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A HISTORY OF ABOUT 300 YEARS OF HIGH WATERS AND HYDROTECHNIC CONSTRUCTIONS IN BANAT (I)

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Abstract. This study is a synthesis on three centuries of hidrotechnical managements and high levels of rivers in Banat, including four distinct periods for the floodings which produced great damages: 1700-1876; 1877-1949; 1950-1972 and 1973-2005. It was also important the flooding from April 14th –30th 2005 in the hydrographical basin Timiş-Bega. Analyzing the frequency and the amplitude of the floodings in time, it can be concluded that these are in a continuous increase. The defend against floodings, the management and the dams, the whole history of the big hydrographical and navigation works could be grouped in the following stages:

- **(a)** From the beginning of the 18th century till the 1848-1849 Revolution;
- **(b)** From 1848-1849 Revolution till year 1871;
- **(c)** From 1871 till the First World War;
- **(d)** The Interwar period;
- **(e)** From the Second World War till 1989 Revolution;
- **(f)** 1990-2005.

As in all EU countries which had to cope with floodings, in Banat as well it must be applied the new concept «more space for rivers», building dams at longer distances than the river banks.

Rezumat. Lucrarea sintetizează cele trei secole de amenajări hidrotehnice şi ape mari din Banat, grupând în patru mari perioade distincte marile viituri, care au produs pagube însemnate locuitorilor acestei provincii istorice: 1700-1876; 1877-1949; 1950-1972 şi 1973-2005. Consemnăm pe lângă alte ape mari şi viitura din 14-30 aprilie 2005 din bazinul hidrografic Timiş-Bega. Analizând frecvenţa şi amplitudinea viiturilor în timp ajungem la concluzia că acestea sunt într-o continuă creştere. Apărarea împotriva inundaţiilor, amenajarea şi stăvilirea apelor, întreaga istorie a marilor lucrări hidrotehnice şi de navigaţie, o putem grupa în mai multe etape importante:

- **(g)** Începutul secolului al XVIII-lea până la Revoluţie de la 1848-1849;
- **(h)** De la Revoluţia de la 1848-1849 până la anul 1871;

(i) De la 1871 până la Primul Război Mondial;
(j) Perioada interbelică ;
(k) După cel de-al Doilea Război Mondial până la Revoluția din 1989
(l) 1990-2005

Şi în Banat, ca în toate ţările Uniunii Europene confruntate şi ele cu mari inundaţii trebuie să aplicăm noua concepție : « mai mult spațiu pentru râuri », construind diguri la distanțe mai mari față de malurile râurilor.

Key words: *high waters, catastrophic floods, hystoric votes, hydrotechnic constructions, hydrotechnic node, cribbing channel, navigable channel.*
Cuvinte cheie : *ape mari, inundații catastrofale, viituri istorice, amenajări hidrotehnice, nod hidrotehnic, canal de plutărit, canal navigabil*

Many speciality works record besides the historical data also information regarding certain extreme climatic or hydrographic phenomena: very low or very high waters. We will deal with the very high waters and their interception in time because they determined floods and huge damages, and the usage of the very low waters for different services of the water courses was very labouring.

The hydrologic phenomena propagated at a certain periodicity were recorded in different ways. These data were found in old annals or charters, geographic descriptions, notations on old eclesiastic books by priests, in monographies, laic books or small memorialistics, communicated from generation to generation as special events kept in the mental of the site, where the catastrophes or big floods were recorded. Most of these floods brought loss of human lives, homesteads and whole villages, with hard to imagine damages mentioned in the documents of that time kept in archives, museums, private collections and historic literature.

There are numerous historic references to the floods on the Danube beginning with the IVth century AD, then to those from Câmpia Tisei and East of Banat, the Xth century, to the rivers from Banat plain and Mureş starting with 1508 and to other rivers like Timiş, Bega in XVIIth century and the beginning of the XVIIIth century, and in the next century (the XIXth) to the rivers Caraş, Nera and Cerna. The most vulnerable area in Banat, constantly threatened by floods is the plain part, in the north and center of the Timiş Plain (Fig. 1).

