Positive and negative effects of damming industry

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Abstract

Dam construction, like other industries, can cause environmental and social losses in a region. The greatest damage is caused by ponds of dams. Although these ponds reduce a few opportunities, they bring with it more opportunities for the development of society. Regardless of all positive effects such as clean energy production, job creation, increasing the reliability of power plants during a crisis, and increasing the credibility of the executives and advisers, it is easy to say that the created reservoirs can be used in such a way by increasing the capacity created; the profits generated could be more than damaging. Firstly, the advantages of this industry are mentioned in this study. Then, the possibility of reducing the adverse effects with the mention of successful experiments is studied. In the end, it came to the conclusion that if these projects were correctly implemented and replaced by hydroelectric power plants, instead of the pollutants that produce environmental pollution, green growth could be improved. Damage can also be justified by proper utilization of water resources behind the dams.

Keywords: Dam, Greenhouse gases, Global warming, Hydropower, Water per capita.

1. INTRODUCTION

The development and improvement of human societies after the Industrial Revolution of Europe is by no means without changes in the environment. During each of the activities, it has always been tried to reduce the adverse effects of various industries, such as dam construction. To this end, many of sciences have been used together to the extent that the high profitability of these structures and their lower complications are assured nowadays. Advances in agriculture, industry, mining, and so on were not possible without the construction of a large dam. So far, 50,000 dams 800 of which are in Iran have been built around the world and advanced society such as Canada and USA have many of them. Below is a summary of advantages and disadvantages of this industry.

2. POSITIVE EFFECTS OF DAMMING

The following are the most significant positive impacts of dams: electricity generation, recreation and tourism, water and water sports, moderating greenhouse gas emission, fish caught and fish farming, water supply, flood control, job creation and foreign exchange entry into the country and high safety factor in times of crisis has been investigated.

2.1. ELECTRICITY GENERATION

Hydroelectricity power plants are considered as the third source of power generation and also the most important renewable energy producer in the world. Currently, these types of powerhouses are the cheapest and most cost-effective power plants in prone countries that are capable of generating electricity. In addition, other renewable energy generating plants can be efficient and helpful, but due to their big problems, they are not economical in the absence of hydroelectric power plants or cannot be effective in meeting the needs of the community.

According to the latest studies, about 19 percent of the world's electricity is supplied from hydroelectric power [1]. China, Brazil, the United States and Canada have 27, 8.5, 7.5, and 7.3 percent of the world's hydroelectric power respectively. This owns more than 90 percent of electricity of 24 countries and as well as more than 50 percent of electricity of 63 countries [2]. While today, due to the destruction of a few old dams in the United States at various assemblies dealing with the destruction of dams in the country, it produces a high percentage of its electricity from the industry and is one of the developed countries in this field by having more than 9000 dams. Population growth and the advancement of energy consuming industries will double the needing

of development of this kind of power plants. According to the statistics the production of power plants in 2014, it was 10778 MW [3]. If we reach the maximum capacity of the country, this figure will be almost a little more than double. Despite problems such as the water crisis in the country and its impact on the performance of hydroelectric power stations, the Ministry of Water and Energy has several plans with the capacity of 22.7 GW in exploitation, implementation and investigation. Yet, the country's capacity is lower than many other countries in the world, such as Tajikistan and Paraguay, which produce more than 98% of their electricity by hydroelectric power plants, also Iran is behind advancing countries such as Japan and Turkey. These countries, despite the damming effects on the perimeter environment, are working seriously to reduce the possible complications of developing this industry with more capacity than Iran. Since per capita energy consumption in Iran is 1.61 times the global per capita and 0.73 times per capita in OECD [1] countries; comprehensive planning in this field will be helpful to development.

