PRESENT STATE OF FLOOD CONTROL AND WATER STREAMS IMPROVEMENT IN VOIVODINA

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Abstract:

Historical development of flood control and regulation of water streams are considered as a set of constructions, activities and measures yielding a decrease of unfavourable effects (damages) caused by floods, as well as a planned water resources management, and environmental protection. To advance further the functioning of the flood control system, some additional measures of the investment and noninvestment character have been proposed on the basis of techno-economical and ecological analyses. At that, some specificities of Voivodina have to be taken into account, and especially the unfinished reconstruction and inadequate maintenance of the existing control systems.

Keywords:

Flood, protection, control, mitigation, river restoration.

1. INTRODUCTION

As is the case with many engineering undertakings, in the domain of water streams regulation, the decisions about acceptance of the majority of projects have been mainly made on the basis of the results of techno-economical analyses in which the parameters of technical reliability, functionality and economy of the proposed solution are of the crucial importance. However, the awareness of the increasing risk to the environment in general suggests that all the engineering projects, including the projects of river improvement for the control of floods, have also to take into account the parameters concerning environmental protection and its advancement [7, 9]. In fact, the word is about bringing into concordance the modern ecological and traditional techno-economical concepts in taking the engineering decisions. In other words, it is a rational compromise between human activities and nature itself, which should ensure a sustainable development of the society with an appropriate protection and advancement of the environment. The problem thus formulated is of general significance, and its solution is sought in terms of the new scientific-technological discipline called "engineering ecology" [2, 6, 8].

Previous activities on flood control and improvement of watercourses in Voivodina have primarily ensured the basic conditions for physical existence of the

major part of population, and then also for general economic and cultural development of the region. In relation to this, the flood protection structures, together with the network imrovement of watercourses (natural and artificial), represent for Voivodina the infrastructure systems of crucial importance, whose proper functioning influences almost all economic and other activities. However, the word is not only about the protective function of the system but also of ensuring the conditions for the development of some new activities, as well as of the enhancement of the utilization value of the land, water, and other resources in Voivodina [5]. It should be especially pointed out that, without flood control objects and water resources management in Voivodina, there would be no possibilities for intensive agricultural production on the reclamation systems based on modern methods of irrigation and drainage.

In view of the above it is obvious that for an effective flood protection it is necessary to analyze both the natural and anthropogenic factors which can yield an increased flood risk. This assumes the continuous co-operation with all the neighbouring countries, systematic measurements, monitoring and research of water streams regime on our territory, as well as the joint studies of different undertakings on the catchment areas and along the parts of water streams on our territory and the territories of the neighbouring countries (Hungary, Romania, Bulgaria, Croatia, etc.).

2. EVALUATION OF THE PRESENT STATE OF FLOOD CONTROL AND WATER STREAMS IMROVEMENT IN VOIVODINA

The numerousness of the water streams in Voivodina and their diversity in respect of the hydrological, hydraulic, morphological characteristics, etc., as well as in respect of the purpose and utilization mode, have necessitated construction of the different structures, and undertaking various measures on the existing flood control and regulation systems. However, a crucial role in flood control and water streams imrovement have undoubtedly played the so-called passive measures, i.e. protection dikes and classical protection structures in the river bed, whereas the so-called active measures (effects of accumulations and retention) are of the secondary importance. An exception makes the main canal network of the Danube-Tisa-Danube (DTD) Hydrosystem, which in certain circumstances can also play an important active role in flood control.

The Voivodina region has been from ancient times endangered by flood because of the plain character of the terrain, as well as because of a developed network of water streams, with the diversity in their size and hydrological-hydraulic regimes (Fig. 1).

