



Investigating the environmental effects of dams

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ABSTRACT

From the beginning of creation, human being has always been hostile towards the ecosystem by changing the environment. Dams are one of the important structures in the systems of water transport and resources. The goal of these studies is to evaluate the environmental effects of the dams, obtaining a comprehensive recognition of the present situation of the environment in the location of dam and the span influencing it. These studies also aim at recognizing the design activities which are done in the considered environment. After gaining a dual recognition, the effects of design activities on all components of the environment (consisting of about 100 factors such as air, water, soil, plant, animal, biodiversity, population, culture, monuments, and etcetera) are determined. In this article, the advantages and disadvantages of dams will be investigated from an environmental perspective. From this perspective, there are lots of advantages as well as disadvantages for dams. They provide reliable water resources, protect the surrounding areas from floods, and also provide a clean energy. Hydroelectric energy (generating electricity by the energy of water) has more advantages than the other two major sources of generating electricity i.e. fossil fuel and nuclear energy. However, dams and water resources also cause some problems. In arid and semi-arid areas, water is easily evaporated from the tanks and canals which transport water. This causes a waste of water and an increase in the density of the salt in water. Dams are a barrier to floods. The floods are important since they enrich the soil with the nutrients which are essential and significant for the ecosystems. Dams change the water flow, the temperature, the transparency of a river; change the water from a current state into a stagnant state. The changes in temperature may have an effect on the living creatures of the river because the life cycle of many invertebrates depend on the temperature. These effects may also have an effect on the situation and behavior of weather, biology, culture, monuments, and etcetera and make them change and more complicated. As a result, with regard to the significance of the positive effects of building dams, it is necessary to minimize the negative environmental effects for the sake of sustainable development. In this article, the negative effects and ways for decreasing these effects in the environment are more investigated.

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Introduction

As we know, among all the natural gifts, water is of a particular importance and this importance originates from the fact that all the scholars look for water as the primary origin of life. Having a glance at the condition of the available water which is applicable for man and all the other creatures that need sweet water, we can realize the depth of problem and the significance of confronting water seriously and cautiously.

The total amount of water in our planet, which we know it as hydrosphere, is about 1360000 cubic kilometers that about %97 of which is salt water and the remaining %2/7 is the sweet water. From this amount, %14/2 consists of polar ice which is unavailable and whatever we have is about 12000 cubic kilometers. From this amount, only a low percentage can be used. Meanwhile, the amount of ground water is a little more than 8000 cubic kilometers from which only three in thousand can be naturally rebuilt. The amount of rainfall on earth is 450000 cubic kilometers in a year which reaches a balance due to the evaporation and from this amount, only 110000 cubic kilometers rains on the continents. Regarding the statistics, we can realize the crisis state of water on earth. In order to prevent

the water from being wasted, we should store water in some places and be careful about contaminating it. This is the point where we realize the significance of the engineering knowledge of building dams. This method can be used as the best method in using sweet water for about seven billion people and many other creatures that have the right to live. Of course, this significance should not turn our attention from an evaluation of dam projects in order not to ruin the environment for the sake of sustainable development.

The effects of building dams on the environment

The environmental effects of dams:

Building a big dam with a high volume can have different considerable effects. A case in point is the physical, biological, social, economic, political, and ecological effects. Generally, the effect of the environment on the lake and dam and the mutual effect of this structure and its lake can be investigated in the framework of the environmental effects of dams. These effects may appear in two different ways:

Useful environmental mutual effects

Harmful environmental mutual effects

It is axiomatic that whatever these dams are aimed at will bring an improvement in the quality of life and social-economic development and these changes can be categorized as the useful effects. However, the harmful effects of a dam and a lake can also cause considerable changes in the environment which will not bring development and will destroy natural resources such as soil, water, jungle, human societies, and environmental health and will also destroy national capital.

Divisions of the effects of the dams on the environment are done differently. Some of these divisions have been done according to the short-term and long-term effects (Nik Aeen and Bidokhti, 1988, June). In the above division, the effects of the time of construction on the construction works of dams and its facilities and possibly a disorder in the environment in the time of construction were the focus of attention and the short-term effects on the river as well as long-term effects on the reservoir of the ecosystem and the basin are the focus of attention. Some effects are divided into local effects and regional effects according to their level of effect.

In other divisions, which are used more than the others, take into account the effects on human beings, plants, animals, weather, water, and geophysics (Bulletin 35, 1982).