2.2. RECREATION AND TOURISM, SHIPPING AND WATER SPORTS

Iran is one of the first five countries in the world in terms of climate diversity and one of the top ten in terms of culture and history. This is while only 0.7% of the world's tourism revenue is devoted to Iran. According to forecasts by the World Tourism Organization in 2020, about one billion and five hundred and sixty million people will go to tourism, and revenues from it will reach $ 1.5 trillion [4]. This issue has been studied in various researches, but due to various shortcomings in this regard, Iran has not yet achieved its main position in this field. Dams and power plants, in addition to being one of the most important sources of water and electricity supply, have created great potential for the development of the tourism industry by creating their own special sights. In many countries, dams and reservoirs are considered to be the most important tourist hubs, attracting thousands of travelers annually. For example, the Grand Dixence Dam in Switzerland is one of them, which capabilities of this dam and its planning have made it one of the largest tourist attractions. The Moiry dam in Switzerland, Navajo in Mexico, and Hoover in the United States are examples of major dams in attracting tourists. Statistics of visiting for the Hoover Dam with a capacity for spectacular sights, boating and water sports is nine million people annually, as well as a visit statistic to the Three Gorges Dam in China with more than one million people sailing and doing water sports [5]. Considering the success of these countries and the capacity to create a dam in the beautiful areas of different province, as well as the successes achieved in some Iranian dams such as Zayandehrood, tourism can be considered the most important horizons of the country's development.

2.3. PREVENTING GREENHOUSE GAS EMISSIONS

Greenhouse gases are toxic to humans, animals and even plants, are the main cause of air pollution, acid rain, climate change, droughts and environmental degradation, and today it is a serious threat to human health and, if not controlled in time, there will be irreparable consequences for all the people of the world and the planet. According to Table 1, a high share of greenhouse gas emissions is generated in the power plant. According to studies, less than 1 percent of the country's power plants are due to hydroelectric power plants. And this low percentage also includes carbon production and can be compensated by planting trees and creating green spaces. This is one of the most important reasons for the development of these types of power plants globally.

Table 1: The share of each energy consumer in poisonous and greenhouse gases emissions in 2014(%) [3]

N_2O	CH_4	CO_2	SPM	CO	SO_3	SO_2	NO_x	Gas/part
4.55	6.94	22.79	2.71	0.52	2.64	2.53	5.84	Final energy consumption Domestic, commercial and public
2.43	3.56	16.67	4.30	0.24	16.85	11.65	8.77	Industry
54.84	80.68	24.93	79.76	97.20	47.68	39.72	49.64	Transportation
32.01	0.98	2.07	5.71	0.13	2.27	3.74	2.74	Agriculture
								Consume energy
0.48	0.79	4.02	*	*	*	*	*	Refinery
5.70	7.06	29.51	7.52	1.91	30.55	42.35	33.01	Power plant
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	SUM

* Values are not available

1. Organisation for Economic Co-operation and Development

Greenhouse gasses cause greenhouse phenomena and therefore global warming. Today, the phenomenon of global warming is one of the problems that various national and international institutions are struggling to resolve. In addition to increase the efficiency of pollutant generating plants, replacing hydropower plants, it is being tried to solve the problem of environmental pollution and global warming. In this regard regional and international meetings are held annually. The most important meeting was held in Paris in 2015. During this conference, Iran pledged to reduce the production of these gases by 8% until 2030, if the international sanctions were lifted, and to put 7.500 MW of clean energy into the electricity distribution network. It should be noted that the domestic institutions have implemented effective and efficient programs to reduce greenhouse gases in different sectors, so that according to the data of Power and Energy in 2009, many damages caused by the gases from transportation, power plants, agriculture and other sectors were reduced. According to the World Bank and World Environment Organization data in Table 2 and the greenhouse gas emission index in the country's power plants, in a calculation in general, it can be concluded that in case of full exploitation of the country's hydroelectric power, it can save 52 million tons of greenhouse gas annually, equivalent to $330 million. This figure is equivalent to 30 percent of greenhouse gases from power plans and 9 percent of total greenhouse gases in Iran according to the data of Power and Energy in 2016.

