

O 40. RESEARCH OF THE EFFECTS OF DAMS AND HYDROELECTRIC POWER PLANTS ON ECOSYSTEM AND TOURISM ACTIVITIES

Sinem Çolak¹, Zahra Salehi^{2*}

¹ *Zonguldak Bulent Ecevit, University, Caycuma Food and Agriculture Vocational School, Chemical and Chemical Processing Dept. Zonguldak, Turkey*

² *Tehran Islamic Azad university of Shinaz, Tehran, Iranian*

E-mail: *saghar.salehi@gmail.com*

ABSTRACT: In Turkey, dams are built for energy production outside to drinking water and irrigation needs. Numerous river-type (dam-free) hydroelectric power plants (HPP) are built on every stream in Anatolia. However, these power plants cause negative environmental impacts on a regional and global scale. These environmental impacts can be listed as the extinction of species and natural habitats, the melting of the deltas, the decline or depletion of groundwater, the drying up natural lakes, the affection of the physical and biological environment, economic inefficiency, and deteriorating socio-economic structure. Due to HPP underwater ancient cities have been increasing recently. Because of when compared to thermal and nuclear power plants, cause less damage to the environment and produce electricity at low cost, HPPs are more preferred. However, disappeared cultural heritage and biodiversity can destroy the benefits of project. In this study was shown the importance of the HPPs negatives effects on ecosystem and tourism. Also was emphasised location selection for HPP should be evaluated with parameters such as negative environmental impacts that may source from the dam, protection the country's resources and the socio-economic structure. In addition, alternative energy resources were also proposed evaluating the existing natural resources of the regions.

Keywords: *HPP, dam, Biodiversity, Underwater City*

INTRODUCTION

In globalizing world, as a result of rapid population growth and industrialization, the need for energy is increasing day by day and also the need for new energy resources emerges. One of the most important energy resources is "Hydroelectric Energy" obtained from power of water. (Gökdemir et al. 2012; Gülgün et al., 2017a). Hydroelectric has an important market potential as green energy in renewable electricity generation.

Dams are as old as human history and humans have built dams for to satisfy their drinking and irrigation water (Ankaya et al., 2018; Yazici et al., 2018). However, today dams are built for energy production besides drinking water and irrigation. In recent years, there has been a significant increase in the number of hydroelectric power plants in Turkey. Everywhere Anatolia numerous "river-type" (without dams) hydroelectric power plants are being built in rivers and on each stream. However, these power plants cause negative environmental impacts on a regional and global scale. These environmental effects can be listed as; the extinction of species and natural habitats, the melting of deltas, the depletion of groundwater, drying of natural lakes, affecting of physical and biological environment, economic inefficiency and socio-economic deterioration (Mayor et al. 2017; Gülgün et al., 2014; Gülgün et al., 2017b). In addition, damaging of fish populations, loss of aquatic habitat, changing in natural flow regimes, flooding of historical buildings and degradation of the landscape are among the negative impacts (Turhan and Çağatay, 2015). HPPs are more preferred because of to cause less damage to the environment and produce electricity at low cost compared to thermal and nuclear power plants. However, the benefits provided by the project cannot be compared with formed negative environmental impacts.

The purpose of this study is to evaluate the negative effects of HPPs on ecology and tourism and to present the necessary precaution for to stopped of these effects. Anatolian lands have a semi-arid (subtropical) climate and streams flow irregularly in deep valleys. Therefore, while choosing the location for the HPP structures, the adverse environmental impacts that may occur due to the dam should be revealed and the protection of the country's resources should be evaluated. In addition, instead of

Proceeding Book of ISESER 2021

HPPs the use of alternative energy sources like solar, wind, biomass and geothermal should be increased. The main criteria that determine pollution in aquatic environments are physicochemical and biological factors. Physicochemical parameters should be measured continuously in rivers where HEPPs are located and it is necessary to examine how changing parameters affect water quality.