The economic, social, and cultural effects (Human Environment)

One of the goals of dams is to have positive economic effects and improve peoples' social situations. Different studies have investigated the conditions in the dam areas before and after building dams and these studies have indicated much economic and social interest in that area (B. STEN, 1988).

One of the most important problems of human being in building dams is to resettle the local residents in the downstream areas (river coasts) and upstream areas (the reservoir area). Resettling the residents involves social, psychological, and cultural dimensions (Bulletin, 1985) and local and cultural problems and land possessions as well as economic interest may make the resettlement difficult and long-lasting.

How many villages with their garden paths are hidden under the water and sediment of the upstream lands? Where do all the memories of the village go? What does the nostalgic feeling of the village change into? How do these people live with their past under the water?

If they feel obliged to migrate, how can they adapt themselves with the new society? Does anyone ask them if they want to leave their land?

In this regard, in the studies related to building dams with regard to the collection of the recognized economic, social, and cultural capital, it is essential to act in a way that it does the least harm to the capital and also provide great and considerable effort to repair the damage and create circumstances to regain capital. We can point to the following items:

- 1) Building new villages with regard to the number of farm lands or the possibility of creating new jobs for the village. In addition, it is necessary for the village to participate actively in this order.
- 2) Combining a village in the surrounding villages with regard to the kind and amount of their social and cultural relationships and also the possibility creating jobs for the village
- 3) The migration of the village to the city and an attempt to settle the residents. This attempt should start before migration and should continue after settlement.

The effects the dams have on the surrounding monuments or they are in danger due to the landslide are the focus of attention such as pyramid tombs in Aswan due to building the Aswan dam (Bulletin, 1981) and ZarZar church in west

Azerbaijan due to building Baron dam. A dam, as an unnatural phenomenon and with a high volume in the natural environment creates inconsistencies which might be objectionable from the aesthetic and visual perspective. Also, ruining the natural views, national parks and waterfalls (Bulletin, 1988) has also been reported in some cases of building dams in Swedish.

Effects and changes in the reservoir

Creating a lake behind the dam makes the water static and changes its characteristics. These changes are as the following:

Sediment

As a natural phenomenon, sediment exists in the basin and depends on the basin conditions and building a dam, in case it causes a lot of damages to the land, increases the sediment. Decreasing the speed and the relative static condition of water makes the sediment to be accumulated in the tank and reduces the opacity of water in the downstream. Rising the bottom of the river and lowering the cross-section of the river and the filling the tank are of the problems in the upstream (Smalley Daniel H, 1978) and the amount of sediment depends on the basin condition. In Iran, there is no particular formula for anticipating the amount of sediment and investigations show the average amount of sediment as about 760 tons in a year for every cubic kilometer of the basin (consulting engineering of MahabGhods dependent on ministry of energy, January 1988). The sedimentation of perishable organic materials in the dam paves the way for contamination. Meanwhile, they decrease the food available in the downstream (Bulletin 65, 1988). Also, the sedimentation of heavy metals and their accumulation in the basin lead to the contamination and long-term changes in dam ecosystem.

Stratification

Stratification is a thermal process and depends on different factors such as size, morphology, depth, geographical conditions of the environment, the ratio of inflow to the volume of the basin and the ratio of depth of basin to its length (Bulletin 65, 1988). As a result of stratification is to create two or three layers of water in which the conditions and characteristics of Epilimnion and Hypolimnion are different and in the Hypolimnion, there might be a decrease in dissolved oxygen and there may even be anaerobic conditions. If these conditions exist and they lead to generating gas, this might make different parts of organic materials in the dam platform to float in the tank. Destratification by itself in spring and autumn leads to a sudden increase in food and brings with it algae bloom which lead to decreasing the quality of water. Those tanks which are stratified have more effect on changing the water temperature compared with the other tanks (Smalley, Daniel H. and Novak John K., 1978). According to some experts, stratification is a significant factor in creating the undesirable conditions in the quality of water.

Eutrophication

Due to the increase and accumulation of food (phosphorus and Nitrogen) in the tank, the algae growth will increase (Bachman, R, 1978). The food enters the tank through sewage and drain and in the recent years, this has increased due to the increase in consuming fertilizers, detergents, and discharging the sewage into the river (Bulletin 37, 1981).

Developing the activities in the upstream may lead to an increase in food of the tank in the long run. A case in point is discharging the sewage of residential and business units in the upstream areas of Karaj dam in the long run can have undesirable effects on the tank (Tavakoli, Ali Reza & Siyamak, 1367). Reducing dissolved oxygen in the hypolimnion is one of the consequences of eutrophication.

