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HYDROELECTRIC POWER PLANTS' RESERVOIRS AND THEIR IMPACT ON THE ENVIRONMENT

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Abstract. *The paper presents the analysis of different types of impact the hydroelectric power plants' reservoirs could make on the environment. Hydroelectric power plants (HPP) produce ecologically safe energy and correspond to the modern striving for sustainability because they are operated on renewable energy sources. At the same time they can provoke various potential dangers for the environment. The objective of the investigation is to demonstrate the interrelation between the type and structure of a hydroelectric power plant and the way its reservoir may impact on the nature surrounding the plant. These effects may be direct and indirect, positive and negative and vary from insignificant that can be easily fixed to those that are irreversible and catastrophic. The latter should be taken into account during the design of HPP.*

Keywords: *HPP reservoir, environmental impact, sustainability, renewable energy.*

Introduction

Hydroelectric power plants (HPP) are operated on renewable energy sources. This energy appears in the atmosphere and on the surface of the planet as a result of interaction of specific substances and forces. It always exists in the nature and does not require any special expenses for being released. Consequently, HPP are a rather attractive type of power stations.

Depending on their capacity, HPP can be classified as large, medium, and small. In Russia, large HPP were most intensively built and put into operation in the second half of the last century. The reasons for this were a great need for the electrical energy and major advantages of HPP in comparison with other types of power stations. Among these advantages, there are low cost of energy production, high efficiency and maneuverability of units, significant automation in the basic equipment' operation, a small number of technical personnel, and others.

HPP structure and its role in the environmental impact

HPP can perform their basic functions only as a part of an energy unit or a hydro complex, which includes supporting structures and a reservoir. Moreover, the component parts (HPP, supporting structures and a reservoir) are interrelated, functionally supplement one another and significantly influence the surrounding environment. For example, the height of the supporting structures determines the power of the HPP, as well as the area of the territory covered by the reservoir. The parameters of a reservoir impact on the amount of manufactured electric power, and its depth and temperature conditions impact on flora and fauna. The mode of a HPP operation and its capacity affects the constructive decisions on supporting structures and water spillway conduits, as well as the range of a water-level change in the reservoir and the banks processing.

With the examination of the problems, related to the impact of reservoirs on the environment, it is necessary to consider their special features. Figures 1 and 2 represent the general views of reservoirs.

Fig. 1. **The reservoir of a mountain hydro-power plant (China)**

It is obvious that reservoirs made on mountain rivers actually do not process banks; however, they do affect to a significant degree the temperature conditions of the river in comparison with the natural conditions, and they also influence an oxygen content in the water flow and a quantity of suspended deposits in it.

Fig. 2. **The reservoir of a lowland hydro-power plant (Poland)**

Large reservoirs of river-bed HPPs, on the other hand, substantially influence the wash-out of coasts, since they very frequently are located of the soft grounds.

Fig. 3. **Coast wash-outs on the Saratov HPP Reservoir (the Volga) near Samara (Russia)**

Classification of environmental effects

The impact of reservoirs on the environment should be classified into direct and indirect. The direct impacts are caused by the fact of creation and the very existence of a reservoir. The indirect influences manifest themselves implicitly through certain factors of specific functions of a hydro-power plant. Both direct and indirect effects can be positive and negative.

Direct impacts

One example of the reservoirs' direct positive impacts on the environment is the seasonal regulation of river flow: a considerable decrease of the freshet discharge due to the water accumulation in the reservoir provides territories protection from flooding in the freshet season, and a water release during the low-water period makes it possible to assuredly supply different users from down the river with water and also to ensure the required navigable depths in the river. Slowing down the flow of water in the reservoir (reduction in the rate of flow in the supported section of river) is the same type of influence. As a result, in winter time, the ice is more rapidly formed, and consequently, more favorable conditions are created for wild animals to walk on the ice.

A change in the load on the earth's crust due to the concentration of significant volumes of water on a limited earth's surface is an example of the direct negative influence of the reservoir. Similarly, flooding of territories, especially the ones suitable for agriculture or rich in minerals, processing of the reservoir banks and such are other examples of direct negative impacts.

Indirect impacts

Indirect positive effects of a reservoir on the environment are: a more active manifestation of the water self-cleaning effect in the reservoir, guaranteed amounts of water from the reservoir for the public water supply and agricultural needs, the use of the reservoir for fish breeding and activities of fish farms, the organization of recreational zones, and so forth. Included in here is the possibility of using the reservoir as an emergency reserve for a rapid power supply for the public in case of emergency and failure of other electrical stations, power system, or electric power lines.

The indirect negative effects include the pollution of water by organic materials because of poorly executed preparation and deforestation of the bed of the reservoir; wash-out and processing of banks in the lower part of the HPP complex because of a frequent water-level change resulted from daily regulation of water. An additional indirect effect is that the water is polluted by petroleum products because of the leaks in the equipment components in the HPP and their penetration into the water stream, a change in water temperatures in the lower part of the HPP and others.

It should be noted that one and the same indirect effect of the reservoir on the environment can have simultaneously both positive and negative impacts. For instance, the use of the reservoir as an emergency reserve besides the positive side noted above has a negative one too – a sharp increase of the water level in the lower part of a HPP will aggravate the erosion of the bank slope.

Conclusions

From what was mentioned above it can be concluded that such large technical structures, as reservoirs of hydroelectric power plants, can have rather diverse influences on the environment. The rate of their impact also varies: from insignificant and easily fixed to those that are irreversible and catastrophic.

When a HHP already operates, it is very important to exclude any possibility of the most dangerous - irreversible - negative environmental impacts of reservoirs and probability of occurrence of catastrophic impacts. At the same time, it is necessary to foresee possible minimal and reversible negative impacts already at the design stage of a future plant and provide protective measures to minimize future negative effects.

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