

## **POSITIVE AND NEGATIVE IMPACTS OF DAMS ON THE ENVIRONMENT**

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## **ABSTRACT**

The human being has been struggling in order to shape the ecosphere in a manner he wants since the first day. The period in which this struggle was observed most intensively was the period covering the transition from a migrant and primitive hunter society to a resident life and farming. The most deep-seated environmental modification against the nature that had been realized in the history of the human being has started at this time. Even the development and downfall of civilizations are correlated to this interaction between the human being and nature.

Dams have one of the most important roles in utilizing water resources. They were started to construct long years before gaining present information about hydrology and hydromechanics.

Dams have a great deal of positive and negative effects on the environment besides their benefits like controlling stream regimes, consequently preventing floods, obtaining domestic and irrigation water from the stored water and generating energy. Wherever the location of a dam is, its ecological results are the same. The environmental impacts of dams can be classified according to different criterions as long term and short term impacts, the impacts on the close area and the impacts on the

regions where the dam services, social and unsocial impacts, beneficial and harmful impacts. These effects may be ordered in an intensive and complicated manner like climatic, hydraulic, biologic, social, cultural, archaeological etc.

In addition to their very important social and environmental benefits, it is important to minimize the negative effects of dams on the environment regarding sustainable development. The mentioned effects and their solutions have taken into account in the environmental impact assessment concept.

**Key Words:** Dam, environment, ecology, water resources.

### INTRODUCTION

Dams have one of the most important roles in utilizing water resources. They were constructed long years before gaining present information about hydrology and hydromechanics. They are not ordinary engineering buildings. Dam projects, which are useful in meeting the demand for water in desired times and in regulating stream regimes, have undertaken an important function in the development of civilization.

Dams have been constructed in order to prevent floods, to supply drinking and domestic water, to generate energy and for irrigation purposes since the old-times.

Dams have a great deal of positive and negative effects on the environment besides their benefits like controlling stream regimes, consequently preventing floods, obtaining domestic and irrigation water from the stored water and generating energy. Dams hold possibilities of considerable harm for living beings in addition to their advantages such as meeting basic requirements of the society and increasing living standards.

Nearly 700 dams were built every ten years up to 1950s. This number grew rapidly after 1950s. While the dams were built and completed it was observed that there was something missing and detrimental. Although the effects of water on human life and the development of civilizations are well-known all over the world, it is claimed that the economical benefits expected from the projects designed to utilize water resources could not be gained and also necessary precautions to decrease the environmental, economical and social losses were not taken. Even some studies aiming to block these water supply projects of the developing countries are carried out by some international organizations. Because of this, in the sustainable management of the water, taking into account the economical, social and cultural development and the environmental impacts which came out as a result of the mentioned studies, has gained an increasing importance.

Therefore, it is essential that these water resources development studies have a legal background to ensure sustainable development. During these water resources

planning studies, the law related to the tasks and authorities of the governmental institutions and establishments, contradicts sometimes with the law directly related with environment. These laws should not be neglected while the planning studies.

Naturally current laws always age and change depending on the improvements and technology. The point that should not be overlooked is to make the changes by relying on the scientific, technological and educational studies. The only way to minimize the contradictions between the laws is to make investigations. The investigations must be continuous. It is definitely necessary to put the blameless responsibility principle into practice.

Plants, animals and people have begun to be damaged from 1960s up today, as a result of uncontrolled extreme population increase, air, water and soil pollution caused by wastes as well as the changes in the ecosystems in parallel. Population increase, technological improvements, the expansions in cities, ways, dams and other engineering studies have disordered the natural balance and the natural body has changed drastically as a consequence of these activities. Meanwhile environment as a subject became popular and has begun to gain importance day by day.

The raising interest against environment cause contradictions between the planners, engineers and some groups in the society who are against all engineering buildings especially dams. On the other hand, it becomes unavoidable to construct the mentioned plants and buildings to enhance the prosperity of the country by realizing socio-economic and technological developments.

Nowadays living cultural, social and environmental values must be taken into consideration in the planning studies which are done based on this new understanding, as well as technical standards and economical values. At this stage, water resources planners have to give more importance to environmental problems in their plans.

The planners should be reformist, broad-minded, sufficient in evaluating critical needs. This innovation is necessary for alternatives such as designing less water demand, encouraging solutions which are not structural in flood control, finding better methods to process wastes and purification of waste water.

The relations between water pollution, air pollution and solid wastes must be known very well from a broad perspective. There is need to evaluate the real necessity that means the parallelism between the water supplied and the population distribution. Moreover, the importance of water projects in ecological relations and the effects of the projects on water pollution should be known. The most important between these is the evaluation of real necessity.