In Voivodina, about 60% of total territory (about 12,900 km^2) is potentially endangered by flood discharge frequency 1/100 per year. On the endangered surfaces there are about 80% of the most fertile agricultural soil, 260 settlements with 1.2 million of inhabitants, about 4,000 km of traffic routes, and a number of capital objects of national economy. The endangered areas are protected by a system of dikes of a total length of 1,400 km, with the accompanying objects and 14 smaller reservoirs. An active role in flood control has also the network imrovement of streams and canals of the DTD Hydrosystem. Out of the numerous flood occurrences, which caused great direct and indirect damages in Voivodina, the most harmful were those of the rivers Danube (1965), the Tisa (1970) and the Sava (1974). The greatest damages were caused to agriculture (above 40%), and total damages in some communes exceeded 10% of the gross national product for the previous year.

The dikes along the Danube and Tisa have been reconstructed after the floods

of the year 1965 and 1970, respectively, as well as in the frame of coastal belt protection from the backwater of the Hydropower Dam "Djerdap I". Reconstruction of the dikes has been completed on the 90% of their total length for one-hundred year high water and protective height of 1.0-1.7 m. The reconstructed dikes are presently in a satisfactory state. However, it should be noticed that there plans on reconstructing their remaining parts and sanitation of the weak points on about 30 locations in the zones of the objects constructed along the main protection line. In the future period, some new calculations and analyses should be carried out in order to quantify the need for constructing additional dikes along the Djerdap accumulation because of the additional back water due to sediment deposition.

