LOWLAND ACCUMULATIONS IN TIMIȘ COUNTY FOR FLOOD PROTECTION

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Abstract. *The paper presents the lowland accumulations in Timiș County and the purpose for which they were executed. As a result of heavy rains and runoff on the slopes, in Timis County, dozens of settlements were affected by floods, people were evacuated, homes, yards, cellars, streets, roads and even agricultural land were flooded. In order to ensure better protection against floods, in order to be able to cope with the consequences of floods, both on agricultural lands and for settlements related to watercourses, lowland accumulations have been set up. The accumulations are non-permanent and are arranged on poorly productive land with the capacity to retain large volumes of water. Floods are a natural phenomenon, nowhere in the world is there a zero risk of flooding. Land improvement works, including those for flood protection and drainage, began about 150 years ago in the surrounding area of Timisoara and its rivers, which was mostly swampy and muddy. Starting with the 18th century, impressive hydrotechnical works were started for sanitation, dams (creation of lowland accumulations) and even drainage. In parallel with the flood protection works, activities were also conducted to improve navigation, to supply the city of Timisoara with drinking water, as well as for industrial purposes. Many of these hydrotechnical works were modern in their time, in which he collaborated with famous specialists of the time, including the Dutchman Maximilian Emmanuel de Fremaut. In the 1970s, a number of hydrotechnical structures were designed, consisting of low-lying accumulations to accumulate water during floods, lowering the level of flooding downstream, and thus reducing the destructive effects of flooding. The paper presents a part of the hydrotechnical structures from the Timiș County river basin, which includes the following structures: 9 permanent accumulations, 12 non-permanent accumulations, 3 transfer channels in the nearby basins, 970 km of dams of which: 824 km on Timiș and 146 km on Bega (as part of the Timiș - Bega interconnection), 4 polders, 1 hydrotechnical node (water distribution structure). Starting with the area from Lugoj, the character of Timiș changes from a steep slope river to a river with plain characteristics, also from here begins the dammed part of the river considerable damage is avoided.*

Keywords*: accumulations, dams, floods, flood waves, river basin, flooding*

INTRODUCTION

The hydrographic area administered by the Banat Water Basin Administration, includes the hydrographic basins of the rivers Aranca, Bega, Timiș, Caraș, Nera, Cerna, located in the southwestern tip of Romania, as well as the Danube River sector located downstream of the confluence with the river Nera - upstream of the confluence with the river Cerna (including the left tributaries of the Danube located in this sector). The total surface of the hydrographic space is 18,393.15 km2. The surface water resources of the hydrographic area administered by the A.B.A. Banat, includes the water resources of the 6 river basins: Aranca, Bega, Timiș, Caraș, Nera, Cerna, plus the water resources of the Danube River. The total length of the hydrographic network related to the hydrographic area administered by the A.B.A. Banat is 6,705 km. On its territory, the water resource is monitored through 81 hydrometric stations. Natural lakes are not a feature of this hydrographic area; there are only 9 lakes with an area larger than 0.5 km2 but all are accumulation lakes (Gozna, Timiș Trei Ape, Secul, Poiana Mărului, Valea lui Iovan, Herculane, Surduc, Murani, Greoni). On the territory of the Banat hydrographic space, 20 bodies of groundwater were delimited: 9 bodies are of permeable

porous type, 8 bodies are of fissure-karstic type and 3 bodies are of mixed type (permeable and fissure porous). Natural lakes are not a feature of this hydrographic area; there are only 9 lakes with an area larger than 0.5 km2 but all are accumulation lakes (Gozna, Timiş Trei Ape, Secul, Poiana Mărului, Valea lui Iovan, Herculane, Surduc, Murani, Greoni). On the territory of the Banat hydrographic space, 20 bodies of groundwater were delimited: 9 bodies are of permeable porous type, 8 bodies are of fissure-karstic type and 3 bodies are of mixed type (permeable and fissure porous).

The Banat hydrographic space has hydrotechnical works with the role of quantitative management of water resources, containing dams, regularizations, derivations of transit of water volumes from one river to another, permanent and non-permanent accumulations. A main feature of this area, a This represents the fact that Banat is the most dammed geographical area in Romania. These works also include the diversion of high water (discharge channel) Bega - Timiş - intended to defend against floods of the municipality of Timişoara of the localities adjacent to the Bega canal downstream Topolovăţ (L = 5.9 km, Qcapabil = 560 m3 / s). The main defense works against floods in the Banat hydrographic area are 29 non-permanent accumulations totalling a volume intended for flood mitigation of 211 million m3, 1,118 km of dams, 1,037 km of riverbed settlements and 150 km of bank protection. a volume of flood mitigation that amounts to approx. 69.6 mil.m3.

