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ENVIRONMENTAL AND LIVELIHOOD IMPACTS OF DAMS: A CASE STUDY

SUMMARY

Albanian hydrographical territory is 57% (more than 152 rivers) larger than its geographical territory. Although with small flows, their considerable cascade makes these rivers substantially important for the hydropower potential offered to the country. Traditionally, Albania electricity is based on hydropower which stays precisely 99.8%. The rise of electricity from hydropower production has been the only solution and therefore, the electricity security strategy is based on the increased generation capacities. This paper aims to present the environmental and socioeconomic impact of Fierza hydro power plant, Koman hydro power plant and Vau i Dejës hydro power plant. Therefore, the main problems and challenges of the municipalities where the hydropower plants are located are identified. In all three hydropower plants, the main environmental problems are solid waste pollution, pollution from the discharge of urban wastewater from dwellings, commercial and industrial entities without prior treatment, sediment accumulation, deforestation, erosion and floods. The economy is not very developed. It is mainly based on the rural economy. Investment absence, mainly in road infrastructure has affected the underdevelopment of agriculture and tourism. Financial problems have affected demographic movements towards large cities. This has affected the closure of schools. These are areas with very good climate and geographical position, which need investment to recover.

INTRODUCTION

Hydropower represents around 18% of global electricity production. And it accounts for 60% of global renewable electricity capacity. Albania is the only country in the Western Balkans to have completed new large hydropower plants in the last decade and at the end of 2020 it had at least 23 operational hydropower plants of more than 10MW, as well as countless smaller ones (Era, 2021).

Albania has been considered a country with considerable water reserves and a hydropower potential that bears an important developmental role for the country. It is quite rich in rivers, with more than 152 rivers and streams forming eight big rivers. The most important rivers are Drin with 340 m^3/sec, Vjosa with 210 m^3/sec, Seman with 101 m^3/sec, Mat with 74 m^3/sec, Shkumbin with 60 m^3/sec, etc. Although with small flows, their considerable cascade makes these rivers substantially important for the hydropower potential offered to the country and only 35.4% of it is being used so far. There are three operational hydropower plants on the Drin River with a total installed capacity of 1350 MW, Fierza hydro power plant, Koman hydro power plant and Vau i Dejës hydro power plant. A concessionary contract has been concluded for "Ashta" hydropower plant on the Drin River between the Ministry of Economy, Trade and Energy and Austrian Company "Osterreichische elektrizitatseirtschafts- Aktiengesellschaft", with an installed capacity of 48.2 MW and it is currently operational (Akbn, 2019).

Using hydropower to generate electricity has both benefits and losses for the environment. Hydropower produces cleaner energy, because they do not produce any air pollutant. Unlike thermal power plants for example, there are no gaseous or fly ash emissions emitted during the energy production. It is a known fact that hydropower often replaces fossil-fired generation, and therefore contributing to the reduction of acid rain and urban smog problems (Abbasi and Abbasi, 2011). Despite all these advantages of hydropower plants, there may also be negative impacts. Lately the impact on the ecological aspects from the power plants has received attention. The report of World Commission on Dams (2000) stated that dams will have effects e.g., on the terrestrial ecosystem and biodiversity, the flow regime, migration of aquatic organisms, and can cause emissions of greenhouse gases. Bratrich *et al*., (2004) affirm that hydropower affects the flow regime, migration of organisms, transport of nutrients and sediments. Abbasi and Abbasi, (2011) claim that hydropower plants cause major ecological impacts in all of the four different habitats, which are associated with the projects; the estuary into which the river flows, the downstream reaches of the dammed river, the reservoir catchment and the artificially created lake. Dam removal, flow regulations, biotope adjustment, fish plantation, sedimentation measures, constructing migration corridors and fish friendly turbines are alternative actions for mitigating the negative impacts of hydropower projects on the environment (Mohammed *et al*., 2018). Besides the environmental impact, reservoir construction can have social costs as well. The land needed for building dams may have already been occupied by people and thus affect their livelihood. Research has proven that one consequence of hydroelectric facilities is impaired estuarine livelihoods. This can cause displacement of ethnic groups and human rights violations.

This paper presents the research findings on the environmental and socio-economic impact of Fierza HPP, Koman HPP and Vau i Dejës HPP. For this purpose, the main problems and challenges of the municipalities where the hydropower plants are located are identified.