Evaporation from the tank and the effects of the tank's bed

Evaporation, which increases due to the water being stored in the tank, influences the quality of water in the river. In cold regions, there is the possibility of water freezing (Bulletin 65, 1988). The stone of the tank's bed can also change the quality of water. Studies in Iran indicate that the gypsum and salt deposits of Gachsaran in Zagros influences the quality of water in the tanks and in central Iran, the gypsum and salt of Qom formation and the below and above red formations influence the quality of water (15 Khordad dam and Estoor dam) (Dr. Reza Maknoon, November, 1988).

River hydrology and climate changes

A change in the river regime and the amount of water in different seasons is one of the direct effects of building dams. These effects may be negative or positive. The quantitative changes also bring hydrophysical as well as hydrochemical changes in water (Nik Aeen and Bidokhti, June, 1988). Flooding of the downstream region of the dam is one of the other consequences. A change in the river's ecosystem is the result of quantitative and qualitative changes and it appears even in further regions such as the estuary. A reduction in the sediments of the river's estuary causes erosion and a change in the coast ecosystem and also the estuary (E. T. HAWS. G. Mc L. Smith, M. R. Day, J. V. Towner, 1988). A reduction in the speed of the water decreases the assimilative power of the river. In Danoob and Rain rivers in Austria, the speed of the river and consequently the assimilative power of the river have decreased due to building several dams (Bulletin 65, 1988).

Building a dam can also bring minor and local changes in the climate of a particular region such a producing fog and a change in the water temperature. A change in the water temperature I the next stages influences the downstream ecosystem and the physical and chemical quality of irrigated soils.

The effects on the ground water

The ground water resources, which are linked to the river or the tank, also change. The effect of surface water on ground water also changes according to the changes of the water levels. The nutrition of ground water and a reduction in the difficulty are of the positive effects. The sediments of the dam, in the long run, may reduce the relationship between the lake and the ground water and may lead to the nutrition of ground water slowing down and ultimately the end of the relationships. Water leakage in downstream lands may lead to the string of lands and also influence the physical and chemical properties of the soil.

Geophysical effects

Watering and filling the dams may lead to the induced earthquakes (A. Volker, J. C. Henry, 1988). This may happen due to the pressure on the earth's crust or a change in tensions in the rocks below and near the dams. In the studies done for 425 dams, only in 15 cases were induced earthquakes from which 10 cases were with more than 5 Richter (A. Volker, J. C. Henry, 1988).

The effects on the animals and the plants

The effects of the tank on animals are mainly related to the fish and their movement being stopped along the river which may lead to a change in their species or extinction (Bulletin 37, 1981). On the other hand, the excess of water can also influence the wild life and the ecology of the river and the dam. The fluctuations of water level in the lake influences the ecosystem of the coast. Sometimes, the dam and the diversion structures of water such as tunnels may make the fish emigrate from one river to the other and this changes the ecosystem.

The effects of the dam on the plants in the upstream are due to the flooding of the regions and this leads to the destruction of the plants and possibly other rare species (Bulletin 65, 1988). In the lake's coasts, it is possible for the new plants to grow and in case the fluctuations of the water level, especially in dry regions, make some of the coasts to be out of water for several years, these organic materials enter the lake with a second flooding.

Sanitary effects

Creating an environment for growing bacteria of disease in warm regions increases the diseases related to water. Malaria, encephalitis, fylaryasys, lytospyrasys are some of the diseases which may develop and intensify (NikAeen and Bidokhti, June, 1988). The intensifications of Malaria, encephalitis, Fylaryasys, Lpytospyrasys are the diseases which may develop and intensify (NikAeen&Bidokhti, June, 1988). The intensification of Malaria in non-rainy seasons (Bulletin 37, 1981) and the significance of paying attention to Shistosima are mentioned in African water resources (Bulletin 65, 1988).

The following points must be taken into account when investigating the effects of building dams in the environment:

- Paying attention to short-term, long-term effects as well as the effect of the construction period
- The significance of comprehensive studies and taking the ecosystem, the river, and its surrounding into account
- Paying attention to the complexity of relationships in the environment and recognizing the chain of comprehensive relationships
- Paying attention to the factor of time in long-term changes (hydrological, biological, chemical, the dam's ecosystem)
- Paying attention to the possibility of changing the effects' orientation during time

Dams and the changes of the river's bed

Of the other effects of dams are the river's bed changes. Usually, the water which is stored before the dam contains a lot of sludge and silt which accumulate before the dams and the water which overflows lacks the sludge and silt and the fast speed of this water when confronting with the river leads to the erosion of the river. Base level is the lowest point till which a river can be worn out. The studies show that paying attention to the environmental issues in the primary stages decreases the next costs (Dr. Reza Maknoon, November, 1988) and the side effects.