Fig. 1 Hydrographic network and location of hydrometric stations (***, 2017)

The Management of Emergency Situations is ensured by the components of the National Emergency Management System, according to the provisions of the Emergency Ordinance of the Romanian Government no. 1/2014 on some measures in the field of emergency management, as well as for amending and supplementing the Government Emergency Ordinance no. 21/2004 on the National Emergency Management System, of Law 15/2005 for the approval of the Government Emergency Ordinance no. 21/2004 with the subsequent amendments and completions, as well as of the Joint Order of the Minister of Administration and Interior and of the Minister of Environment and Forests no. 1422/192/2012

for the approval of the "Regulation on the management of emergencies generated by floods, dangerous meteorological phenomena, accidents at hydroelectric constructions, accidental pollution on watercourses and marine pollution in the coastal area" (***, 2014).

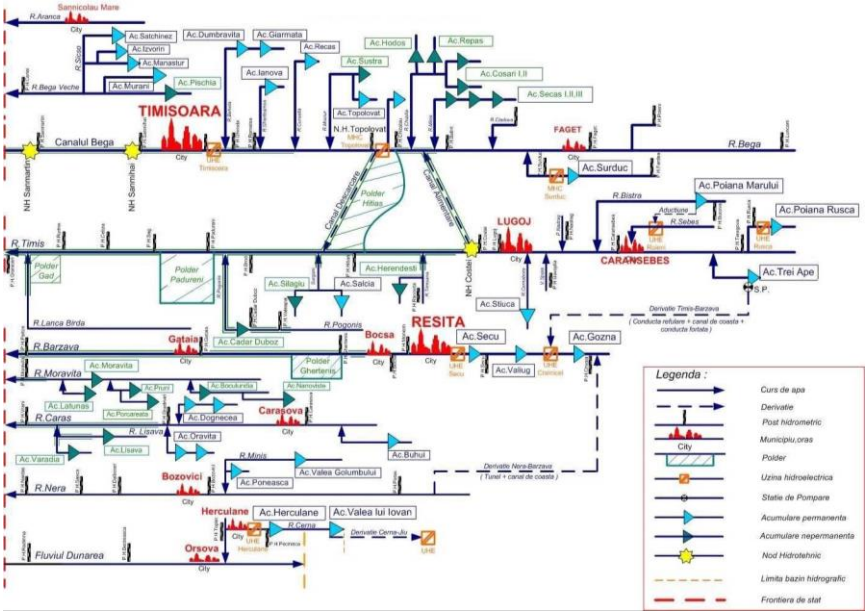

Fig. 2 Existing water management scheme in the Banat river basin with main hydrotechnical and hydro energetical arrangements (***, 2017)

MATERIAL AND METHODS

Floodplains are known as those in the upper basin of the river Bega and tributaries, Bega Veche and tributaries, Timisoara to Lugoj and tributaries, Bârzava between Resita and Gataia, Caraş and Nera.

The history of the floods on the Timiş River begins with the year 1753, when the first significant flood took place, which determined the appearance of the first projects for the development of the Bega and Timiş basins. However, the biggest flood in Banat took place in July 1859 with significant negative consequences (***, 2014)..

The twentieth century brings with it extreme hydrological events. Important and noteworthy are the floods that took place in 1912, 1966, 1999. In the 21st century, it is important to remember the extreme events of 2000, 2005, 2006 and 2010, respectively.

In 1966 there were floods in the entire Banat river basin, and they culminated in the rupture of the defense dam on the Timis River, on the left bank around Gad locality. As a known cause of these floods was the large amount of rainfall that fell throughout the space. This exceptional flood generated peak flows of 1,100 m3 / s at Lugoj and 1,416 m3 / s at Sag.

The floods of February 1999 were caused by floods of pluvional origin and occurred in the river basins Bega Veche, Bega - the middle and lower basin, Timiş - the lower basin, Pogăniş, Moravița, Bârzava - the middle and lower basin.

In the year 2000, on the background of the existence in the mountain and hill area of a consistent layer of snow, over which large amounts of liquid precipitation were recorded (120 mm in 24 hours) led to the outflow of rivers from the riverbed in the undeveloped areas and when the

dam overflows and breaks on the Timiş River, left bank, in the area of Grăniceri locality, causing the flooding of some large areas of land on the left bank of the main course.