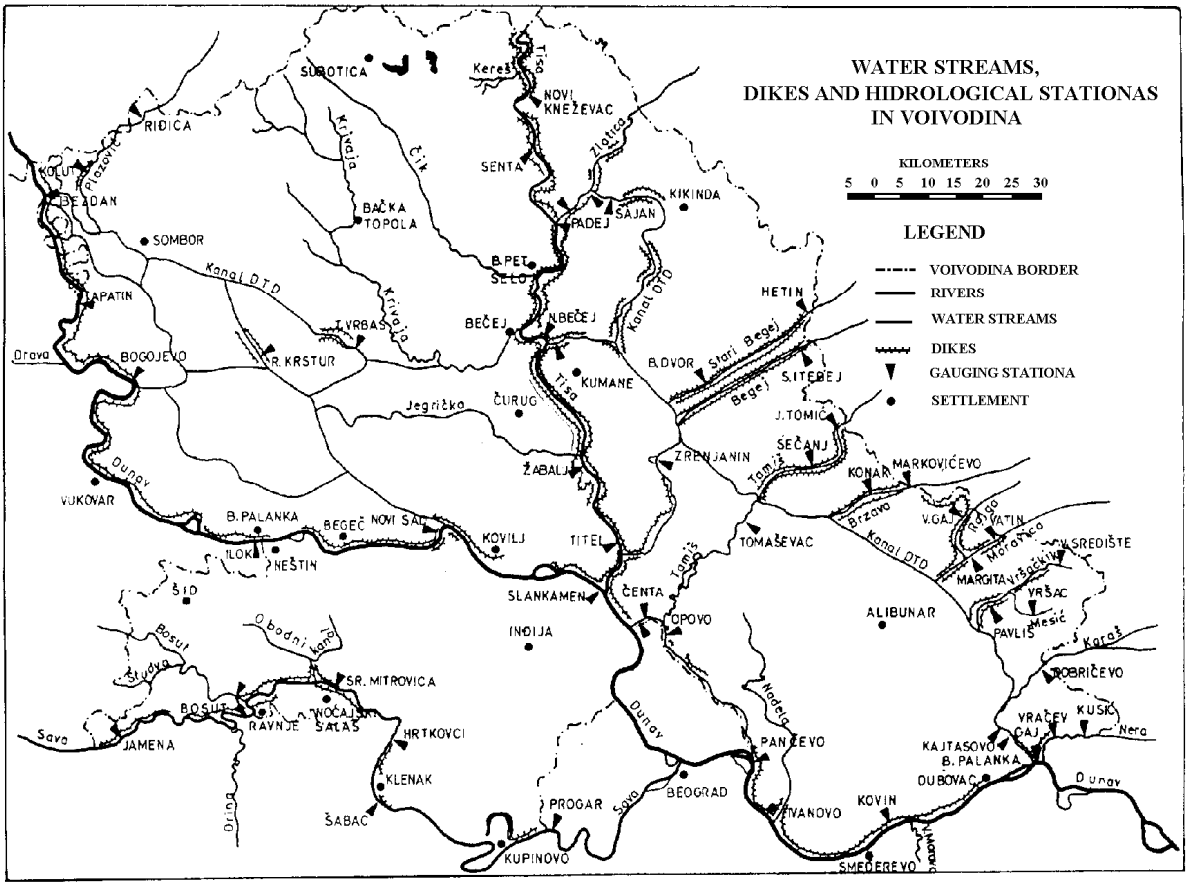

Fig. 1. *Water streams, dikes and hydrological stations in Voivodina.*

As for the smaller plain water streams, with the exception of the Karas river, they have been encompassed by the projects of dike construction, as well as by the projects of partial reconstruction of the dikes along the Stari Begej and Plazovic and some other small water streams. However, the realization of these projects will be probably slowed down because of the shortage of financial resources.

When the Voivodina torrents are concerned, the state of flood control is inappropriate and uneven. Although there are protecting structures on some of such streams, flood damages are evident, especially if the stream is flowing through the settlements [4].

In order to increase the reliability of flood control systems in Voivodina it would be necessary, in addition to other works, to design and construct the border-line dikes, with the aim of preventing the uncontrolled breach of water from the neighbouring countries to the Voivodina territory during high water occurrence. A

considerable attention should also be paid to the protection from ice-caused floods, i.e. to the prevention of formation of ice barriers. However, the ice protection service is not organized and equipped at a satisfactory level. It would be necessary to complete the icebreaker fleet along the Danube, Tisa and Sava rivers, as well as to establish and equip mobile teams to fight ice formation on smaller water streams.

On the whole, the state of flood control system in the region of Voivodina cannot be considered as fully satisfactory, so that it would be necessary to continue the action on realization of the works mentioned above. It would be highly desirable to do prompt sanitation of the weak points along the main protection lines, as well as to pay more attention to the systematic auscultation and maintenance of all the control system objects.

The works on regulation of the water stream beds in Voivodina have been very extensive and diverse in the previous period [4]. The most comprehensive works have been carried on the Danube with the aim of providing waterway traffic and protecting the river banks from deformation. In the period since the end of the 19th century to the present, the following works have been carried out on the Danube: 155.9 km of revetments; 27.8 km of groynes; 6.7 km of bariers; 1.1 km of bed fixation by sills ; 21.9 km stone deposition; 15 km cutoff meanders and other structures. The extent of regulation works has been directly influenced by the more stringent requirements for increasing the depth and other characteristics of the waterway. In 1965, in accordance with the recommendations of the Danube Commission, an investment programme was elaborated concerning regulation of the Yugoslav part of the Danube for the river traffic, requiring the minimal waterway depth of 2.5 m (the former minimal depth was 1.8 m and then 2.0 m), minimal width of 180 m, and minimal radius of the waterway bending of 1000 m. Up to now, more than 60% of the works have been carried out in accordance with this programme [5], allowing thus a satisfactory state of the waterway traffic on the section Hungarian-Yugoslav border to Belgrade.

After the construction of the hydroelectric power station "Djerdap I", there has been no need any more for regulation works on the Danube downstream of Belgrade, because of the favourable effect of the back water on the Danube navigation characteristics. However, very extensive works had to be carried out on rising and reconstruction of the embnkments and revetments along the accumulation, with the aim of protecting the coastal belt from the increased water level and erosion action of the waves. Also, the works have been carried out on reconstructing of the quays in the settlements, water tapping objects, and on some other coastal structures.

