

Original Paper

Evaluating Negative Environmental Impacts Caused by Dam Construction

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Abstract

Dams are one of the most important structures in the water resources transmission and storage systems. Thus, given the growth and development of dam construction in the world, evaluating environmental consequences of the dam has high importance. Dams leave positive and negative impacts on the environment. The destructive impacts of dam construction include social, economic, hydraulic, biological, health, and atmospheric impacts, etc., leading to change and complexity. Hence, given the importance of the positive impacts of dams, it is essential that negative environmental impacts of the dam to be minimized for sustainable development. The current article evaluates the negative environmental impacts caused by dam construction.

Keywords

dam, environment, negative impacts, evaluation

1. Introduction

Given the vital role of water at all periods of human life and increasing population growth, water shortage crisis is predictable and it has always made the experts reduce its losses and provide it to public easily by introducing water control methods and plans (Pirestani & Shafghti, 2009). Nowadays, dams are considered as important water structures constructed in all parts of the world, especially in arid and semi-arid areas for surface water management. These structures have close relationship with geological conditions in which they were constructed. Hence, all risks in the scope of dam and reservoir need to be investigated and eliminated or reduced, as much as possible (Parhizkar, 2007). Moreover, the dam construction has been known for long time as being a suitable solution to supply water for agricultural, drinking, and industrial consumptions, flood control, production of hydroelectric energy, quality control, and so on. However, it should be claimed that there is almost no dam without

environmental problem (Shabankari & Halabian, 2010). Thus, developing water facilities on the rivers and construction plans related to it can affect the environment in various forms. By stopping the river flow and water storage, dams can be considered as non-stabilizing factor in nature, but if this instability is not at the tolerance and capability of environment, destructive impacts of this structure will gradually emerge and destroy the dam construction goals. Moreover, construction of dam can result in development of urbanization, agriculture, and industry in the dam spring well, which contributes to increased agricultural, urban, and industrial wastewater, and transmission of materials to the lake behind the dams. It finally leads into an active and appropriate environment for biological activities of microorganisms and reduced water quality (Alizadeh et al., 2015). The environmental impacts of construction of dams and reservoirs after the end of the World War II were well recognized and knowledge on the risks of dam construction on the environment reached its peak in the twentieth century (Kyohei & Toshio, 2009). Paying increased attention to environment has caused conflicts among planners, engineers, and some eco-friendly groups against structural activities, especially dam construction. On the other hand, preventing the construction projects will not possible for development of technology and enhancing the quality of life. Thus, in addition to technical and economic standards, environmental standards should be considered (Tahmicioglo et al., 2007).

2. Environmental Impacts of Dam Construction

The impact of the environment on lake of dam and the interaction of this structure and its lake on the environment can be investigated in the form of “environmental impacts of dams”. These impacts might emerge in two forms (Karimi & Chamanchi, 2007).

-Negative or harmful environmental impacts

-Positive or beneficial environmental impacts

This article tries to present the possible negative or harmful environmental impacts induced by dam constructions.

2.1 Negative or Harmful Environmental Impacts

The ecological results of the dams would depend on their location. It is possible to classify the environmental impacts of dams based on various short-term and long-term criteria, area where dam is constructed, and useful and harmful social and non-social impacts, while there are other classifications in this regard.

In general, based on the guideline of the International Committee of the Great Dams (ICGD), environmental studies of dams should be conducted in the form of sections, which include physical and chemical impacts, biological impacts, health impacts, and social and economic impacts. However, in most of the cases, the environmental impacts are examined and evaluated separately for the two periods of construction and exploitation (Tahmicioglo et al., 2007).

2.1.1 Social and Economic Impacts

- a) The impacts of dam construction on neighboring villages and communities flooded in the dam's lake, and this phenomenon leads to increased population of cities and false jobs (Pirestani & Shafghti, 2009).
- b) Impact of dam construction on facilities and structures: destruction of roads and power transmission lines as a result of passing through the lakes, lack of access to some points of the dam scope, old canals, dikes, and so on are among the losses of the large dams (Pirestani & Shafghti, 2009).
- c) Loss of agricultural lands to provide materials or their submergence in water cause unemployment for great number of people (Pirestani & Shafghti, 2009).
- d) Sometimes, the employment of non-local workers at the stage of construction and development during the exploitation are some other problems disturbing the security of city and village. These problems are exacerbated in some cases such as attracting tourists, and they can change the traditional and cultural structure of that city or village in the long term (Pirestani & Shafghti, 2009).
- e) Historical sites and places with special and beautiful topography, found rarely by going under water (Karimi & Chamanchi, 2007).