RESULTS

Hydroelectric Power Plants in Turkey

In Turkey the total installed power of the Hydroelectric Power Plants is 31.336 MW. The General Directorate of State Hydraulic Works (DSI) defines hydroelectric power plants as environmentally, clean, renewable, highly efficient, without fuel expense, long life, very low operating cost and non-dependent domestic resource (Ürker and Çobanoğlu, 2012). The number of large and small-scale HPP projects, whose number has started to increase rapidly, has been calculated to be 1700 by 2023 (Bobat, 2012). In Turkey, 596 HPPs are actively operational, 83 HPPs are under construction and 639 HPPs are planned to construction. (Yaman and Haşıl, 2018). Hydro-energy production in Turkey from 2000 to 2019 is given in Figure 1 as terawatt-hour (Jaganmohan, 2021). Due to the geographical location of Turkey, hydroelectric power is used considerably and it can be seen that HPP projects have increased recently in Figure 1.

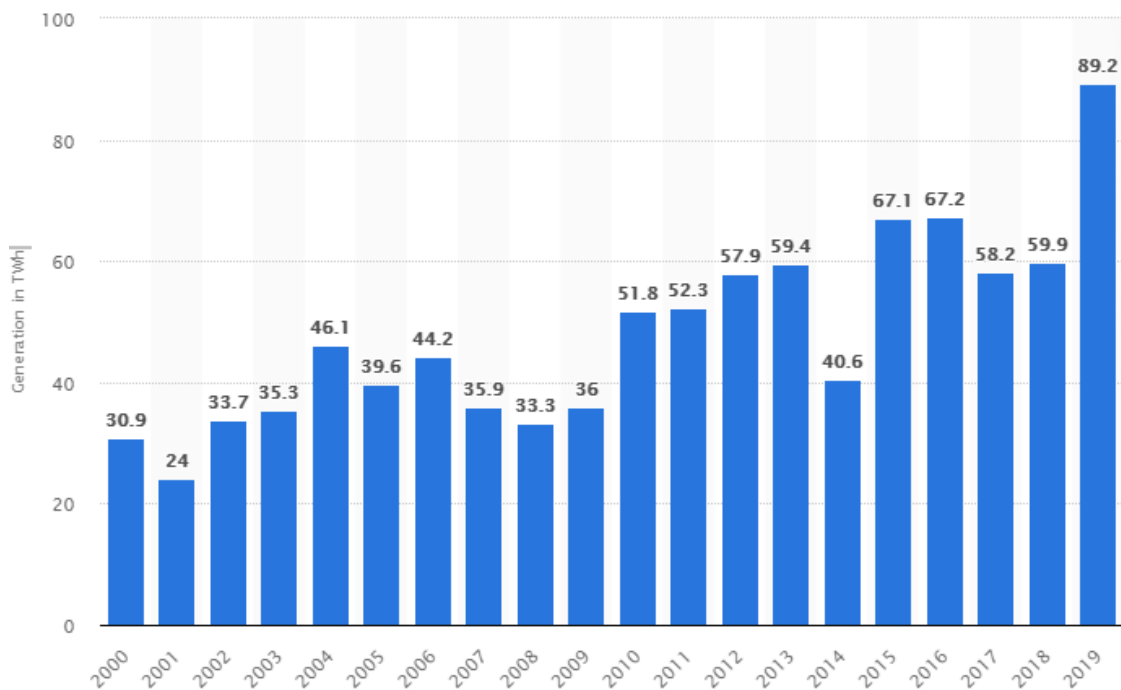


Figure 1. Hydro power generation in Turkey from 2000 to 2019 (Jaganmohan, 2021).

Effects of Hydroelectric Power Plants

Although hydroelectric power plants seem to be environmentally friendly, they can cause many negative effects. For example; because of HEPPs plants can decay in underwater, which may result in to release of large amounts of greenhouse gases into the atmosphere (Hook, 2015).

In Figure 2 shows that HPPs are increase employment, enrich commercial life and make significant contributions to the local economy. However, for these reasons, its environmental effects should not be ignored. Ecological diversity, which constitutes the natural resources of countries, is necessary for the continuation of human existence. Since the economy is generally dependent on natural resources, biodiversity and tourism are also great importance in the development of countries. However, HPPs are cause the extinction of plant and animal species. (Keleş and Hamamcı, 2005).