Water projects and acceptable public studies will continue to provide public health and security. Some projects may exchange alternatively. Hydroelectric pro-

jects may take the place of insufficient fuel oil. Purposes like hydroelectric, irrigation, flood and recreation spots should be thought all together. Storage pollution changes when better treatment serves more effectively.

In case of a need for a new project arise, the planner has to assess the ecological impacts in and around the stream carefully and he/she has to improve his project in a manner that it will have the least hazardous impacts.

Wherever the location of a dam is, its ecological results are the same. The environmental impacts of dams can be classified according to different criterions as long term and short term impacts, the impacts on the close area and the impacts on the regions where the dam services, social and unsocial impacts, beneficial and harmful impacts. These effects may be ordered in an intensive and complicated manner like climatic, hydraulic, biologic, social, cultural, archaeological etc.

#### **THE POSITIVE AND NEGATIVE IMPACTS OF DAMS ON THE ENVIRONMENT**

While preparing the water resources projects, it is important to make clear what the environmental impacts of the project may be when it is executed. The environmental impacts of the dams have been written down below in numerical order. These are;

1. As a result of dam construction and holding of sediments in reservoirs, sediment feeding of downstream channel or shore beaches is prevented. Corrosions may occur. As the transfer of sediments is avoided by this way, the egg lying zone of the fishes living in the stream ecosystem is restricted, too.
2. Archaeological and historical places in company with geological and topographical places that are rare with their exceptional beauties, disappear after lying under the reservoir.
3. Reproduction of migrating fishes is hindered by the floods that harm the egg beds. Or the egg gravel beds can be destructed while the excavation and coating works in the stream beds.
4. Temperature of water, salt and oxygen distribution may change vertically as a consequence of reservoir formation. This may cause the generation of new living species. (International River Network, 2001; Canadian Dam Association, 2001).
5. Normal passing ways of territorial animals are hindered since the dam works as a barrier. Meantime the upstream fish movement aiming ovulation and feeding is prevented and thus fish population decreases significantly (Stott and Smith, 2001).
6. The fishes can be damaged while passing through the floodgates, turbines and pumps of the high bodied dams. Drainage of marshes and other water

- accumulations and the excavation works causing changes in the stream bed structures affect the creatures living here negatively; even result in their death.
7. There will be serious changes in the water quality as a result of drainage water returning from irrigation that was done based on the irrigation projects. In other words, overtransfer of food and the increase in salt density can raise water lichens and may change water living species.
  8. The species may change parallel to the erosion caused by the human activities or the permanent increase in the water turbidity as an outcome of the dam construction.
  9. Discharge of toxic matters (pesticides, toxic metals etc.) and their condensation in food chain may affect sensitive animals immediately; all living organisms may expire when the stream becomes unable to recover itself.
  10. The water regime may change as a result of destruction of nature, unexpected floods may occur and consequently vegetation and natural structures in the riverbanks can be damaged.
  11. Some increase in earthquakes may occur because of filling of big dam reservoirs.
  12. Rise in evaporation loses may be expected as a result of the increase in the water surface area.
  13. Microclimatic and even some regional climate changes may be observed related to the changes in air moisture percentage, air temperature, air movements in big scale and the changes in the region topography caused by the stagnant, big scaled mass of water.
  14. Water-soil-nutrient relations, which come into existence downstream related to the floods occurring from time to time in a long period of time, change. Depending on this fact, compulsory changes come into existence in the agricultural habits of the people living in this region and also in the flora and fauna.
  15. Dams may cause increases in water sourced illnesses like typhus, typhoid fever, malaria and cholera.
  16. Dams affect the social, cultural and economical structure of the region considerably. Especially forcing people, whose settlement areas and lands remain under water to migrate, affect their psychology negatively.

Numerous other effects can be added to this list. The most important point that must be considered here is to distinguish the temporary harms from the long term and irreversible harms clearly. It is compulsory that the groups consisting of biologists, engineers, hydrologists, social scientists and other profession groups attend the environmental impact assessment studies and that the alternatives do their duty in the estimation of environmental effects.

Dams, which contribute to the national economy from many aspects like irrigation, drinking water supply, flood control, electricity generation, fishing, tourism, are also effective in increasing the living and cultural level of the region that they were constructed. Meanwhile, the new environment created by the dam also supports the arrival of different species to the area. Dams are not only important in economical growth, but also in overall economical and moral development. In many developed countries, dams have performed a key role in the development of the underdeveloped regions.