Table 2: The amount of savings from non-polluting gases in 2013

N_2O	CH_4	CO_2	SPM	CO	SO_3	SO_2	NO_x	
*	60	3	123	53	*	521	171	Saving cost (Dollar/Ton) [3]
654	4243	177744913	31105	177660	6586	627934	651610	Total annually gas emission(Ton) [3]
*	0.1	170	13	3	*	110	37	Amount of annually saving by total hydropower capacity(million dollar)

*unknown

2.4. FISHING AND BREEDING FISH

One of the most important benefits of this industry is the creation of fishing opportunities. Of course, the aquatic ecosystem created is greater than that of before damming. Therefore, the opportunity to increase the population of aquatic animals, especially with the special support of the new methods, is provided. The quiet environment of the ponds behind the dams is more susceptible to current rivers for catching fish. Developing dams in cold regions such as Chaharmahal and Bakhtiari, with less water BOD, can provide more opportunities to breeding fish in cages. According to the report released by the Department of fisheries of Chahar Mahal and Bakhtiari, the Karoon IV Dam reservoir has the capacity to raise 3000 tons of salmon trout, which is equivalent to about 30 percent of cold blooded fish from Chaharmahal and Bakhtiari province, the largest producer in the country. It is also equivalent to 2 percent of cold-blooded fish produced in the country in 2014, and 30 percent of the fishery products exported to foreign countries in the year 2016 [6].

The Karoon IV Dam basin, with a volume of 2190 million cubic meters, forms only a small fraction of the total dams in the province. Behesht Abad, KaroonV, KhersanI, KhersanII, KhersanIII, Bazoft and several other dams, such as the Karoon IV dam, can contribute to fish farming potential and increase the province's income. If the fish farming capacity in the dams of this province is increased in the same way, after the exploitation of these dams, this figure will increase to 14,000 tons per year (equivalent to $50 million gross). And if this action is taken in other provinces, Iran can be one of the largest exporters of cold-blooded fish. According to the data of Iran Water Resources Management Company, the capacity of the study, implementation, and exploitation dams of the country is 50000, 24500 and 48500 million cubic meters respectively, which in case of fish farming in 25% of these waters, 40,000 tons of fish can be produced annually. It is almost equivalent to $130 million of gross domestic product (this figure can be increased by processing and canning and exports to other countries). Obviously, investing in cage breeding is one of the low-cost schemes, which gathering of more production units in one area, the costs of breeding are reduced, as well as in the production and marketing of products and the processing of products, a lot of help is given to it.

Dam construction is different in various parts of the country. According the table 3, the volume of water in reservoirs of Khoozestan dams is much higher than adjacent provinces, while using the existing plans and studies of Chahar Mahal and Bakhtiari and Lorestan provinces; it is possible to create 23573 million freshwater pond cubic meters for various uses. These statistics, as well as similar statistics, indicate that there are still areas of the country that despite adequate capacity, have not been given priority to the development, and damming industry has still not reached the final capacity of 10 percent.

Table 3: Comparison of Dam Development in Khoozestan with other provinces

Religion	Number of Dam				Volume of reservoir (million cubic meter)			
	Study phase	Implementation	Exploitation	Sum	Study phase	Implementation	Exploitation	Sum
Khoozestan	22	5	20	47	7647	379	21711	29739
Chaharmahal and Bakhtiari	19	7	8	34	6675	1576	2290	10541
Lorestan	31	12	3	46	5701	6299	22	12022

2.5. WATER SUPPLY FOR AGRICULTURE, DRINKING AND INDUSTRY

According to the 2015 United Nation Organization Water Report, the world's renewable freshwater per capita in 2013 is about 1700 cubic meters, on the verge of tension [7]. In recent years, a large part of Iran has faced tensions due to insignificant rainfall despite a large population. According to the World Heritage List, in 2014, among the 182 countries, there are 58th in renewable water sources. Brazil holds 8647 billion cubic meters per year and Russia, the United States, Canada and China are ranked after Brazil which is the first [8]. But it's important to note that Iran has less renewable water per capita than the first 10 countries in the world [7 and 9]. Table 4 shows the renewable water per capita of the top ten dam building countries in the world. Iran's renewable water per capita and GDP per capita are less than the world's 10 most dam building countries, with the exception of India. Similarly, the per capita water behind the dams of Iran is much lower than that of those countries, which if the dam construction continues, this figure will reach from 423 to about 1500 cubic meters. This figure is almost equivalent to the renewable freshwater per capita, which is very easy to achieve at low cost, and can increase the country's resistance to the drought phenomenon and facilitate the development of agriculture and industry. Water as a source of life is one of the most important sources of development in industry, agriculture, and, consequently, for the improvement of economic indicators and the lack of dependence on oil.