MATERIAL AND METHODS

Energy Corporate of Albania (KESH) is the public producer and, at the same time, the largest electricity producer in Albania. KESH operates the most important electricity generating plants in the country (Era, 2021). KESH is also responsible for the administration, the proper operation as well as for guaranteeing the technical and operational safety of the power plants it operates. Kesh report (2020) is a study that identifies the environmental and socio-economic impact of Fierza hydro power plant (HPP), Koman hydro power plant (HPP) and Vau i Dejës hydro power plant (HPP) (Fig. 1).

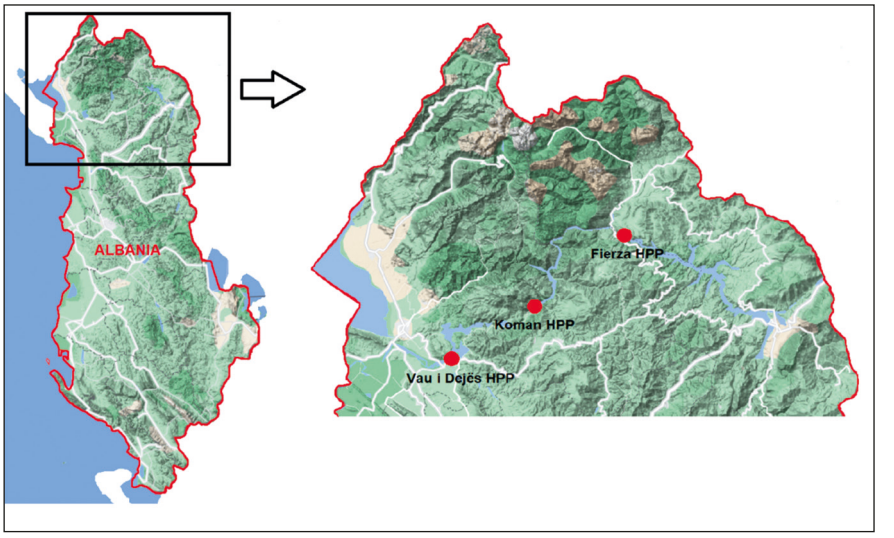

Fig. 1- Geographical location of Fierza HPP, Koman HPP and Vau i Dejës HPP.

Fierza HPP

Fierza is the upper HPP of the Drin River Cascade. Based on the installed power, position and the volume of the reservoir, Fierza plays a key role for the exploitation, regulation and safe operation of the cascade. Its construction began in 1970 and it started to operate in 1978. The dam is filled with stones and has a clay core. The dam is 166.5 m high and 380 m long. The width of the dam ranges from 574 m in its base to 13 m in the crest of the dam. When it was built, Fierza Dam was the second in Europe for the height of its type. The dam has a total volume of 8 million m^3. The dam has created a reservoir with a volume of 2.7 billion m^3 and a surface area of 72 km^2, Fierza Lake, which is the largest artificial lake in the country. The useful volume of the reservoir is 2.3 billion m^3. Fierza HPP is classified as a first-class work in terms of risk. Its dam is designed for maximum calculated flow for 1 in 1000 years (6100m^3/sec) and maximum control flow during the rainy season

for 1 in 10000 years (9600 m^3/sec). The bypassing of the water flow in Fierza is carried out through discharge tunnels; Tunnel 4 with a capacity of 890 m^3/sec, and Tunnel 3 with a capacity of 1780 m^3/sec. The Intake System was built for the water supply of the plant from the lake. It conveys water from the intake portal, through tunnels, to the 4 turbines of the power plant building. The system has a capacity to transport up to 500 m^3/sec. Auxiliary and control-monitoring devices are also located in the plant's building. The importance of Fierza, besides energy production, relates to the capacity of its lake, which regulates the annual inflows, increasing the efficient use throughout the cascade (KESH, 2010).

Koman HPP

Koman is the second and most powerful HPP of the Drin River Cascade. Considering the installed power, position and the volume of the reservoir, this HPP plays an important role for the exploitation of the entire cascade. Komani HPP has the biggest power generation capacity in the country. Its construction began in 1980 it started to produce electricity in 1985. The small reservoir volume and rapid precipitation discharges from the Alps and the Puka highlands necessitate the dynamic monitoring of the hydro situation and the proactive operation of the HPP, in accordance with the specific meteorological conditions of the Koman watershed. Komani HPP is also considered as a first-class work in terms of economic, social and environmental risks. Koman has a 500 million m^3 reservoir and a 5 million m^3 concrete screen rock filled dam. Koman dam is designed for maximum calculated flow during the rainy season, for 1 in 1000 years (7245m^3/sec), and maximum control flow during the rainy season for 1 in 10000 years (10560 m^3/sec). The total water discharge capacity at the 176 m level is 3400 m^3/sec. The intake system was built for the supply of water from the lake to the plant. It conveys water from the Intake Portal, through two tunnels, at the balance towers, from this point the tunnel splits into 4 intake pipes, one for each turbine of the power plant. The system has a capacity to transport up to 720 m^3/sec. The importance of the Koman hydro power plant relates primarily to its energy production capacity, as the most important generator of the Electricity System. Koman Lake, due to its level stability, is used for the transport of goods and passengers, throughout the year, in such a remote and mountainous area. Travelling through Koman Lake is also considered a beautiful attraction for the wild nature loving tourists (KESH, 2010).