#### **PRINCIPAL BASIC BENEFITS THAT WILL COME INTO EXISTENCE AFTER THE DEVELOPMENT OF WATER SOURCES**

1. Flood control benefits; it decreases and remove the flood effects.
2. Land improvement benefits; are the extra benefits that will occur after an increase in the soil productivity because of drainage and land improvement precautions.
3. Electricity energy benefits; are the energy benefit value of the more economical project out of two alternative projects.
4. Transportation benefits; are the benefits that will happen in case of there is waterway transportation in the project.
5. Providing drinking water and domestic water benefits are different from each other and should be investigated one by one.
6. Irrigation benefits; defines the distinction benefits between dry and irrigated positions.

#### **EFFECTS OF DAMS ON HYDRAULIC SYSTEM**

The main hydraulic effect is the discharge of the collection basin to a stationary reservoir instead of a stream bed. Therefore, an instant change will start downstream; downstream of a stream dries partially or totally whenever the reservoir begins to accumulate water. During this temporary or periodically repeating time interval, the hydrological balance can collapse; Irreversible death, disappearance and structural jumps are observed in the water dependent ecosystem. Decay of dead flora and fauna in the new coming water body speeds up. So, upstream water flows polluted, without oxygen in deeper parts, dark coloured for a long time and usually smells rotten because of sulphurous hydrogen disposal. Although after this process the stream forms a new and healthy ecosystem in this part of it, neither this new aquatic balance nor the terrestrial ecosystem and even the sea environment that the stream joins the sea have the chance to join their previous health.

Assuan Dam is a good example for this case. This dam has changed the feeding characteristics of the Eastern Mediterranean besides the Nile River ecosystem. It is possible to correlate these changes to 6 different factors listed below:

- ◆ Flow speed of the river becomes stationary in its downstream part since the water level in the stream bed does not change significantly. Therefore, energy flow characteristics modify in the living ecosystem.
- ◆ Positive variations may occur as a result of the increasing leakage into the groundwater (It has been calculated that it will be possible to supply water for Nubian Desert from the river for domestic and agricultural purposes, with the help of the water leaking from the Lake Nasr which is over the Nile River).
- ◆ As the reservoir works like a big settlement basin, turbidity in the water flowing downstream decreases and erosion around the lake decreases slowly.
- ◆ Increases in the evaporation losses because of the enlargement in the water surface can be observed.
- ◆ The variations in the temperature regime of the water environment can be classified in two groups:
  1. Thermal variations that may end in seasonal thermal layer formations depending on the water depth in the dams,
  2. The variations that happen in the water temperature inside the reservoir related to the water depth that was able to leak through the downstream gates and the exchange of water with constant temperature. The river will behave like a cold climate river from chemical and biological qualifications point of view, as the water will be always cold even in summer, if the gate depth lies below the thermocline of the reservoir. On the contrary, it will behave like a hot climate river if the flowing water is at surface water temperatures. Effects similar to these can continue kilometers along the downstream.
- ◆ Serious changes occur in the chemical qualifications of the river water similar to temperature variations. Depending on the reservoir depth, water that is suffering from oxygen and even includes sulphurous hydrogen may take part in the deeper parts of river. When water flows downwards, very important vital changes may occur in the downstream part, related to the depth of dam Gates. The decomposition products of the organic matters accumulated in deeper parts of the river where oxygen is in limited amounts may come up to the surface accompanied by sudden gas releases. This results in a sudden addition of different chemical nutrient substances to the biosystem and be-

sides a frequently fluctuating water quality. Furthermore, it has been observed that nitrogen in the air was dissolved in extreme saturation levels in the downstream part of the falling water. By this way, water that is saturated approx. 150% to nitrogen can be fatal for fishes.

#### **EFFECTS OF DAMS ON THE ATMOSPHERIC SYSTEM**

Variations in moisture percentage, temperature and air body movements of air caused by the big stationary water body differentiate microclima related to region topography. In addition, regional scaled climatic changes can be observed. These alterations may seem not very harmful for human health, but they are notable for many plants and animals. Their secondary effects influence human being.

#### **EFFECTS OF DAMS ON THE EARTH'S CRUST**

Eventhough it is claimed that the dam reservoirs have some seismic effects, it must be stated that this is not proven scientifically.

#### **EFFECTS OF THE DAMS ON TERRITORIAL BIOLOGICAL SYSTEMS**

Biological life of the river changes fast both in the reservoir and in downstream. The parts of the biosystem that are affected from the dam are the watered parts on the shore.

During the filling works of the dam, while the lands remain under water the land part of the region decreases. However, the water-land boundary extends. Thus, plant, animal or human being settlement areas change. Forests, agricultural areas may come under water.