Table4: Comparison of Iran with developed and developing countries [8 and 9]

Country	GDP per capita (2014)	Dam capacity per capita (2010) (M^3/year)	Total renewable water resources per capita(2014)(M^3/year)	Total renewable water resources(2014) (billion cubic meter)	Dams number
China	7390	589(2013)	2018	28040	23842
USA	54075	2304	9538	3069	9261
India	1579	189(2005)	1458	1911	5102
Japan	36343		3397	430	3112
Brazil	11306	3460	41603	8647	1411
Canada	49805	24134	80746	2902	1170
South Africa	6423	577	942	51.35	1114
Spain	30354	1149	2418	111.5	1063
Turkey	10170	2102(2012)	2690	211.6	972
Iran	5246	423	1732	137	802

According to the International Committee of the Great Dams in 2000, India, China, Turkey, South Korea, Japan and Iran, are in the process of studying and developing the largest dams in the developing world. According to Table 4, Iran has a lower per capita water capacity and water per capita behind the dam reservoir is less than some of these countries. These countries, despite the capacity of the dam's ponds more than in Iran, are developing this industry, or they have already had a very high record in this regard.

2.6. FLOOD CONTROL

Flood event is one of the three major natural disasters in Iran. There is a destructive flood at least at a point in this land. Several people every year die due to rivers flooding, or their homes and agricultural lands destroy. The most important impacts of dams, especially large dams, on rivers such as Karoon, Dez, Bazoft, Khersan and Beheshtabad is flood control. The statistics of the country's floods from 1951 to 1990 are presented in the table below.

Table5: Distribution of events and flood damage during 1951-1991 [10]

Period	Cities		Events	
	Percent	Number	Percent	Number
1951-1960	16	101	10.1	191
1961-1970	21	131	13.3	251
1971-1980	25	154	23.3	440
1981-1991	38	239	53.3	1008
SUM	100	625	100	1890

During this period, approximately 48 incidents occurred annually throughout the country, with 75 deaths. Although the flood damage in Iran is not comparable to some countries, the likelihood of a devastating flood must not be ignored. The 1932 floods, with more than 10,000 casualties in the Netherlands, occurred at a time when there were no such measures as flood control such as damming. At the same time, due to the flooding of the Anwar River in Italy, damage to the country's historical monuments was irreparable. The most severe flood caused by cyclone rains occurred in Canada in 1954. In October of this year, the outbreak of the Alliance, the Canadian state of Ontario and New York, flooded the United States into a catastrophe. The 1954 flood of India occurred as a result of rainfall of 250 to 500 mm of rainfall at 67,000 km in the northeast of the country, and about 9.5 million people were injured and 247 people were killed. The estimated area of the damaged agricultural land in the flood is estimated at 5.5 million hectares [10]. The financial losses caused by the flood are not accurately quantifiable, but more accurate new estimates show that countries such as Korea and Russia are losing $ 500 and $ 380 billion annually, respectively. United Nations statistics show that over the course of a 25-year period (1991-1996) there were 1358 floods in the whole world, with flood events accounting for 13.5% of the world's total risk of occurrence. The same reference has mentioned the number as 305,000 dead and more than 266,000 people injured. Meanwhile, 1.06 billion people are estimated to have suffered from flood damage.

