POSSIBILITY OF STREAMFLOW REGULATION WITHOUT CREATING LARGE-CAPACITY RESERVOIRS

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Editor's Note. Hydraulic engineering and the operation of hydraulic structures are directly associated with one of the most important natural resources—streamflow—and consideration of ecological requirements introduces substantial changes into what has been its traditional use. The protection of nature and the environment when developing industrial and power projects is becoming an inseparable part of our way of life. Engineering planning should develop in the direction of increasingly more complete prevention of the undesirable consequences of disturbance of the established balance of natural processes. The editor invites readers to express themselves concerning possible directions of the practical solution of problems of streamflow use. Although the creation of small-capacity reservoirs with small surface cannot provide conditions of the full use of hydropower resources, the system of regulation proposed by B. A. Bulgakov can be of interest in particular cases of power construction and can be advisable for use in irrigation, water supply for cities and industry, and creation of navigable depths on rivers.

The use of streamflow in each branch of the economy has its own specific characteristics, which are expressed in the regime of water consumption, but usually in construction and operation the goal is to obtain a small variation of the streamflow parameters. This is achieved by creating reservoirs whose useful capacity stores a considerable part of the streamflow for guaranteed use.

Daming of a river at a site convenient for this purpose and the creation of a reservoir is the traditional method of obtaining the necessary head for power generation or another use of the stream. Topographic conditions predetermine both the limit of possible rise of the reservoir level and the degree of regulation of the natural runoff, i.e., the possibility of obtaining the maximum guaranteed flow and power production. The height of the backwater is selected on the basis of a technical and economic comparison of variants, and often it is below the level which could be taken with respect to the topographic conditions. In this case the reduction of the possible useful capacity of the reservoir imposes a limit to streamflow regulation and decreases the guaranteed discharge. Sometimes this discharge is determined by the possibilities of only daily regulation and in essence is through-flow.

On rivers of any type there are limits within which has occurred a perennial variation of the levels which determined the natural conditions of development of flora, fauna, and economic activity. These limits depend on long-term variations of the natural runoff. In many cases the topographic conditions permit raising the water level in the reservoir above the upper level of the natural variations, but in this case the established ecological conditions are disturbed and flooding of lands of various values, which had not happened before in nature, and environmental consequences accompanying this occur.

The loss inflicted by economic activity is compared with benefits for the national economy and such parameters of streamflow regulation are selected for which the expenditures being made are justified. In recent years there has been a vital need to prevent damage to the ecological conditions and not to allow the possibility of disturbing the balance of nature.
Fig. 1. Static and dynamic system of streamflow use on a schematic longitudinal profile of a river.

1) Line of the crests of bank slopes of the river valley; 2) maximum levels of rise of the water under natural conditions; 3) low-water levels; 4) maximum possible backwater level of reservoir; 5) backwater level of the reservoir that is advisable in a national economic aspect without consideration of ecological consequences; 6) backwater level of a system of small reservoirs that is justified with respect to conditions of environmental protection.

established through the ages. It can be stated that on the basis of conditions of environmental protection a decrease in the height of the backwater to levels corresponding to the maximum natural rise of the water in the channel is economically justified. In this case, just as in the traditional selection of the backwater level, a decrease in the head (and also of the guaranteed discharge as a consequence of a decrease of the storage capacity of the reservoir) is the price for preserving the natural conditions at a level corresponding to the requirements of environmental protection (see Fig. 1).

Under these circumstances one should search for the possibility of compensating for the decrease in head and useful capacity of the reservoir as a static system by increasing the discharge due to dynamic streamflow regulation. What does this mean? Instead of a large-capacity reservoir created by a high dam it is suggested to examine the possibility of creating in the basin a system of reservoirs following one after the other with backwater levels no higher than the maximum rise of water under natural streamflow conditions. The additional construction of small reservoirs within the floodplain under favorable conditions can maintain the guaranteed discharge at the lower (outlet) site at a level having the same degree of regulation. The total consumption of materials on the structures in this case can even be reduced. But there still exists the possibility of increasing the guaranteed discharge at the outlet by using the difference in time of passage of the maximum discharges at each of the upstream sites, especially if they are located on tributaries originating in lakes.

Variability of discharge is a result of the effect of climatic factors, which in the aggregate characterize the concept "wetness of the year." Depending on the geographic location of the basin and its size the wetness characteristic at different points of the drainage network is, as a rule, different. However, the velocity, slope, and discharge of the river at each site for each definite elevation of the level in the river are constant. The indicated characteristics make it possible to obtain a formalized picture of the runoff in the basin on the main water artery and its tributaries. For a system of sites located along the entire basin we can compile a table in which the velocities, slopes, and discharges will be given for each wetness characteristic at each site and for each level. The completeness of the formalized picture depends on the number of sites, which, however, can be limited. Such a table can serve as the basis for selecting sites for a system of small reservoirs equipped with spillways, which is compared to a large storage intended for delaying the runoff so as to provide a maximum guaranteed discharge.

To obtain the maximum guaranteed discharge in a system of small reservoirs for the outlet selected it is necessary to have at all sites on the river and its tributaries transmitters sending to the outlet information on the levels and discharges at each instant. Know-