As the water level differentiates periodically, some species begin to live under water from time to time, in the tide zone. This area may turn to marshy land or reed-bed depending on the soil structure.

Water-soil-nutrient relations, which were settled after floods in the downstream of the dam, change in a long period of time. Furthermore, compulsory changes occur in flora, fauna and the agricultural traditions of people in the region. This effect can extend for kilometers.

#### **EFFECTS OF DAMS ON AQUATIC ECOSYSTEMS**

At the beginning, the decomposing organisms cause an increase in the nutrient substances in water in a short period of time. Therefore, BOD (Biological Oxygen Demand) value of water rises. An anaerobic decomposition media is performed with the help of the stationary layers along the reservoir depth. This results in a dark col-



oured lake smelling badly. Afterwards, an enormous increase in phytoplanktons feeded by the increased amount of nutrients is observed. Besides the plants covering the water surface as large green-dark coloured bodies, macroflora grow up on water surface. These events can be harmful both for the live of the lake, and also for the people fishing, taking a boat-trip and even for the dam gates and turbine propellers. Sometimes, macroflora created here acts like a source for disease vectors. Separatly, this increase in water plants cause more evaporation losses than it happens by evapotranspiration normally.

The dam is a real obstacle for the animals swimming from one end of the river to the other end. The existance of the dam means death for the fish species spending certain parts of their life in the spring or in the flood water and other parts in the crossection where the river joins sea. We know that some sea fishes come to fresh water and swim up to the spring in order to lay eggs. Later on, they return to sea with new young fishes. A dam that will be built on this way will interrupt the life cycle of these creatures and cause deaths in a mass. It has seen that by-pass flows are designed for this purpose.

#### **EFFECTS OF DAMS ON HUMAN LIFE**

Inspite of the fact that the dams are an important target for development; they are not easily acceptable for the people whose agricultural areas, houses and the environment they are living in go under water. For example, when the Volta Lake was created in Ghana in 1969, although a much better settlement area was provided for 80 000 people in another location, these people have returned as 100 000 people and have built their own houses unplanned on the lake shore. Such an unsuccessful experience caused by the social-psychology can be very dangerous for the biosystems in the region and for the reservoir itself.

There are changes in the employment and production systems starting before the construction of the dam including expropriation of the land, employment of construction workers and the transport of construction material with the machines to the site. Unqualified workers are employed from the site; however the technicians and experts come from other places. Generally settlement areas, social buildings, hospitals, schools etc. are built for the people coming from outside at the site. The more these facilities can be hold open for public usage the more the dam becomes a kind of symbol for development. The new settlements improve by this way and result in second ecological needs and changes. For example, drinking water, domestic waste water, waste water treatment etc. Moreover, the social life becomes active, trade increases, cultural activities rise. Important alterations are observed in the transportation system. The ways lying under water and their surrounding area are

important from this point of view. The new roads that were constructed to prevent any break down in the transportation services result in additional expenses and additional environmental costs.

At the same time dams decrease the pollution effect considerably in the downstream part by lowering the pollution load coming from the source, thanks to their big storing reservoirs. In addition, they decrease the pollution load again by containing water continuously in their beds during dry periods.

Dams decrease the flood risk in the downstream, by their storing opportunity in their reservoir.

Undoubtedly there are real and potential benefits obtained from these projects. Industrial development has gained speed; irrigation channels and food production have improved as a result of the increase in electricity generation. Meanwhile, dams protect the people living downstream from floods. After comparing harms and benefits for a long period of time, a decision can be given about dams. Maybe the unwanted side effects of dams will be no longer in force because of the benefits in the future. But these big engineering structures should remind us that we are not able to change only a part of the ecosystem. Because whole chains are connected together in the ecosystem. Even only a link breaking out of the chain or a piece coming out of the cog will destroy the whole system. So, the environment subject should be examined in detail at the planning stage. Precautions should be taken beforehand to big hazards caused by the most little sensitive responses.

In addition to their very important social and environmental benefits, it is important to minimize the negative effects of dams on the environment regarding sustainable development. The mentioned effects and their solutions have taken into account in the environmental impact assessment concept.

In summary, the environmental changes coming out of dams are in various amounts and in different importance degrees. It is difficult to consider the relations between these effects beforehand and determine which positive and negative effects will come up. This estimation should be made separately for each dam and reservoir. On the other hand, it is false to comprehend the effects totally negatively. The important point is who will do the assessments and from whose point of view. Will they be based on the fisherman, based on the industrialist or the farmer whose field will be under water? No matter who has taken the decision or whom the decision will take into centre, as long as whole environmental effects are explained totally according to their importance level.

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