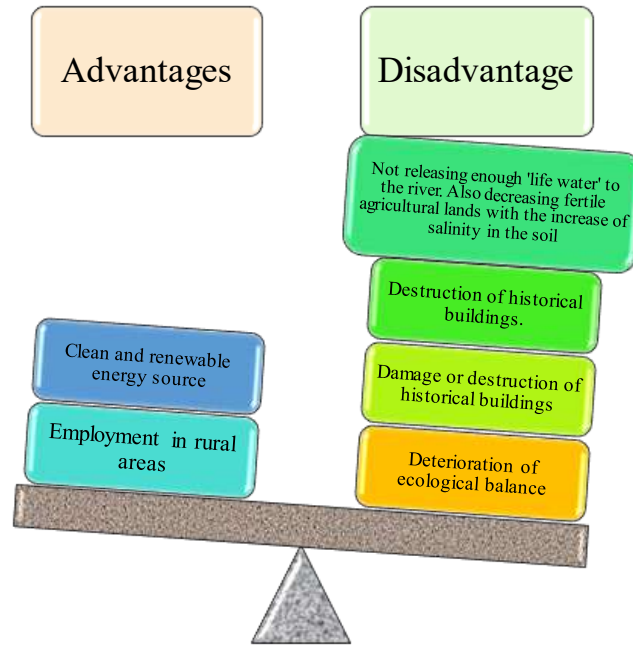




Figure 2. Advantages and disadvantages of HPP.





The Impact of Hydroelectric Power Plants on Historical Artifacts

Turkey is very rich in rivers and rivers. The villages and ancient cities where the dams built into the waters of these rivers were flooded and continue to remain. For example; Atatürk and Birecik Dams on the Euphrates River, Ilisu and Dicle Dams on the Tigris River, Seyhan Dam on the Seyhan River, Yontalı Dam on the Bergama Yontalı Creek have caused the formation of underwater ancient built. Table 1 includes some examples of historical artifacts that sink due to dams (Özdil, 2020). It has also been reported that the 3500-year-old Lycian bridge remains were destroyed during the construction of the HPPs. (Turhan and Çağatay, 2015).

Table 1. Important historical buildings under the dam lakes.

Historical place City	Dam that Caused	Photo
Lidar Mound Şanlıurfa	In 1987, it was remained completely under the Atatürk Dam Lake.	
Samsat City Adıyaman	It was remained under the Atatürk Dam.	
Tille Mound Adıyaman	It was remained under the Atatürk Dam.	
Zeugma Ancient City Belkıs-Gaziantep	It was remained under the Birecik Dam.	
Horum Mound Gaziantep	It was remained under the Birecik and Karkamış Dam.	

Proceeding Book of ISESER 2021

Rumkale Gaziantep	It was remained under the Birecik Dam.	
Savaşan Village Şanlıurfa Hasankeyf Batman	It was remained under the Atatürk Dam. It is in danger because of the Ilisu Dam on the Tigris River.	
Çatıtepe Mound –Motit Castle - Siirt Eğil Ancient City Diyarbakır	It is in danger because of the Ilisu Dam. It was remained under the Tigris Dam.	
Augusta Ancient City Adana	It was remained under the Seyhan Dam. It was remained under the Yontalı Dam.	

The Impact of Hydroelectric Power Plants on the Ecosystem

Exploding dynamite during the construction of HPP projects causes air and soil pollution, and generated noise seriously affects wildlife. Therefore, it has emerged necessary to consider the effect of noise on wildlife.

During the construction of the HPP, the leafes are covered with dust so the light transmittance of the plants decreases and the speed of photosynthesis and the growth level of the trees are negatively affected. During the operation periods of HPPs, when the amount of sediment transported from rivers to the seas decreases, biodiversity is affected and the risk of coastal erosion is increased (WWF-TR, 2013). For example; the flora and trees around the Alakır River were seriously affected, and the mortality rates of wild animals started to increase. And also the habitat of the endangered red spotted trout living in the Alakır River have restricted because of HPP. In Figure 3, photographs of the Alakır river are seen on the left side before the HPPs and on the right side after the HPPs. (<http://www.bilim.org/kus-seslerinden-kepce-seslerine-alakirda-hidroelektriksantraller/>).

Proceeding Book of ISESER 2021



Figure 3. Photographs of the Alakır river are seen on the left side before the HEPPs and on the right side after the HPPs.

Different Renewable Alternative Energy Sources

Turkey's natural renewable energy resources are quite varied, such as hydro, geothermal, biomass, biomass waste, plant waste and solar. In Table 2, renewable energy resources potentials (natural, technical and economic) of Turkey are given. (Demirbas and Bakıs 2004).