2.1.2 Physical and Chemical Impacts

- a) Dam construction acts as a barrier for movement of floating objects along rivers, such as trees, ice parts, fish, ships, and so on (Pirestani & Shafghti, 2009).
- b) As a result of sedimentation of sediment materials in reservoir and lake of dam, dam construction causes relative reduction of the solid materials and river sediments. This would disturb the natural balance of sediment transmission potential at dam downstream and exacerbate the erosion in the downstream river (Pirestani & Shafghti, 2009).
- c) The impact of sediment in the reservoir in blocking the floodgates and dischargers (Pirestani & Shafghti, 2009).
- d) The impact of muddy water discharge containing sedimentary materials on the downstream areas of the dam and environment of the region.
- e) Occurrence of many floods resulting from releasing the water of dischargers and spillways causes major physical, chemical, and biological changes in downstream of dams (Pirestani & Shafghti, 2009).
- f) The water system might be changed as a result of environmental destruction and create unexpected floods, leading to damage to the vegetation and natural structure in the river passageways (Pirestani & Shafghti, 2009).
- g) Salinization of agricultural land due to increased groundwater level and drainage of lands caused by surface irrigation. When groundwater level approaches to the surface of earth, the capillary phenomenon brings soil salt to its surface. Secondary salinity might occur even when groundwater is used under proper control, due to poor groundwater quality. Salinization of lands reduces yield of salinity-sensitive products, which it make land unproductive (Cadiver, 2007).

2.1.3 Health Impacts

- a) Impact of the lake on growth of plants: In shallow lake, the growth of water plants causes damage to fish and provides an appropriate environment for spawning of the insects (Karimi & Chamanchi, 2007).
- b) Lake of dams can be source of many contagious diseases, such as malaria and blood diseases. This issue has caused high losses in some countries, such as African countries (Pirestani & Shafghti, 2009)
- c) The greatest impact of diseases outbreak and spawning of insects is seen the tourist dams, due to presence of more people and the creation of garbage and wastewater, but in reservoir dams, due to stagnation of water accumulated in the lake, the outbreak of pathogenic bacteria is seen more (Naderi, 2007).

2.1.4 Impact on the Ecosystem of Aquatic Organisms

- a) In the construction phase, increased erosion and sedimentation occurs at the dam downstream, which benthic animals die with increasing water particles and their sediment. It leads into elimination of the nutrients of some species of aquatic environments and interference of ecological balance of these environments (Kamali & Kukhezkadeh, 2007).
- b) At first, decomposition of living organisms in a short term increases the amount of nutrients in the water, so the Biological Oxygen Demand (BOD) of the water increases and forms an anaerobic decomposition environment by help of layers staying in deep of reservoirs, leading to creation of a dark and smelly environment in the lake. Thus, an excessive increase of phytoplankton is seen (Pirestani & Shafghti, 2009).
- c) In addition to plants covering the surface of the water as a wide dark green layer, macro flora grows on the surface of the water. This can be hazardous for both life of lake and people fishing and boating, and even floodgates and turbine propellers. Sometimes, the macro flora acts as source of disease carrier. In addition, increased aqueous plants increases the abnormal evapotranspiration (Kyohei & Toshio, 2009).
- d) Dams are considered barriers for movement of fish from the upstream of river to downstream of river. Thus, dam means the death of a species of fish, spending a part of its life in springs or water floods and the other part at the intersection of the rivers and the sea. As some of the marine fish come to fresh water and lakes for laying and then return to the sea with young fish, the presence of dam prevents this movement and disrupts the cycle and causes extinction of the fish. Secondary passageways are constructed sometimes for this purpose (Tahmicoglu et al., 2007).
- e) Drainage of swamps and cases like this and drilling operations alongside of river will have destructive impacts on aquatic animals and even lead to their death (Pirestani & Shafghti, 2009; Tahmicoglu et al., 2007).
- f) Temperature, salinity, and oxygen amount can be changed vertically, resulting in non-oxygen conditions and new species emergence (Pirestani & Shafghti, 2009).
- g) Due to dam construction and keeping the sediments in its reservoir, their transmission to downstream is prevented, which could be a reason for corrosion in the reservoir and river bed. On the other hand,