In April 2005, a rainfall surplus was registered, especially in Banat. Most of the meteorological stations in Banat have broken the old monthly records for the amount of water recorded. These precipitations, to which was added the contribution from the melting of the snows, produced in the Timiş basin a composite flood wave in which a main peak and other secondary peaks that preceded or followed the main peak can be noticed. Thus, there are exceptional floods caused by the breaking of dams on the right bank of Timiş. On the Romanian territory, it affected large areas of land, around Otelec, Iohanisfeld, Foeni and Cruceni.

In 2006, in April, the precipitation amounts exceeded the multiannual average (10.4 mm in Cebza up to 28.6 mm in Gătaia). The nature of the precipitation and the quantities of water recorded led to the formation of a monotonous flood on most of the watercourses, a flood that had the effect of exceeding the defense quotas (***, 2014).

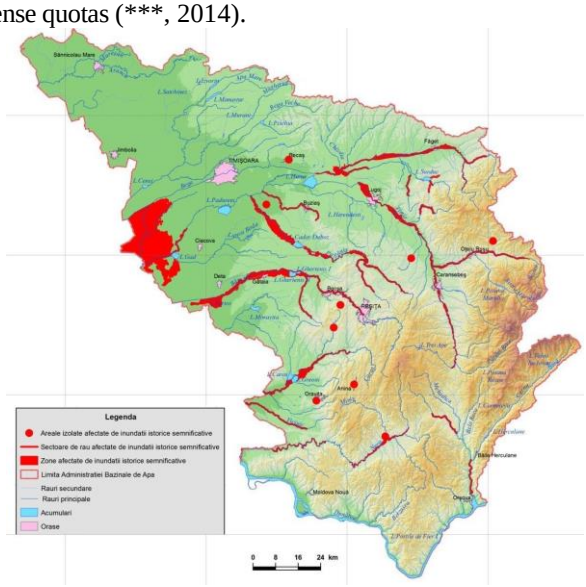

Fig. 3 Areas affected by significant historical floods (***, 2017)

Through the hydrotechnical arrangements executed in the high area of the system, the entire surface of the hydrographic network becomes controllable in the sense of obtaining a favourable hydrographic regime.

The regulation of the drainage regime and of the humidity of the ground is conducted by 3 methods, namely:

- control of the flow of watercourses upstream by regularization accumulations.
- ensuring the flow of water downstream to high levels through the existence of dams.
- ensuring the drainage of water in the depression areas by means of the network of canals and pumping stations.

On the territory of Timiș County there are twelve non permanent accumulations which presented below (***, 1973), (***, 1971-1974).

The accumulation of non-permanent **Satchinez** on the Sicșa brook with the aim of combating the floods in Satchinez commune and downstream of it, contributing to the reduction of the flood flow on the Bega Veche River. Accumulation controls a reception area of 52 km.

The **Izvorin** accumulation is a non-permanent type of accumulation, located along the Izvorin brook with the aim of combating floods in the village of Mănăștiur and excess moisture in the Bega Veche hydrographic dam, helping to reduce the flood flow (by attenuating the flood wave). The accumulation controls an area of 105 km.

The non-permanent **Mănăștur** reservoir is located on the Rât brook, upstream of Bărăteaz, with the aim of combating floods in the Bega Veche River basin by attenuating the flood wave and controlling a reception basin area of 136 km^2.

Murani accumulation, non-permanent type accumulation, located on the Măgheruș brook, upstream of the Murani-Pișchia communal road, with the aim of combating floods and excess moisture in the lower areas of the Ier-Niarad-Beregsău river basin and flood mitigation.

The **Pișchia** accumulation is a non-permanent accumulation on the Beregsău river, at the confluence with the Băcin brook, with the aim of combating floods in the Bega Veche River basin by attenuating the flood wave and controlling a reception basin area of 275 km^2.

The **Știuca** accumulation is located on the valley of the Cernabora brook, about 1.5 km upstream from the locality of Oloșag and was made by constructing an earth dam at kilometer 27 + 500.

The **Herendești** accumulation is located on the Fata valley, about 1.7 km upstream from the Herendești locality and was made by executing an earth dam at kilometer 4 + 070.

The **Topolovăț** accumulation is located on the Mociur valley, about 600 m upstream of the Topolovățul Mare locality, and was made by executing a homogeneous type of earth dam. The site formed behind the dam stretches upstream at a distance of 700 m, at a permanent level of 107.70 billion MB and at 1100 m at the maximum level with a 20% insurance at 110.70 billion MB.

The **Recaș** accumulation is located on the Curașița valley at about 2000 m upstream of the Recaș quality and was achieved by building an earth dam at km 6 + 800.

