of a modern hydropower 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 word provides approximately one-fifth of the world's total electrical energy.

Hydropower has a long list of positive characteristics that explain its strong support and 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 under valued), flow regulation, multiple use and fossil fuel avoidance. The other major beneficial aspects of the hydropower can be listed as following.

- Because hydro is a domestic resource, governments and utilities in developing countries often prefer hydro generati on to electricity produced from fossil fuels, which must be imported or, if the nation has its own supplies, are valua-ble sources of export revenues.

In addition, the relatively low maintenance cost and simplicity of operation associated with hydro projects are sign-i ficant advantages of 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.

### **3.2. Dam and Irrigation**

Dams have played a key role in the development since the third millennium BC when the first great civilization evolved on the major rivers. Initially, only small dams were built for water supply and for irrigation. According to WCD study, 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 of how this food could have been produced by other means.

Most of the dam projects not only have the objective of economic benefits, but they also address the overall socio-economic development of the people at the region. The major irrigation projects, which are dependent on dam construction, often help prevent the migration of rural people to the cities, while giving them a higher standard of living in their native areas.

The needs 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 still growing world's 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 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.

### **4. CONTROVERSY ON LARGE DAMS**

Large dams have often been seen as an effective way of meeting water and energy need. However, Global Review has emphasized the wide range of problems associated with them. Dam 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. The public debate on large dams has been characterized by the increasingly tone adopted by dam advocates and opponents. The break down 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 amount 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, MeadftHunt, Inc., 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 population has forced those countries to give to the development of water resources a top priority. But, green movement flourished in developed countries, which had completed water resources development process, launched some campaigns.

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.

## **5. 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 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 insuring informed decisions. During the development of the projects, environmental impact assessment 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, mitigation, 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.

## **6. RESETTLEMENT AND EXPROPRIATION**

The rapidly growing world population, rising level of economic activities, and a steady change in the life-style have a direct impact on very significant increase in water demand. The economic activities in the world has 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 through the construction of dams on rivers and their tributaries.

Many people have benefited from the services of large dams, while their construction and operation have led some negative social and human impacts. The adversely affected population includes directly displaced families and host communities where families are resettled.

As it is denoted by Professor Michael M. Cornea that '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 word 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 plan should include the all families affected from the project construction. Because planning pro-vides many benefits. New settlements can be created without destroying the environments. The human consideration are usually the most important, and these considerations involve not only the resettled population but also the host popu-lation.

According to the WCD report, the findings and lessons regarding to social performance of large dams, 40-80 million peo-ple 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 compensation provided was inadequate etc.

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## **Biography**

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Graduated in 1975, Faculty of Civil Engineering, Black Sea Thecnical University ,Turkey; postgraduate diploma in irrigation methodologies , IHE (International Haydraulic Institute) ,Holland. He has been USA for practical training programme on Water and Environment. Formerly, 1992-2012, Deputy Head of Investigation& Planning Department of DSİ ( State Hydraulic Works), Turkey, acting as a coordinator , developing new strategies for integrated water resources development comprising irrigation, hydroelectric energy generation, domestic & industrial water supply , flood control projects and environmental impact assesment reports, Attending many international conferences , meetings and seminars, as a panelist or/and speaker, all over the World, related with



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