preventing the transmission of sediments to river downstream blocks the spawning sites of the fish at the path of flow and makes their reproduction to face with problem (Teodoru et al., 2006).

h) Due to construction at the river bed, the flow regime might change, and the sudden flood of water behind the dam threatens the vegetation and animal life around the coasts (Tahmicoglu et al., 2007).

2.1.5 Biological Impacts

a) Reduced concentration of the nutrients at dam downstream and its impacts on the plant and animal community of that area (Pirestani & Shafghti, 2009).

b) Water storage impact in shallow reservoirs on the growth and development of planktons.

c) Thermal layering and the feasibility of using water with a low degree of this lake power plants and drinking water consumptions, etc. (Pirestani & Shafghti, 2009).

d) The water temperature, distribution of salt, and oxygen might be changed due to formation of the reservoirs and lead into production of new species (Canadian Dam Association, 2000).

e) Serious changes will occur in the water quality (Pirestani & Shafghti, 2009).

f) Species might change due to erosion resulting from human activity or increased water turbidity caused by damming operation (Pirestani & Shafghti, 2009).

g) The release of toxic substances (pesticides, toxic metals, etc.) and their density in the food chain might leave impacts on sensitive animals immediately and extinct their generation, when the river is not able to revive itself (Pirestani & Shafghti, 2009).

h) The river's biological life changes rapidly both in reservoirs and downstream. Parts of ecosystem affected by dams are coastal waters. When the reservoirs are filled, as lands are pulled toward under water, dry lands are reduced and water boundaries are expanded. Therefore, habitat of humans, animals, and plants is changed, and the forests and agricultural lands may be pulled toward under water. As water surface is constantly changing, some species begin living in the tidal areas under the water and these environments may be transformed into swampy lands or sandy bed, depending on the soil structure (Tahmicoglu et al., 2007).

i) The relationship of water, soil, and food established after floods changes over time at dams' downstream. These compulsory changes occur on the plants, animals, and agricultural traditions of the people of the area, which its impact will be expanded and predicted up to kilometers (Tahmicoglu et al., 2007).

j) As drainage of the dam occurs in the rainy season, lower level of water is reaches to dam and river downstream. Given fixed volume of wastewater and other input pollutants in the downstream parts, it is expected that the level of pollution to be increased at the upstream. Additionally, the concentration of surface water pollutants is increased in downstream parts during the water shortage period, so that it is exacerbated by high withdrawal of water at downstream (Kamali & Kukhekezadeh, 2007).

2.1.6 Impact on Atmospheric System

a) Large dams cause change in the content of air humidity, air flows, and its temperature in the region and the surrounding areas. While such changes seem to be hazardous for humans, they are important

for many plants and animals. Atmospheric changes affect the secondary standards, developed for human health (Pirestani & Shafghti, 2009).

b) In a research conducted on a dam constructed on the Nile River, it was shown that organic materials stored in sediments of the reservoir floor can be decomposed over time and converted into carbon dioxide and methane. Annual production of 200000 to 300000 tons of carbon has been reported around the reservoir. However, no hazard caused by greenhouse gases has been reported around the dam (Teodoru et al., 2006).

c) Changes in rate of humidity, temperature, and air displacement due to increased volume of still water will change the climate related to topography of region. Moreover, graded climatic changes are seen. For example, with the construction of the Kalghan dam in East Azarbaijan, very large volume of water is stored behind the dam, leaving impacts on air and climate of the region. Some of these changes are increased absorption of solar energy at the region level, the exchange of temperature between the lake water of dam and surrounding atmosphere and changes in the rate of evaporation and fog. By increasing the level of evaporation, the rate of evaporation increases. While these changes might not be hazardous for health of humans, they are significant for many of the plants and animals and their secondary impacts on humans will be seen (Pirestani & Shafghti, 2009; Tahmicoglu et al., 2007).

d) Another harmful impact of dams is release of greenhouse gas from reservoirs due corrosive vegetation and carbon flow from the basin (Cadiver, 2007).

e) It should be noted that by development of region, traffic state will change and the traffic of vehicles increases, leading to increased air pollution (Kamali & Kukhehzadeh, 2007).