Vau i Dejës HPP

Vau i Dejës was the first hydropower plant built on the Drin River and is located in the north-western part of Albania. It is located downstream of Drin River, at Vau i Dejës gorge, about 18 km away from the city of Shkodra. Since Vau i Dejës dam and lake are located to the lower part of the river cascade, its importance, apart from electricity generation, is also related to the impact that its lake has on the sub-Shkodra lowlands. Water discharges from the lake have a major impact on

floods that occur in the lowlands of Lezha and Shkodra. Its construction began in 1967 it started to work in 1971. The maximum volume of Vau i Dejës Lake is 580 million m^3. Its surface is 25 km^2 and it climbs from the Vau i Dejës Gorge for about 27 km upstream the Drin River valley, near the Koman HPP. The active volume of the lake is 263 million m^3. As part of the cascade, Vau i Dejës HPP is designed as a first-class work in terms of the risk bearing level. The safe maximum flow for 1 in 10000 years was calculated at 10000 m^3/sec. The total discharge capacity of the HPP at the 76 m level is 7500 m^3/sec. The generation units installed in the plant have "Francis" vertical turbines, with 50 MW power each; 3-phase synchronous generators and lifting transformers for connecting with the substation. The total installed power of the HPP is 250 MW. Auxiliary and control-monitoring devices are also located in the Plant's building. The average annual production is 1000 Gwh. The plant was constructed using Chinese equipment and technology, but it went through a full rehabilitation during 2003-2007; mechanical equipment from Andritz and electrical and control installations from Alstom (KESH, 2010)

RESULTS AND DISCUSSION

The main problems and challenges of the municipalities where the hydropower plants are located are environmental protection and local economic development.

Problems and challenges in environmental protection

Fierza HPP. The management of solid waste is the main problem in Fierza HPP. Domestic and commercial solid waste has increased in recent years, while inert waste has decreased due to the low number of constructions. Some of them are thrown into rivers, which end up in the lake or collected near the lake. Two of the main deposits of Kukës city are near Fierza Lake. One is 400 m away from the lake and the other is 50 m (predisposed to cause pollution).

Another pollution source of the Fierza lake are the wastes from Kosovo through the discharge of the Drini i Bardhë and Drini i Zi Rivers. Numerous discussions have been held with local authorities in Kosovo about a possible cooperation agreement and financial contribution for the cleaning of the lake, but no concrete action has been taken in this regard. The local government and some residents have contributed to cleaning the lake, but this is not enough. It is important that people become aware of not throwing and depositing waste in rivers and lakes.

The discharges of urban and industrial wastewater into rivers, near or directly into the lake, constitute a worrying problem. This affects the continuous pollution of Fierza Lake, making it impossible to use it for ecotourism activities or for the development of fishing.

Flooding and soil erosion are problematic in villages and soils near the lake, not in the soils wetted by the lake.

Koman HPP. The environmental problems of Koman Lake are similar to the problems in Fierza Lake, where the most essential are the problems with waste management, the discharge of polluted water into rivers or lakes, floods and erosion on lake sides.

The urban, hazardous and hospital waste are thrown into rivers and end in Koman Lake. The disposal of urban waste in Fierza is located near the Fierza - Fushë Arrëz national road and the Fierza Lake dam. Due to the slope, the deposit is at risk of erosion. When the wastes are in large quantities and when it rains and strong winds blow, they fall into the lake. In addition to urban and industrial discharges, the mining industry causes pollution in Fierza Lake as well. Their wastes are dumped near the rivers, causing their pollution with heavy metals. The rivers cause pollution of the lake, by increasing the concentration of heavy metals in the lake and damage the aquatic ecosystem and biodiversity.

Floods and soil erosion are one of the main problems of Koman Lake, due to the interference with Fierza HPP and Vau i Dejës HPP. The most endangered area is Dushaj village, especially when there are heavy rains and the Fierza HPP doors are opened. The water level can rise immediately, thus flooding the agricultural soils and causing erosion.