The **Șuștra** reservoir is located on the Lipari Valley, at km 2 + 900. Homogeneous earth dam and simple trapezoidal section. The body of the dam is grassed with a plant layer of 0.50 m and sown.

The **Iosifalău** accumulation is located on the Cernavoda Valley, at km 4 + 600 and is achieved by raising the existing road embankment. The earth dam is homogeneous and has a simple trapezoidal section.

The **Giarmata** reservoir is located on the Behel brook, at km 17 + 350, about 800 m upstream of the Giarmata-Ianova communal road.

The **Dumbrăvița** reservoir is located on the Behela brook, at km 7 + 530, immediately upstream of the Green Forest, and is the second step in regulating the flows on the Behela brook.

The **Ianova** Reservoir is in the Bega River Basin, on the Gherteamoș River 3.5 km upstream of Ianova.

On the **Buculundia** valley and on the Nanoviște valley, a temporary retention arrangement was made for the maximum water leaks that are formed, especially during torrential rains. The construction of the retention basins was formed by the transversal damming of the valleys with an earth dam.

RESULTS AND DISCUSSIONS

According to the data from the development of land improvement works in Banat, 5 stages can be distinguished as follows:

- the period of the Habsburg administration began with the sanitation of the swamps around Timișoara, simultaneously with the regularization of Bega from Făget to Timișoara.

Thus, the Bega canal became navigable (1728-1732) and the regularization of the Bega-Timiș rivers continued through the dams from Coștei and Topolovăț (Fremaut, 1759-1761) - which connected Timișoara through the Tisza-Danube system to the central European river system. Perhaps the most interesting action of that period is the construction of polders according to the Dutch model (dammed surfaces outside the Bega canal / Timiș river, which in case of too large amounts of water, were flooded directed by breaking the main dams);

- the period of the Hungarian administration is notable (due to the massive previous deforestation due to human intervention, the catastrophic floods of 1859 occur) by expanding the network of drainage channels, by filling with new polders, by modernizing the Coștei node and by building locks. However, the period ends with the catastrophic floods of 1910-12 (as a result of these due to the continuation of massive deforestation).

- During the Romanian administration between 1918 and 1945, there is a slight increase in swampy areas. The role of local rural communities in clearing the drainage canals belonging to the related agricultural lands is still preserved.

- During the communist period, by the state taking over the ownership of the agricultural lands, respectively of the system of drainage channels, irrigation and combating soil erosion, after a period of stagnation, starting from 1960, at the level of Timiș county the length of the drainage channels was increased to 11,542 km, and to 437,898 ha of drainage in large systems (1). This period was dominated by the floods of the 70's, after which the Surduc dam was built (also necessary for taking water from melting snow).

- In the period after 1991 in terms of land use planning, Timiș County "risks becoming a swamp again due to the indifference or ignorance of some of the decision makers, the lack of appropriate legislation, the non-application of the existing one and the chronic underfunding after 1990".

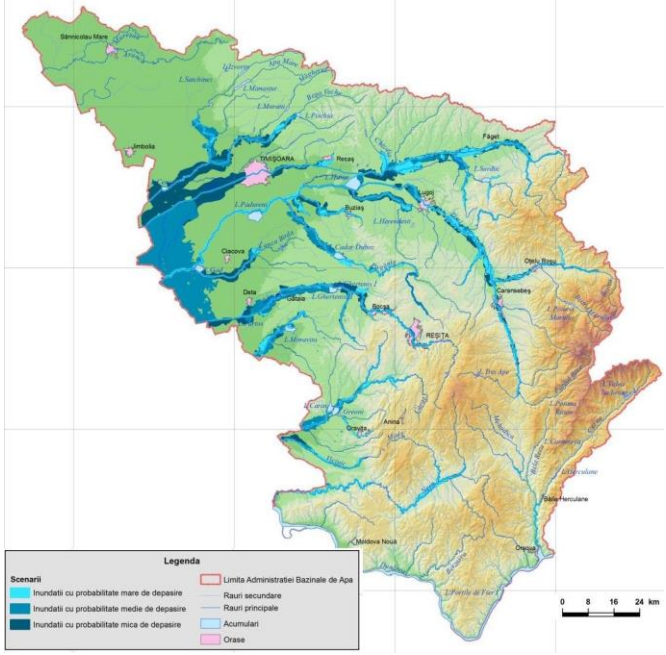

Fig. 4 Extension of floodplains in the three scenarios (0.1%, 1%, 10%) (***, 2017)

Areas with a significant potential flood risk were identified in the Preliminary Flood Risk Assessment (the first stage of implementation of the Flood Directive, reported by the I.N.H.G.A. for all A.B.A. in March 2012). Flood hazard maps provide information on the extent of flooded areas, water depth and, where appropriate, water velocity, for floods that may occur over a period. The development of these maps is done using various techniques, such as hydrological and hydraulic modelling, based on a detailed mapping of the river and the major riverbed. Therefore, the process of making these maps is a complex one and requires both an extended period of elaboration and a sustained financial effort.