Policies, rules, and regulations of controlling the environment

Policies, rules, and regulations of conserving and controlling the environment are important and influential factors on the design in the stage of studies and exploitation. The general policies such as the policy of conserving the wild life, the policy of ethnicities and nationalities, conserving natural and cultural resources provide major guidelines. In Iran, the environmental protection agency is responsible for regulating environmental criteria based on the establishment law and also the law of water adopted in 70/03/1983.

The rules and regulations of the designer and consultant organizations as well as the rules of the organizations which provide validity influence the design. For example, the World Bank has paid particular attention to social security and environmental issues for the designs of water resources development and providing validity (G. E. Schuh, G. Lemoigne, M. Cernea. R. J. A, 1988).

Ways for facing environmental damages

Economic, social, and cultural effects (human environment)

The most important issue is resettling the residents, which is recommended to provide the maximum economic, cultural and social compensation in order to decrease the side effects.

Anticipating the proper facilities for welfare, new job opportunities, the possibility of having access to education for a better job can decrease the negative effects of resettling the residents (Bulletin 35, 1982). There is no need for trying to disrupt or change the peoples' culture and customs since it may lead to other new problems (Bulletin 50, 1985). The productivity of the results of the dam to people such as electricity services, good roads, and water supply should be taken into account. In some studies, resettling the residents is the focus of attention with regard to its human dimensions (Danoob) (K. Neimarevic, 1988). Preserving the monuments is also considered as one of the cultural values and has been paid considerable attention to in several cases such as global efforts for replacing the temple in Egypt which was in danger due to building Aswan dam (Bulletin 37, 1981). Policies such as having a second look at pricing the lands, the taxes and etc can be taken into account as levers for helping people and developing the future of the region.

The effects and changes in the dam's tank

Sediment

Watershed, improving the conditions of the basin and reducing the sediment in the mountains are important because of decreasing the sediment which enters the tank. Anticipating the required dead volume for keeping the sediment and discharging and dredging the sediment is done for maintaining the dam's tank. Discharging the sediment by deep valves is particularly used in heavy sediments (J. Rambaud M. Clair, 1988). Lower discharging has been also reported for removing the food. (M. Bzioui, M. Haddaoui, 1988). In order to decrease the opacity of water in downstream when flooding, the discharge of water from different valves and its mixture have been used (S. Fujimoto, Y. Moridita, 1988). The amount of this affect when flooding and opacity is also influential (S. Nakamura, N. Yotsukura, 1988).

Stratification

Some of the solutions are in order to disrupt the Stratification state or to prevent their formation. The above solutions consist of disrupting the tank's water and aerating (P. L. Johnson, J. F. Labounty, 1988). Other ways of changing the water program are in the times of the tank's stratification from the layers of water (N. Kubo, K. Shiota. Y. Kitamura, 1988). In this state, watering usually starts from the epilimnion which is in a better situation.

Getting full of food

Prevention methods consist of controlling the sewage input into the tank. Many people prefer these methods to controlling ways in the tank (G. Ackermann, 1988). Anticipating the suitable drainage in agricultural land and leading the drainage water to the downstream is also influential. Recognizing and deleting the sources of pollution in the stage of construction and then the stage of controlling the urban and services development in the upstream are the best ways from the perspective of discharging the sewage. In the first stage of watering the dam, clearing the lake's environment from perishable organic materials contribute to decreasing and deleting the food. In order to control the food especially phosphorus, sometimes the high purification of the sewage in times of difficulty have been used (S. Jung, W. Kim, 1988). Purification methods consist of extended aerating, purification with Alum, copper sulfate, and other herbicides (S. Jung, W. Kim, 1988). These methods are used particularly when the algae is growing.

The third group of methods consists of discharging the organic materials through the lower valve (M. Bzioui, M. Haddaoui, 1988) or through changing water program when there is pollution or by valves which are in the high mountain of dams (S. Oike, M. Anyoji. T. Takada, 1988).