Vau i Dejës HPP. The environmental problems at Vau i Dejës HPP are different compared to the problems of Fierza HPP and Koman HPP. Pollution from solid waste is less evident in this lake, because most of it is accumulated in Fierza HPP and Koman HPP. Also, the number of residential centres and businesses along the Vau i Dejës Lake are fewer, compared with the other lakes.

The main problems are discharge of urban and industrial wastewater of the villages around Shkodra city in the lake and the place were Drin River junction Buna River. There are many rain falls during the year in this area, resulting in floods. The biggest floods occurred in January and December 2010, where the water loads in Buna were 3600 m^3/s and 4000 m^3/s (Donald, 2011). The 2010 flood was a serious event with major environmental and social consequences. Heavy and prolonged rainfall in the winter season often combined with snowmelt in late winter/early spring, caused overflows in the Buna, Drin, Kir Rivers and Shkodra Lake. The opening of the Vau i Dejës HPP gates and the non-operation of the drainage system, affected the flooding of the surrounding villages and the peripheral part of Shkodra. The floods in this site have affected the erosion. Coastal erosion is created by sediments and solid materials brought by rivers, which are prevented by the Drin River dams. These problems affect the ecosystems of the area.

The management of urban solid waste is problematic in deep administrative units (Shalë, Pult, Shosh, VigMnelë and Hajmel). These areas have few inhabitants, but road amortisation has prevented waste management by the responsible companies, throwing them into rivers or Vau i Dejës Lakes. Meanwhile, inert waste has suffered a downward trend compared to other waste, due to the lack of constructions.

Problems and challenges in local economic development

According to INSTAT (2022), the northern region of Albania is less economically developed. The economy of this area is mainly focused on the two largest cities, which are Shkodra and Kukës. In Kukës district, the economy is based on agriculture, hunting, forestry, fishing and mining industry. In Shkodra district, the economy is based on the sector of agriculture, hunting, forestry, and fishing. The industry is slightly developed. Despite the economic growth of these cities, the area continues to have its main support in the rural economy, which does not provide large profits. Important indicators of economic development are investments in the construction of apartments, offices, factories, etc. The municipalities that have invested the most in construction are the municipalities of Shkodër, Tropoja, Vau i Dejës, Kukës, Pukë and Fushë-Arrëz.

The agricultural economy is little developed, because some of these villages have a lack of agricultural soil as a result of the lake's formation, floods and erosion. Agricultural soils can be located far away from residential areas and there is no infrastructure to reach and use them.

The lack of investments in the road infrastructure has influenced the demographic movement from rural areas to the biggest cities within the country, but also in emigration abroad. This has affected the closure of schools. The impossibility of developing roads has induced the floating service to be developed in order connect the villages by selling agricultural or animal products. Moreover, the lack of infrastructure has influenced the isolation of some areas, where the wastes are thrown into lakes or rivers. Cleaning the lake from accumulated waste requires investments, local cooperation, but also campaigns and education of the population.

The municipalities of Shkodra, Tropoja and Kukës have developed tourism. They have great potential and enough assets to attract tourists, especially the outstanding natural resources in the mountain tops, alpine pastures, deep valleys, spectacular lakes and rivers. The most evident attractions to the tourists are Fierza Lake, Shishtaveci, Gjallica Canyons, Albanian Alps, Shala River, Rozafa castle, which rises on a rocky hill to the west of the city, surrounded by the waters of three rivers; Drini, Buna and Kiri, Shkodra Lake, the largest of the Balkan Peninsula, with two main points Shiroka and Zogajt, etc. The infrastructure development and alternative transport networks will affect the further development of tourism

CONCLUSIONS

Hydroelectric power plants with big dams have social-economic and environmental impacts. It may not consume non-renewable resources or emit large amounts of greenhouse gas, but its facilities affect soil use and rivers.

In all three hydropower plants, the main environmental problems are solid waste pollution, pollution from the discharge of urban wastewater from dwellings,

commercial and industrial entities without prior treatment, sediment accumulation, deforestation, erosion and floods. The economy is not very developed. It is mainly based on the rural economy. Investment absence, mainly in road infrastructure has affected the underdevelopment of agriculture and tourism. Financial problems have affected demographic movements towards large cities. This has affected the closure of schools. These problems require cooperation between the central and local governments. Municipalities should develop supporting policies and programs for the prevention of waste disposal in waterways, the closure of hazardous disposal areas (legal and illegal), and their rehabilitation. These are areas with very good climate and geographical position, which need investment to recover.

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