Turkey's hydroelectric capacity has the highest potential in Europe, but only one-third of this capacity is used. Turkey is also one of the richest countries in Europe in terms of wind energy potential. Although the geothermal industry is highly developed, excellent geothermal resources are still underdeveloped in Turkey. Because the cost of a new natural gas power plant is only half that of a new geothermal power plant. However, if Turkey uses all of its geothermal potential, it will be able to satisfy 14% of its total energy demand (Benli, 2013).

Hydroelectric power plants have negative effects on the environment both during the construction and during the operation (ETKB, 2016). HPP projects are based on water, but water is more important than energy. Therefore, the use of alternative energy sources instead of HPP should be widespread.

Table 2. Renewable energy resources potentials of Turkey (Demirbas and Bakıs, 2004)

Renewable energy source	Usage kind of energy	Natural potential	Technical potential	Economic potential
Solar energy	Electrical energy (TWh/year)	977,000	6105	305
	Heat (mtoe/year)	80,000	500	25
Hydraulic energy	Electrical energy (TWh/year)	433	216	127.4
Wind energy				
Direct terrestrial	Electrical energy (TWh/year)	400	110	50
Direct maritime	Electrical energy (TWh/year)	–	180	–
Sea wave energy	Electrical energy (TWh/year)	150	18	–
Geothermal energy				
Geothermal energy	Electrical energy (TWh/year)	–	–	1.4
	Heat (MW _t)	31,500	7500	2843
Biomass energy				
Biomass energy	Fuel (classic) (mtoe/year)	30	10	7
	Fuel (modern) (mtoe/year)	90	40	25

Proceeding Book of ISESER 2021

Physicochemical Parameters of River Waters

Because of for HPPs was used most of the water from rivers, the flow rate, depth of the river and bottom structure could change greatly. As the flow rate of the river decreases, the amount of dissolved oxygen in the water decreases. When the oxygen falls below a certain value, a lot of fish deaths can occur. In addition changing of water temperature also adversely affect the life of species sensitive to temperature. Also a different effect; after a certain amount of suspended solids, it usually causes physical contamination of the water, clouding of the water and increased toxicity. In this case, light transmittance and oxygen amount decrease, aquatic organisms are damaged.

To determine the effect of a HEPP in operation on water quality were investigated some chemical parameters such as; temperature, pH, total dissolved solids (TDS), sodium, ammonium nitrogen, chloride, nitrate nitrogen, nitrite nitrogen, fluoride, sulphate, dissolved oxygen (DO), biological oxygen demand (BOD₅), anionic surfactants, chemical oxygen demand (COD), heavy metals (Pb, Zn, Cr, Mn, Fe, Cu, Cd, Co, Ni, Al, Ar, Se, B), phenol, total phosphorus, nitrate and nitrite (Akyüz and Şencan, 2017). Knowing the water quality is necessary to protect or improve the existing quality and also to determine the purpose of water use. Therefore, samples taken from different parts of the rivers where HPPs are located should be measured parameters of physico-chemical and compared according to water quality standards.

CONCLUSION AND DISCUSSION

As a result, hydroelectric energy is a necessary type of energy since the construction of HEPPs is inevitable, but renewable energy sources cannot always be sustainable. Especially, HEPPs have significant and irreversible effects on the nature and life in the construction and operation state. Therefore, the extend of the destructions caused by the environmental and social impacts of HEPP investments should not exceed the benefit of energy generation.

The suggested preventions to eliminate and avoid the negative effects of HEPP are listed below;

- HEPP investments should be planned and performed in a way that takes into account the ecological characteristics of water resources, protects historical and architectural buildings and ensures that they are sustainable.
- Apart from HEPP, alternative energy potentials according to the regions in Turkey, it should be used that biomass, geothermal, solar and wind energies with maximum efficiency. In addition necessary investments should be made to encourage these renewable resources.
- Especially in rivers where HPPs are located, water flow, water depth, dissolved oxygen, water temperature, pH, electrical conductivity and turbidity should be measured routinely. In order to improve and protect the current situation, it is necessary to periodically check the physicochemical effects that may arise from the HEPP activities and make recommendations to the relevant official units to take