Flood risk maps published nationally shall be prepared for each probability of exceeding the maximum flow of 0,1%, 1% and 10%, according to the legislation in force, for the following indicators:

- approximate number of inhabitants affected (for which the statistical method was used)

- indicators, related to the other types of consequences - economic, environmental, cultural heritage.

Based on flood and hazard risk maps, a statistical analysis was developed both at national level (including the Danube River) and at the level of each Water Basin Administration, based on the results obtained from the application of the average scenario, respectively events with medium probability (once every 100 years), and is presented in a major integrated project proposals.

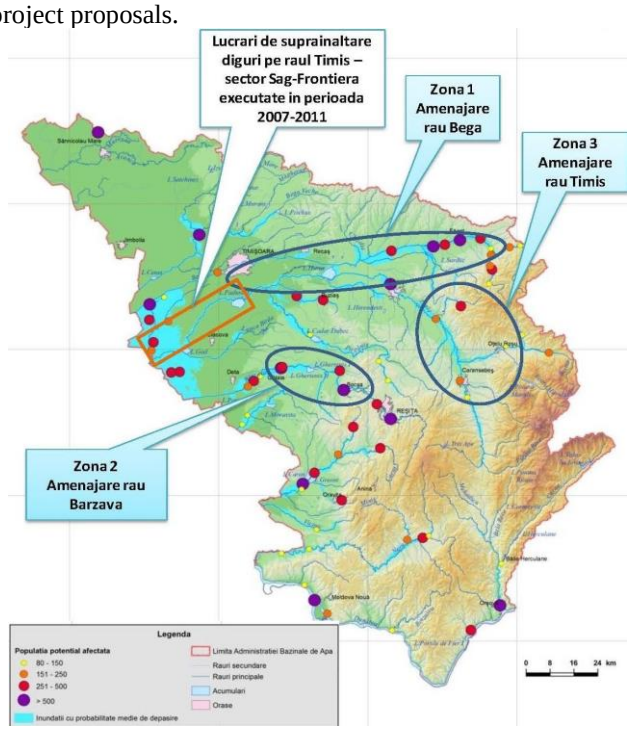

Fig. 5 Major integrated project proposals (***, 2017)

CONCLUSIONS

Romania has been severely affected by devastating floods in the last decade. Large-scale floods with catastrophic effects occurred in 2005, 2006, 2008, 2010 and 2014. According to the study conducted by DG Environment in 2014 at European level, (Study on Economic

and Social Benefits of Environmental Protection and Resource Efficiency Related to the European Semester - DG Environment - February 2014), in the period 2002-2013, 20 events took place major floods with a total cost of 4.1 billion Euros resulting in an average of about 310 million Euros per event. The results of the study led to the conclusion that the extrapolated damages were 6.3 billion Euros, and the number of victims registered by 183 people proves to be the highest in Europe.

In these conditions, in Romania it is necessary to improve the monitoring, early warning and alarm systems, in the conditions in which a change of approach is required from "flood defense" to a "proactive action" oriented towards flood risk management, in order to reduce both the effects of hazard and to reduce vulnerability and increase resilience to floods.

The Banat hydrographic space has hydrotechnical works with the role of quantitative management of water resources, containing dams, regularizations, derivations of transit of water volumes from one river to another, permanent and non-permanent accumulations. A main feature of this area, a represents the fact that Banat is the most dammed geographical area in Romania.

Most of the flood protection works are conducted in the Bega and Timiş river basins (550 km of dams and 480 km of regularizations, the protected area being 230,000 ha). These works also include the diversion of high water (discharge channel) Bega - Timiş - intended to defend against floods of the municipality of Timişoara of the localities adjacent to the Bega canal downstream Topolovăţ (L = 5.9 km, Qcapabil = 560 m3 / s).

As main works of defense against floods in the Banat hydrographic space there are 29 non-permanent accumulations totalling a volume destined to the attenuation of floods of 211 mil.m3, 1,118 km of dams, 1,037 km of riverbed regularizations and 150 km of shore defences. Accumulations with a complex purpose provided a volume of flood mitigation amounting to approx. 69.6 mil.m3.

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