The hydrology of the river and weather changes

Exploitation of the dam for the sake of its goals (hydroelectric, agriculture ...) changes the regime of the river. Regulating the minimum flow of the river is done after achieving the primary goal (such as irrigation). The minimum flow is mainly for conserving the environment or meeting the natural refining power of the river. Determining the minimum flow does not have a general solution agreed upon by everyone (A. Volker, J. C. Henry, 1988). Some people recommend the minimum flow for mountain rivers 0/2, for more uniform rivers 0/5, and for large rivers 0/8 till once of the average of the least annual flow (A. Volker, J. C. Henry, 1988). Decreasing the flow and speed of the water lead to a reduction in the assimilative power of the river for the compensation of which increasing the volume of the discharged water or more purification of the sewage for discharging into the river are recommended (Bulletin 65, 1988). For regulating the discharged temperature of water, watering from different mountains of the lake or anticipating a warming swimming pool in the downstream for increasing the water temperature have been used (T. H. Yoon, C. W. Kim, 1988).

Effects on the ground water

Drainage of the downstream lands of the dam is compensable with draining (M. Breznik, 1988). In order to prevent from the nourishment of the ground sources and raising the ground water substrates, blocking the ducts, draining, anticipating wells and holes for discharging water in the edges of the ground water substrates are possible (Bulletin 50, 1985). Anticipating the observing wells in the downstream of the dam has been done for studying, recognizing, and chasing the changes in the stones' capability of penetration as controlling tools (C. Kutzner, 1988).

Geophysical effects

Controlling the filling of the dam in the watering stage has been presented as a method for decreasing the induced earthquakes (T. Vladus, 1988).

The effects on the animals and plants

The anticipation of the fish ladder and bypass for the immigration of fish to the upstream and the anticipation of new and replaced places and for compensating laying fish of the fish have been used (Bulletin 65, 1988). In addition to maintaining the movements of the fish, its development can also be considered as the design (L. Boiry. R. Quiros, M. Servant, 1988).

About the animals out of the water ecosystem, the anticipation of the movement in the soil ecosystem is also suitable. The movement of the life conditions for both animals and birds in the new environment and also creating natural parks for conserving the rare species of animals are methods of compensating environmental damages (D. N. Kulkarni. V. V. Patki, 1988).

Flooding in the upstream region leads to removing the plants and rare species for conservation of which planting in new regions or creating natural parks are the focus of attention. Reconstructing the natural resources and jungles (Delmonico, P. Zeiter, P. Bachofner, 1988) and creating gardens out of local plants of the region (A. J. Mills, R. H. Pattle, 1988) have been used

Sanitary effects

The physical elimination of disease factors by spraying the fixed pools and drainages, covering the canals' levels, repeated discharging of the canals for preventing the insects from laying eggs are some direct methods of removing the factors of disease (Nik Aeen & Bidokhti, 1987). Cultivating some plants are

poisonous for some worms carry the disease has also been considered (A. Volker, J. C. Henry, 1988). The prevention and curing methods such as providing the people with sanitary facilities, training people at sanitary, vaccinating people, a constant controlling and survey of the individual events, complying with health and sanitary such as proper disposal of the sewage and providing healthy drinking water are ways which decrease the consequences related to sanitary.

Conclusion

The main problem in our country is the lack of comprehensive and sufficient studies for building dams. Over the last half century, most of the dams in Iran were constructed by foreign engineers and designers who may not have national and patriotic sense and the heritage and environmental issues did not matter for them during that time. As an example, there is not enough care in location and some of the dams were constructed near active faults. According to the minister of energy, Lar dam has the problem of water break from the tank and this problem still does exist. Other problems are: The death of more than two hundred flamingo chicks after watering Sivand dam, Bolaghi strait going under the water in this region, not using the sedimentary plains in the upstream while having a good texture and a depth of about 90 meters for Aquifer management, the closeness of Sivand dam to the Great Cyrus Tomb (about 5 kilometers), the difference of the water level with the Great Cyrus tomb (4 or 40 meters according to different stories), the destructive effect of the Sivan dam's moisture on the historical monuments in Pasargad and ruining the last remaining of a road belonging to the great kingdom of Achaemenid.

Iran is considered as the most vulnerable countries in the world due to being located in the seismic belt of "Alp-Himaliya". However, lack of attention to this situation has increased the building dam trend in the most risky mountains of the country from tectonic dimension.

Some thought-provoking questions:

How much economical is the amount of capitals for building dams?

How much the amount of precipitation in constructed dams has been estimated during these years?

Does anybody know how much the amount of handling the invisible money is in building dams?

How much is the amount of blank and unseen profit of the dam builders out of each dam?

How much is the negative effect of building dams after the revolution?

Can we use the natural resources by using better tools for conserving and keeping these resources?

Is building dams the only way for saving the country, the agriculture, and the environment?

Or not!!!

Building dam is the sign of development!!

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