On the river Tisa, significant regulation works were carried out still in the end of the 19th century. To the end of 1875, the length of the river bed of Tisa was shortened from 1419 to 962 km, which was due to the realization of 110 cutoffs (13 cutoffs on the Voivodina territory), with simultaneous constructing of a number of regulation objects. In the period of constructing the dam on the Tisa at Novi Becej it was necessary to reconstruct 8.5 km of revetments, to build the quay walls in the urban zones of Novi Becej, Knezevac and Senta (including the bed fixation by sills), and cutoff meander near the village of Sanad.

In comparison with those carried out on the Danube, Tisa, and Sava, the regulation works that have been performed on the smaller water streams have been significantly less extensive in their scope. However, these works have allowed the majority of these water streams be successfully incorporated in the basic canal network of the DTD Hydrosystem, ensuring thus water regime management in the largest part of Backa and Banat. It should be especially pointed out that very

favourable results have been obtained in protection of canal banks of the DTD Hydrosystem from erosion using biological means [1] and new synthetic materials [3]. In the Srem region, the situation in respect of regulation and control of water regime of smaller water streams is more unfavourable, but on the basis of the realization of the water supply project, a significant improvement in this region is to be expected.

Small longitudinal slopes of the majority of the natural water streams and canals in the plain region, as well as the periodic action of back waters, bring about a decrease in the transportation capacity for sediment and formation of deposit layers in the stream bed. As was already mentioned, this problem will be more acute in the near future, especially in the Djerdap accumulation, although some unfavourable consequences have also been evident on a large scale with some other water streams. For example, it was found that, to the year 1987, in the basic canal network of the DTD Hydrosystem there had been about 12 million m^3 of deposit, which had significantly diminished water conducting capacity of the canals, and there had been the instances when the deposit formed had greatly hindered operation of water gates, water locks, and other water management objects. Besides, the unfavourable characteristics of these deposits can cause substantial problems in the functioning of the drainage and irrigation systems [10].

3. CONCLUSION

The works and structures involved in flood control and regulation of the natural water streams and canals represent the infrastructure systems of primary importance, crucially influencing the overall economic and social activities in the Voivodina region. Thanks to the structures of flood control and water streams regulation, the whole Voivodina region has become a complex water management and land reclamation system. If it is taken into account that Voivodina represents the most developed region and the granary of Yugoslavia, then it can be concluded that a normal functioning of this system is of vital interest not only to Voivodina but to the country as a whole. Related to this, the auscultation and normal maintenance of the protection objects have to be considered as a permanent obligation of the whole community.

The nature of occurrence of floods, as well as the experience that has been gained in many countries of the world indicate that an absolute flood control cannot be achieved, but the application of a range of mutually compatible measures of the investment and noninvestment character can only yield rational diminishing of flood risks and damages. The largest part of Voivodina will be further protected by dikes (passive measures), with a reasonable utilization of the existing accumulations, retentions, and canal network of the DTD Hydrosystem (active measures). The measures of noninvestment character as a supplement to the investment ones, represent a set of administrative, legislative, and institutional measures aiming at the preventive reduction of flood damages. The key elements of these measures are: specific landscape planning and land reclamation on the flood-endangered territories; regulations related to the mode of utilization of land, objects and other resources on the endangered areas; specific technical regulations in the domain of construction, utilization and maintenance of flood control objects on the flood-endangered areas; specific regulations concerning insurance of the property on the endangered areas. These measures are to be consequently applied in the forthcoming period.

Further advancements in the domain of designing, constructing, and utilizing of the system for flood control and regulation of water streams should be based on modern achievements of science and technology. All this assumes modernization of

the equipment for field and laboratory research, application of modern methods for simulation, prediction and control of the processes important for all the activities in the field of flood control and water streams regulation. Besides, it is necessary to strengthen the co-operation with the neighbouring countries and promote joint synchronized actions on flood control and water streams regulation.

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