FOREIGN EXPERIENCE AND TECHNIQUES

FOREIGN HYDROTECHNICAL CONSTRUCTION AND ENVIRONMENTAL PROTECTION PROBLEMS*

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The construction of hydraulic structures indisputably has an effect on the environment, the character of which in many respects depends on the correctness of engineering decisions, on the depth of study of various aspects of the interaction of the hydraulic installation with the environment. The development of hydropower and irrigation is inevitably associated with the construction of dams and canals, with the creation of regulating reservoirs altering the annual and long-term distribution of streamflow, which is accompanied by a change in the groundwater regime and sediment discharge. In the vicinity of a hydrostation the landscape and natural ecosystem change and a microclimate is created over a considerable length of the upper and lower pools.

In the literature of recent years there have been many contradictory reports on the effect of hydraulic structures on the environment and statements — from demands to completely cease hydropower construction as incompatible with the conditions of environmental protection to the demand for complete rehabilitation of hydropower as the branch most corresponding to man's aspirations not only to preserve but also to improve natural conditions. The current state of experience in the design, construction, and operation of hydrostations, improvement of scientific knowledge about the interrelations in nature, and the complex approach to problems of the development of river basins being introduced everywhere permit an optimistic evaluation of the prospects of hydrotechnical construction and, in particular, hydropower construction.

The complex approach to evaluation of water-management measures requires a more thorough study and understanding of the ecological and social consequences of the accomplishment of large water projects. The need for such investigations is reflected in the legislative acts of a number of countries, in the activity of international organizations, in the creation of a special agency for environmental problems under the UN with headquarters in Nairobi (Kenya). The problem of the interaction of reservoirs with the environment has two aspects: the impact of the reservoir on the environment and the impact of the environment on the reservoir. The first is acute in developed countries and the second in developing countries.

The creation of reservoirs changes the natural conditions in a river basin. The conditions of sedimentation and the temperature, chemical, and biological conditions change in the reservoir zone in comparison with the natural. The creation of reservoirs for power regulation of the runoff leads to a considerable equalization of the discharge during the year, which has a substantial effect on the downstream conditions. Flora and fauna appear and develop in the reservoir which previously had not been typical for this region. This pertains to both the simplest organisms and to more complex ones, e.g., fish and waterfowl. Reservoirs also have a certain effect on the climate due to evaporation from the water surface, which can greatly exceed evaporation from the same area covered with vegetation. When planning reservoirs it is also necessary to take into account purely aesthetic aspects, landscaping requirements, and the need to preserve the most valuable natural tracts so that the reservoirs serve to enrich nature. The change in groundwater levels around power-canal hydroelectric stations with long canals influences the choice of agricultural measures — draining or irrigation.

How these changes manifest themselves — favorably or adversely — depends on the degree of understanding and consideration of the most essential circumstances associated with water-management construction. Therefore, at the current stage it is especially important to study and generalize the available experience. In Austria a special investigation of the effect * Materials published in journals were used.

of reservoirs on the environment was carried out. Data on the reservoirs Moozerboden and Wasserfalleboden (in operation about 20 years), Gepatsch (10 years), Kops (7 years), Fermunt (45 years), Lünersee (15) and the data on the development of the valleys of the Kapruner, Ill, and Zemm rivers after their hydropower development were used in the analysis of the problem. The main conclusions of the analysis are: high-mountain reservoirs do not adversely affect the environment, the creation of these reservoirs enriches nature, they become objects of tourism, recreation, and sports. Transport development of the valleys during construction, which afterwards is turned over for public use, just as the communication lines, the provision of power supply, and the construction of housing become the most important factors stimulating the economic development of extensive regions. These favorable consequences of hydropower construction for the economy of the regions being developed are favorable also for their permanent population, whose employment rate increases, and income from tourists increases.

Reservoirs created on flatland rivers and in piedmont regions also have a favorable effect on the environment, although they give rise to numerous problems requiring solution. It was noted in the investigation that the flatland reservoirs of Austria on the Danube, Inn, Enns, and Drav rivers have a favorable effect by increasing the quantity and improving the quality of water for water supply, creating recreation zones for the population, developing tourism and water sports, and improving the conditions for fish and animal life. Reservoirs are regarded as providing an enrichment of the landscape, with the exception of their brief periods of drawdown and filling. Changes in the hydrologic regime, which are feared for river reaches within the valleys, reliably can be eliminated by designating an appropriate operating regime of the hydrostation.

During the period 1975-1976 the portion of hydropower in total power production was: in Austria 58-67%, in Switzerland 80%, in Italy 25-29%, and in West Germany 4-6%. In the future the portion of hydropower in Austria and Switzerland will decrease as a consequence of the fact that 50 and 90%, respectively, of the hydropower resources of these countries are now being used. However, the value of rivers as a source of power will continue for a long time. At the same time, multipurpose reservoirs satisfying the requirements of water supply, flood protection, increase of low flows, recreation, etc., are acquiring ever greater importance. Experience with operating hydrostations in Switzerland, Austria, and Italy shows that no untoward consequences for the environment encompassing large territories are related to hydropower construction in the Alps. Hydroelectric stations with regulating reservoirs use only the surplus runoff from snow and glacier melt and rain, which are not used either by the plant or animal world and do not penetrate into the soil by infiltration. Therefore, with the exception of a narrow bank strip of the rivers being used it is not necessary to fear a noticeable effect of construction on the ecological conditions and system and such an effect has not as yet been noted anywhere in the Alps.

Thus, the long-term experience with hydropower construction in a number of countries of the Alps region permits the statement that with appropriate careful planning those disturbances which are considered inevitable when constructing hydrostations with regulating reservoirs can be eliminated or reduced to an acceptable minimum. In that case such disturbances cannot be compared with the energy-economy effect of using continuously renewed hydropower resources – the source of the most valuable peak electric energy whose production does not result in a detrimental effect on the environment.

This conclusion cannot, however, be extended everywhere. It was pointed out in the same investigations that the creation of reservoirs on flatland rivers can cause problems that are difficult to solve. For example, the problem of removing suspended and bed loads is complicated. On large rivers the construction of settling basins is a very costly measure, and for all practical purposes mechanical and hydraulic removal of accumulated sediments remains the means of controlling siltation of reservoirs. The deposition and consolidation of sediments are promoted by the discharge of warm wastewaters, since the viscosity of water decreases with increase in temperature. When operating a hydrostation in a daily regulating regime and with a large amount of wastewater such deposits give off unpleasant odors. Also complicated is the problem of the passage of floodwaters. Dissipation of the flood-water energy and the form of conjugation of the pools determine the effect of the flow on the downstream channel. Attempts to limit flooding lead to the need to construct levees along the pools.