About the beginning of the hydrometric activities on the rivers from Timiş County and Banat we can mention that in the first stage – that starts from the second half of the XIXth century – there were set up 21 hydrometric stations at: „Făget (1875), Balinț (1875) and Timişoara (1856), all of them on the river Bega; Podul Cenei (1888) on Bega Veche; Lugoj (1874) and Şag (1874) on Timiş; Partoş (1880) on Bârzava. Another important moment is the year 1919. Now, there were installed other 17 hydrometric stations on the connecting channels between rivers and small branches that functioned almost continuously until 1951-1952 when they were liquidated. In the first stage at the hydrometric stations are made only measurements of the water levels, and also is growing the hydrometric knowledge degree at a large number of stations on the main rivers from this part of the country.

After 1950 the hydrometric activity meets a qualitative and quantitative jump because in this period began the systematic and complete activities regarding the levels observations and volume measurements at the 29 stations in Banat[1].

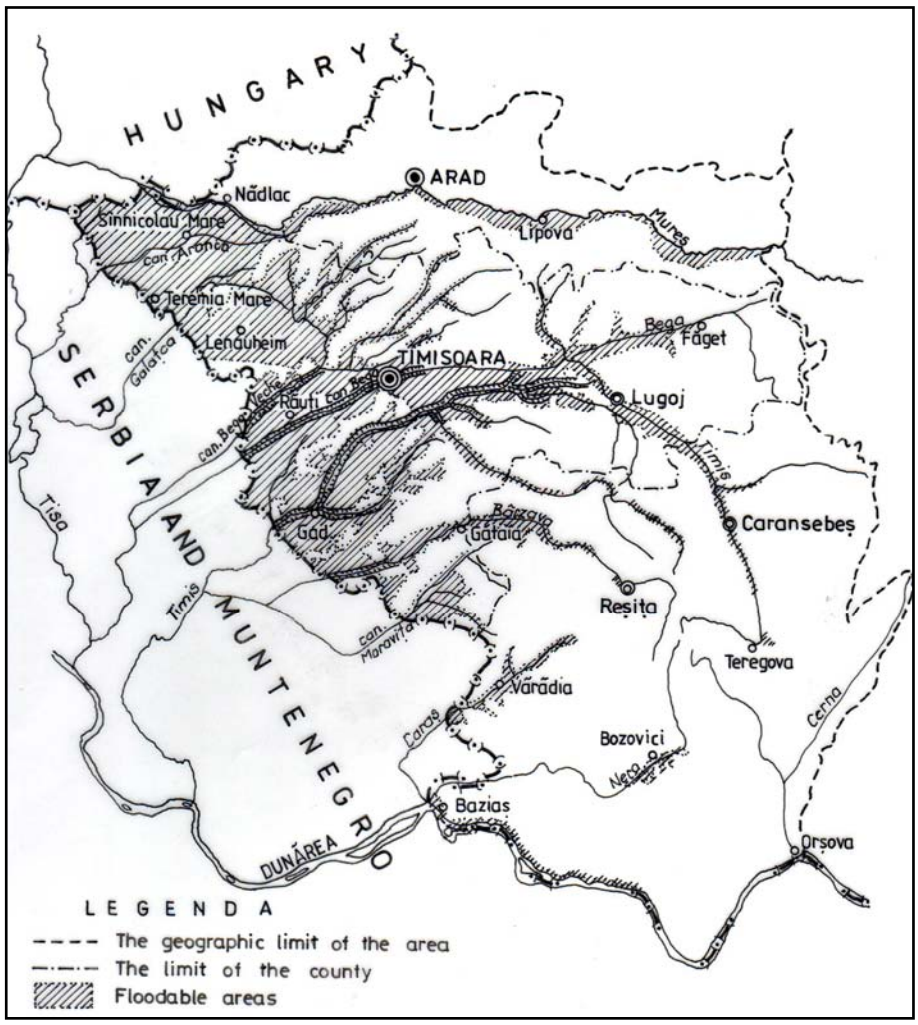

Fig.1. The surface of the maximum floodable teritory in Banat (after A. Zănescu, 1974)

In the period 1952-1962 at the 95 hydrometric stations were effectuated 4829 volume measurements, constituting a hydrometric data stock that covers the whole geographic area of Banat[2].