The number of floods in the future is anticipated to increase due to global climate change. During the period from 1952 to 1991, floods with the severity of 2016 flood of Khoozestan hasn’t been occurred. However, the likelihood of similar floods in the country's management should be taken into account. It was one of the most unprecedented floods in the country, which threatened to destroy the cities of Khoozestan including Dezful, Ahvaz and Abadan and a large number of villages and fields of Khoozestan. The entrance flow to the Dez dam was 80,000 cubic meters per second, however, with the Dam the flow reaching 5,000 cubic meters per second. It is obvious to anyone that the damage caused to the province in the absence of dams could have been hundreds of times higher. In the absence of the dam, the metropolis of Ahvaz would have been devastated, which, like the earthquake-stricken city of Bam, had to be used for several years by the country's large budgets to reconstruct it, but with the cost of building the Dam and several other dams this damage was heavily controlled and diminished. It is safe to say that, even if all of the revenue and effects of the dam were ignored, most and perhaps all of the cost of making the dam was justified and compensated only by controlling the flood of 2016. Of course, this flood did not only affect Khoozestan, but also affected the provinces of Ilam and Lorestan. Previously, a flood happened in 2005, which, fortunately, was controlled by the dams of the province. In fact, the existence of dams in flood-prone areas of the country can turn the natural threats of the region into opportunities by storing water and sediments, generating electricity, exploiting clean water in other industries and other positive effects.

But the question is, whereas dam construction projects in the similar provinces have been sufficiently developed and capable of controlling possible floods? The comparison of dam construction in Khoozestan province with Lorestan and Chaharmahal and Bakhtiari in the Karoon area and its branches (Table 3) shows the number of dams and the small volume of reservoirs in these provinces, indicating the weakness of these provinces against floods. In the event of a similar or even weaker flood occurrence in Lorestan and Chaharmahal and Bakhtiari, there will certainly be significant losses in the absence of dams and the damage caused would be more than thousands.

2.7. THE OPPORTUNITY TO WORK IN THE COUNTRY AND FOREIGN COUNTRIES, AND THE ENTRY OF FOREIGN CURRENCY

In addition to creating employment, this industry can help the country to enter currency. According to Tavanir's statistics in 2016, more than 1,500 people across the country are engaged in permanent employment at hydroelectric plants [11]. From the time of the initial studies to exploitation, after which several thousand people are employed in the construction of a dam and power plant. This can be the solution for the high unemployment rate in the country. Neighboring countries, such as Iraq, Afghanistan, Pakistan, etc., are one of the opportunities that can only be exploited by the proper planning of the capacity of natural resources and their growing industries to enter the currency and adjust the unemployment problems in the country. Today, according to the brilliant

records of domestic companies in this field, one of the sources of currency entry to the country with a high degree of reliability is the implementation of hydroelectric projects in foreign countries. The success of private and public companies in hydropower projects in Tajikistan, Pakistan and etc. are due to the fact that for the past thirty years, various projects have been implemented at the domestic low expense level. It is safe to say that the casualties caused by the destruction of dams in Iran are zero. In the case of European and American countries, several destructions of soil and even concrete dams occurred, for example, the demolition of the Malasso dam in France killed more than 500 people. Therefore, the development of this industry, in addition to direct revenues, will be effective in building credibility and attracting the trust of other countries and will result in the assignment of important and expeditious tasks abroad.

2.8. CREATING A HIGH SAFETY FACTOR IN TIMES OF CRISIS (WAR, EARTHQUAKE, ETC.)

Nonproliferation measures are called non-combatant measures that increase deterrence, reduce vulnerability, sustain the necessary activities, promote national sustainability and facilitate crisis management against all types of threats and military actions of the enemy. The dispersal of hydroelectric power plants, their excessive distance to the country's boundaries and the deployment of these power stations deep underground ensures that, in the event of war and earthquake crises, the overall vulnerability of the power grid is very low and the compensation will be possible more quickly. The fuel consumed by the thermal power plants is provided through pipelines from areas with high oil and gas supply, which during the wartime is likely to target pumping stations and even pipelines. Obviously, in the event of damage to the facility, it can cause irreparable damage to the restoration and repair of the power plant in the densely populated cities of the country. Hydraulic power plants in such cases can help a lot and provide emergency power to units such as hospitals, industrial centers, and so on.