2.1.7 Noise Pollution

a) With introduction of machinery and devices used for construction of the dam during the construction phase, the noise level in the region is increasing sharply. The sound generated by the relevant machinery and the explosions performed in the dam construction operation disrupts the relaxation of the region and leaves undesirable impacts on wildlife. Leaving the nest, migrating to surrounding areas, the probability of abortion in mammals and birds' laying are some of the impacts and consequences of sound pollution caused by project activities in the construction phase (Kamali & Kukhehzadeh, 2007).

b) With start of construction operations of reservoir dam, the level of noise balance in the project scope will increase. Based on the estimates, noise resulting from construction activities reaches to about 2 km from the project scope to 71 dB, which is the standard level of open environment. In this radius of the scope of reservoir dam, no residential places are seen. However, providing personal protective equipment against noise is essential for workshop personnel (Piri, 2011).

2.1.8 Impact on Seismicity

a) Some researchers argue that dams might leave impacts on the land structure, which are unchangeable. Some earthquakes are attributed to dam construction. Changes in land slope and topography and accumulation of sediments behind the dam reduce the content of sediment in the river

route and erosion of its bed as one of the most important factors threatening the environment is other issues related to dam construction (Şahin & Kurum, 2002).

b) The reaction between the lake water level, environment humidity, and various layering along with dam reservoir create landslide, which its impacts are revealed in two forms of reduced volume of the lake and creation of long waves of dam and/or its destruction. As change in water level in the hydroelectric and reservoir dams is less than that in the flood control dams, the occurrence of landslide in these dams is less, while flood control dams will have more impact on landslide due to particular practice of exploitation and frequent dehydration and alternate drying and wetting of the lands of reservoir wall (Naderi, 2004).

c) Due to impact of water load on the lake floor, there is the possibility of occurrence of induced earthquakes, which reservoir and hydroelectric dams leave high impact on induced earthquakes due to having large quantities of water. These earthquakes occur due to the heavy weight of lake water and disturbed balance of pressure in various layers of the earth. For example, in investigating the Karkheh Dam, it was found that the number of earthquakes increased immediately as dam dehydration increased and their number decreased over time, as water level was fixed. Thus, if the height of water in the reservoir is kept at fixed level, seismicity of the area can be controlled to some extent. Additionally, according to scientists, the first reason attributed for the Bam earthquake was the water accumulated behind the Jiroft dam (constructed in southern part of Iran), while another reason was proposed for it later by several studies (Naderi, 2004).

2.1.9 Impact on Hydraulic System

a) The main significant hydraulic impact is the drainage of the basin flows into a fixed water resource rather than discharge into river bed. Thus, the stability change will occur in the downstream, since downstream would dry partially or completely due to closure of floodgate. It leads to disturbed balance in the downstream ecosystem, problem in life of aquatics, and loss of many organisms.

Due to temperature variations and content of oxygen in the water resource, the balance will be disturbed and death of the organisms would be seen in upstream. As a result, the decomposition of plants and animals is expanding in the water resource. Hence, the water resource is contaminated in upstream, the content of oxygen would be low in deep parts, and due to decomposition of organisms and presence of hydrogen sulfide, the color of water would be dark and smelly and conditions would be oxygen-free (Teodoru et al., 2006).

b) The major hydraulic impact is transforming the river basin with flow to a still reservoir. Thus, the downstream undergoes immediate changes, so that with accumulation of water in the dam reservoir, downstream or part of it is dried. Hydraulic balance is disturbed during this time, and irreversible destructions, sudden structural mutation are seen in aquatic ecosystem. The corruption and decay of dead animals and plants in the water flower is accelerated. Thus, upstream water flow is contaminated and becomes oxygen-free in the deeper parts. Its color would be dark for long time along with smell of corrosion caused by hydrogen sulfur secretion. While there is the possibility of creation of a new

ecosystem for the river after this stage, his area has no chance of returning to previous position due to new balance for soil ecosystem and even the marine environment (Tahmicioglu et al., 2007).