[1] *Monografia hidrografică a râurilor din Banat, 1964, pp. 28-29*

After Alexandru Zănescu, specialist and hobbyist of these phenomena, we group the hydrologic information - on a period of over 270 years (1700-1972) -, characterized by data continuity (table nr. 1), - in three distinct periods: *1700-1876 period* that comprises the possible informative data based on historic documents and recordings; *1877-1949 period* that comprises the techno-relative part with empirical data, observations and high waters levels measurements; and *1950-1972 period*, the certain technical-scientific stage with volumes and levels measurements[3].

The first period that extends on 176 years from which 67 are years with high waters and 161 floods; in the next 73 years, *from the second period*, 46 were years with floods, on all the rivers there were 129 high waters; and *in the last period 1950-1972*, from the 23 years, 22 were years with high waters and 144 levels that got beyond the floods marks (table nr. 1).

Tabel 1. The frequency of the years when high waters and floods happened on the rivers from Banat (1700-1972)

River and basin	Probable data 1700-1876				Subjective certain data				Objective certain data				Periods ensemble 1700-1972			
	period, years	years with high waters	frequency of floods/ years	%	period, years	years with high waters	frequency of floods/ years	%	period, years	years with high waters	frequency of floods/ years	%	period, years	years with high waters	frequency of floods/ years	%
Number of years with high waters		67	1/2,6	38,1		46	1/1,6	63,0		22	1/1	95,5		135	1/2	49,6
Mureş		40	1/4,4	22,7		12	1/4,9	20,6		17	1/1,4	73,9		72	1/3,8	25,5
Bega-Veche		**9***	**1/5,7**	**17,4**		**25**	**1/2,9**	**34,2**		**13**	**1/1,4**	**56,5**		**47****	**1/3,1**	**32,4**
Bega		**30**	**1/**	**17,0**		**16**	**1/4,6**	**21,9**		**18**	**1/1,3**	**78,2**		**64**	**1/4,3**	**23,5**
Timiş	**176**	**25**	**1/7,0**	**14,2**	**73**	**34**	**1/2,1**	**46,6**	**23**	**16**	**1/1,4**	**69,5**	**272**	**75**	**1/3,6**	**27,6**
Timiş-Bega ensemble		**42**	**1/4,2**	**23,9**		**35**	**1/2,1**	**48,0**		**18**	**1/1,3**	**78,2**		**95**	**1/2,9**	**34,9**
Bârzava		15	1/11,7	8,5		19	1/3,8	26,0		19	1/1,2	82,5		53	1/5,1	19,5
Other courses		30	1/5,9	17,0		14	1/5,2	19,2		22	1/1	95,5		66	1/4,1	24,3
Total of registered phenomena	161				129				144				434			

* For Bega-Veche the statistics can be made only after 1830 when the adjustment works began.
* * From the same reason 46 floods in 142 years are taken into account.
Source: A. Zănescu, 1974

In Banat, from the mentioned statistics comes out the fact that in the interval between 1700-1972, there were 135 years with high waters and a number of 434 floods on all the rivers, floods with a frequency of 49,4%[4] (table nr. 2), from which we can deducethat the frequency of the high waters happens at a quick pace on the rivers from

[2] *Idem, p. 31*
[3] *Al. Zănescu, Statistica apelor mari, istorice, pe râurile din Banat. Hidrotehnica, 19, Bucureşti, 1974, p. 231*
[4] *Idem, p. 232*

Banat, almost annually, covering all months of the year and the greatest balance comes to February, March, April and May (fig. 2).

High waters distribution by seasons shows differentiations from one season to another. Thus, in spring there are the most floods (48%), then in winter (25%), in autumn we have the lowest frequencies (5%), although in Banat the second pluviometric maximum is recorded in the autumn months as a consequence of the influences of the submediterranean climate (table nr. 3). The origins of the pluvial high waters are in May-November, and the nival, the high ranks are in December-April (table nr. 4)[5]. The flood from 1966 recorded one of the highest volumes on the main rivers, the origin being the thaw of the snow, rainfall and the combination of these two phenomena[6].