3. NEGATIVE EFFECTS OF DAMMING

3.1. DESTROYING THE TREES

Destruction of trees in the pond and at the site of the construction and access roads is one of the damages that could be a hindrance to the development of this industry if modern technology is not used to mitigate the effects. Of course, this is not the only industry that is destroying trees. Road construction, railways, petrochemicals, etc. cause damage to the wild animals and plants environment. In such cases, the continuation of the development process is subject to proof of moderation and compensation. One of the industries that can easily compensate bio-plant damage is damming because of the high water availability of dams with high volumes, which can be exploited by using its insignificant amount in creating vast parks and green spaces. Obviously, the created parks in addition to the compensation can be very effective in attracting tourists.

3.2. DESTROYING ANIMAL SPECIES

Although the reservoir is damaging the animal environment, creating a relatively large reservoir can provide water for drinking animals, birds, the amphibian, fish and migratory birds. The natural breeding of different species of amphibians and fish with the transmission of baby fish and marine animals increases the population of fish species and birds. Reviving the species of animals, birds and fish is more complicated than being included in an article. But given the fact that water is available in these projects as a source of life, today's technology can be used to compensate for and create new opportunities.

3.3. DESTRUCTION OF RESIDENTIAL HOUSES

The adverse effects of drowning dwelling houses in reservoir can be reduced by creating settlements in the right place. In various levels of the study, the construction of a dam will be considered and estimated for damages to villages close to the project. If possible, it will be effective in locating the dam, even in the event of pond damage to the villages nearby, the residents of the region will be re-evaluated in the implementation of the project. In cases where we are forced to move the people of the region, by creating a town in the best place and developing it with proper management, we can manage water resources, waste, energy, and even create affordable amenities.

3.4. DESTRUCTION OF BRIDGES, RAILS, TUNNELS AND OTHER STRUCTURES

Laying damages to road, tunnel, bridge and other facilities has been partially decreased in comparison to the profits from the production of clean energy and various facilities for exploiting the reservoir. In some cases, to modify the damages, it is necessary to move the location of the site, change the height or displacement of the structures. In any case, the damage to the facility is much easier and can easily be estimated during phase one of evaluation.

3.5. DESTROYING THE FOUNTAINS AND THE AQUEDUCTS

Applying the various abilities of the consulting engineers and contractors of this industry can lead to the registration of global records and the creation of international credentials for them. The rescue of Bel fountain, by utilizing the special abilities of domestic specialists, indicates their high ability in this field. Bel fountain with 3000 liters per second flow in the Darian Basin was saved by the efforts of domestic researchers from drowning in the pond. In addition, the displacement of religious constructions in the KaroonIII Dam reservoir using special methods to their appearance, they are unique measures that can be used to save other old structures from dangers such as dipping in ponds, floods and earthquakes.

4. CONCLUSIONS AND SUGGESTIONS

The dam construction industry, like any other development project, has many benefits and damages. Social damages, destruction of nature and structures are some of the main damages. Of course, under the pretext of development, there cannot be much damage to society and nature. On the contrary, it is not possible to comment on the precision of an industry with losses and burdens. In all survey phases, which usually take several years, they try to investigate damages and ways to reduce them. Therefore, nowadays, the advantages and disadvantages of each industry are measured by different researchers and ultimately the development methods are communicated to the relevant executives. Sometimes, despite the losses of the industry, even if other options are available, it is also possible to make the losses incurred justifiable. Some of the most important factors influencing the development of a country are climate, population, distribution of resources and the level of native technology. The possibility of reducing damages and increasing the profits from current and future dam construction for each region should be investigated separately and especially. From the benefits that can be gained over time, the use of water resources in reservoirs as fishing, reforestation of forests and animal species, tourist attraction, drinking water and agriculture can be mentioned. Using the accumulated water can further increase the dam benefits. Today, efforts have been made to reduce the damage to society and nature by many researchers. The results of their studies show that only scientific methods and the use of incident technologies can be taken to this goal.

The high capacity for damaging in Iran and future needs for clean water and energy, as well as the insignificant development of Iran compared with countries such as the United States, China and Canada, and the need to create jobs are some of the reasons that will reveal the need for development in this field. In addition to flood control and energy production during a crisis with high reliability are some other goals that can only be achieved through the development of damming. In addition, the ability of domestic specialists in this field is logical justification to continue damming in large areas of the country.

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