REFERENCES

- Ankaya, F., Yazici, K., Balık, G., and Gülgün, B., 2018, Ecotourism in Turkey and The World Social Cultural and Economic Benefits. Presented at the International Symposium for Environmental Science and Engineering Research 2018 .
- Akyüz, H., and Şencan, A., 2017, İşletmede Olan Bir Hidroelektrik Santralin Nehirsuyu Kalitesine Etkisi, *DSİ Teknik Bülteni*, No: 125.
- Benli, H., 2013, Potential of renewable energy in electrical energy production and sustainable energy development of Turkey: Performance and policies. *Renewable Energy*, 50:33-46.
- Bobat, A., 2012, HES projelerinde 3E İlişkileri, *Türkiye 12. Enerji Kongresi: Dünya Enerji Konseyi Türk Milli Komitesi*, Ankara, 1-21.
- Demirbas, A., Bakis, R., 2004, Energy from renewable sources in Turkey: status and future direction. *Energy Sources*, 26:473e84.
- ETKB, (2016), 2016 Yılı Faaliyet Raporu, Ankara: Enerji ve Tabii Kaynaklar Bakanlığı.

Proceeding Book of ISESER 2021

- Gülgün, B., Yazici, K., and Öztürk, S. 2014, Escalating Water Problems in The World and in Turkey and Legal Social and Tecnical Measures. *J.Int. Environnemental Application Science*, 8(2), 280–287.
- Gülgün, B., Yazici, K., and Ankaya, F. 2017a, Effects on Plant Growth of Agricultural Water Quality. Presented at the 2nd International Conference on Civil and Environmental Engineering .
- Gülgün, B., Yazici, K., and Ankaya, F. 2017b, Ecotourism in Turkey from Past to Present and the Related Scientific Awerenss. Presented at the VI European Ecotoursim Conference, Safranbolu
- Gökdemir M., Kömürcü M.I., Evcimen, T.U., 2012, Overview of Hydroelectric energy and HPP Applications in Turkey(Turkish), *Journal Chamber of Civil Engineers(IMO)*, 471:18-26.
- Hook, P., 2015, Çevre Terimlerinin Küçük Kitabı, (1. b.), (B. Kurt, Çev.), Ankara: TÜBİTAK Popüler Bilim Kitapları yayını.
- Jaganmohan, M.,2021 Hydro energy generation in Turkey 2000-2019. <https://www.statista.com/statistics/893633/hydro-energy-generation-turkey/>
- Keleş, R. and Hamamcı, C., 2005, Çevre Politikası, (5. b.), Ankara: İmge Kitabevi.
- Ko,ç C., 2012, Problems and Solutions Related to Hydroelectric Power Plants Constructed on the Buyuk Menderes and the West Mediterranean Basin. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 34(15):1416-1425.
- Kuzey Ormanları Savunması, (<http://www.bilim.org/kus-seslerinden-kepce-seslerine-alakirda-hidroelektrik-santraller/>).
- Mayor, B., Rodríguez-Muñoz, I., Villarroya, F., Montero, E., López-Gunn, E., 2017, The role of large and small scale hydropower for energy and water security in the Spanish Duero Basin. *Sustainability*, 9:1807.
- Özdil S., 2020, <https://www.neredekal.com/blog/baraj-gollerinin-altinda-kalan-12-batik-sehir/>
- Turhan, E. and Çağatay, H.,2015, The Environmental and Social Impacts of Hydroelectric Power Plants (HEPPs) : A Case Study of Alakır Valley (Antalya). *4th Water Structures Symposium*, Antalya, 67-76.
- Üçüncü, O. and Demirel, Ö., 2020, Measures To Be Taken And Protection Actions On The Negative Environmental Impacts Of Hes Projects, Kılıçlı Regulator And Hes Project Example. *Turkish Journal of Landscape Research*, 3:1, 31-39.
- Ürker, O. and Çobanoğlu, N., 2012, Türkiye'de Hidroelektrik Santrallerin Durumu (HES'LER) ve Çevre Politikaları Bağlamında Değerlendirilmesi, Ankara, *Ankara Üniversitesi SBE Dergisi*, 2: 65-88.
- WWF, 2013, 10 Soruda Hidroelektrik Santraller, WWF Türkiye yayını, (www.wwf.org.tr).
- Yaman, M. and Haşıl, F., 2018, The Evaluation Of Hydroelctric Power Plant (Hepp) Practices In Turkey From The Environmental Perspective. *International Journal Of Afro-Eurasian Research*. 2018-1E-ISSN2602-215X.
- Yazici, K., Gülgün, B., and Dursun, Ş. 2018, Sustainable Relationship Among Environment Landscaping and Ecotourism. Presented at the 8th International Conference of Ecosystems 2018 .