3. Conclusions

As discussed in the present paper, dams may have several destructive or negative impacts in addition to their benefits. Given the increasing trend of technology and empowerment of humans to overcome nature, we every day experience destruction of part of this nature, unfortunately. As stated several times, despite many benefits of construction of dams and ignoring their negative impacts on the environment, and finally human life in the long term, it might be better to think on using alternative methods to control water and flood.

4. Recommendations

Some of the considerations that can be taken in to account in-order to reduce the negative environmental impacts of dam construction may include the following:

- Conducting scientific and research studies to identify plant and animal species in the region.
- Using short earth dams as an appropriate alternative to large dams to protect plant and animal ecosystems.
- Defining and determining the ecological boundaries of the project and providing comprehensive management plans to improve the environmental status.
- Training and enhancing the knowledge of residents of the affected region to reduce environmental damage and increase public involvement in promoting the environmental indicators of the region.
- Passing laws for residents of that region and tourists to prevent the destruction of animal and plant habitats and to prevent the health consequences of dam construction, especially when dam's lake is used as a tourism region in order to reduce the damage to environment.

References

- Alizadeh, O., & Pourazari, A. M. (2015). Cross-sectional study of water quality changes in the lake behind the Aras dam. *Scientific and Research Journal of Wetland Eco-biology*, 6.
- Baba, K., & Hirose, T. (2009). Environmental Impact Assessment of Dams and Reservoirs. *Water Storage, Transport and Distribution*.
- Cadaver, M. S. (2007). *Dams and Development* (1st ed.).
- Canadian Dam Association. (2000). *CDA's frequently asked questions*. Canadian Dam Association Web Site. Retrieved from <http://www.cda.ca/cda/main/newlets/fall00/faq.html>
- Karimi Jashni, A., & Chamanchi, M. (2007). *Comparing the destructive environmental impacts of dams with using Veten-Verau matrix*. The First Specialized Dam and Environment Workshop.

- Kamali, M., & Kukhekezadeh, M. (2007). *The impact of environmental factors on water resources development Planning: A Case Study of Kalghan Dam*. The First Specialized Dam and Environment Workshop.
- Naderi, M. (2004). *Investigating the environmental impact of dams*. 11th National Civil Students Conference, Iran.
- Pirestani, M. R., & Shafghiti, M. (2009). Investigating the environmental impact of dam construction. *Quarterly journal of human geography*, 1(3).
- Parhizgar, M. R. (2007). *Investigation the geological hazards in the Tang-e-Sorkh dam area of Shiraz (with a view to solubility of gypsum)* (Unpublished master's thesis). Tarbiat Modarres University, Iran.
- Piri, H. (2011). Evaluating the environmental impact of construction of the Nime Chaharom Chah Dam in Zabol. *Land Use Planning*, 3(5).
- Shabankari, M., & Halabian, A. H. (2010). Investigating the environmental impact of Zayandehrud dam lake. *Journal of Human and Environment*, 8(1).
- Sait Tahmicioglu, M., Anul, N., Ekmekci, F., & Durmus, N. (2007). *Positive and negative impact of dams on the environment*. International Congress on River Basin Management, Turkey.
- Teodoru, C., Wuest, A., Wehrli, B., & Gewasserschutz, A. (2008). *Independent review of the environmental impact assessment for the Merowe Dam project (Nile River, Sudan): Eawag*. United Nations Environment programme, UNEP.
- Şahin, Ş., & Kurum, E. (2002). Erosion risk analysis by GIS in environmental impact assessments: A case study—Seyhan Köprü Dam construction. *Journal of Environmental Management*, 66(3), 239-247. <https://doi.org/10.1006/jema.2002.0574>