Tabel 2. The statistics of the high waters from Banat, distributed by months when these happened

Nr.	Season	Number, period and percent						Total	%
		1700-1876		1877-1949		1950-1972			
		number	%	number	%	number	%		
1.	January	6	4,4	2	1,6	12	8,3	20	4,9
2.	**February**	**22**	**16,0**	**7**	**5,5**	**27**	**18,8**	**56**	**13,7**
3.	**March**	**16**	**11,7**	**36**	**28,3**	**12**	**8,3**	**64**	**15,7**
4.	**April**	**12**	**8,8**	**20**	**15,8**	**21**	**14,6**	**53**	**13,0**
5.	**May**	**17**	**12,4**	**28**	**22,0**	**34**	**23,6**	**79**	**19,4**
6.	June	9	6,6	7	5,5	10	6,9	26	6,4
7.	July	13	9,5	10	7,9	9	6,2	32	7,8
8.	August	22	16,0	3	2,4	2	1,4	27	6,6
9.	September	3	2,2	5	3,9	2	1,4	10	2,5
10.	October	-	-	-	-	3	2,2	3	0,7
11.	November	2	1,5	-	-	1-	6,9	12	2,9
12.	December	15	10,9	9	7,1	2	1,4	26	6,4
	Total	**137**	**100**	**127**	**100**	**144**	**100**	**408**	**100**

In the interval 1972-2005 there were torrential rains as a consequence of dramatic thaws due to temperature increase, fact that determined significant increase of the maximum flow in 1977, 1978, 1982, 1994, 1997, 1998, 1999, 2000[7], 2001, culminating in catastrophic floods from April 2005.

The flood from 14-30 April 2005 in the hydrographic basin Timiş-Bega has a pluvial nature. From the big floods history of Timiş-Bega basin we record that from 25-30 May 1912 – the biggest taking into account the maximum flow value (approximately 1600

[5] *Ibidem, pp. 233-234*

[6] Râurile României, 1971, p. 148

[7] *Eugenia Stanciu, Consideraţii asupra caracteristicilor ploilor torenţiale din Banat, Regionalism and Integration, 2000, pp. 289-294*

m^3/s) -, also of pluvial nature[8]. The volume of the flood from 2005 was three times lager than the volume of the floods from 1966 and 2000[9], but the biggest flood remains that from 1912 (fig. 3). In the afloat area between Timiş and Bega flew over 350 million m^3 of water in April 2005 and only 99,6 million m^3 were evacuated with the pumps, the rest by evaporation from the water surface.

Tabel 3. Number of floods distributed by seasons and periods

Nr.	Season	Number, period and percent						Total	%
		1700-1876	1877-1949	1950-1972	1700-1876	1877-1949	1950-1972		
		number	%	number	%	number	%		
1.	Winter (December-February)	43	31	18	14	41	28	102	25
2.	**Spring (March-May)**	**45**	**33**	**84**	**66**	**67**	**47**	**196**	**48**
3.	Summer (June-August)	44	32	20	16	21	15	85	21
4.	Autumn (September-November)	5	4	5	4	15	10	25	6
	Total	**137**	**100**	**127**	**100**	**144**	**100**	**408**	**100**

Source: Al. Zănescu, 1974, p. 233

Tabel 4. The statistics of high waters by origin

Origin	Period			
	1700-1876	1877-1949	1950-1972	1700-1972
Nival (%) December-April	51,8	58,3	51,4	53,7
Pluvial (%) May-November	48,2	41,7	48,6	46,3

Source: Al. Zănescu, 1974, p. 234

After the analysis regarding the statistics of the historic waters in Banat – high waters that get beyond the high water marks -, result a series of conclusions; the most important is that *the frequency and amplitude of the floods are in a constant growth*, and the causes are multiple:
- alluvium deposition between the barrages, a colmation process that raised the minor and major beds, as well as the banks and bed erosion;
- backwater phenomenon on the Serbia and Montenegro territory, due to the excessive expanding of the arboreal vegetation in the minor and major bed, becoming thick in the

[8] *V. A. Stănescu, R. Drobot, Viitura din perioada 14-30 aprilie 2005 în bazinul hidrografic Timiş-Bega, Hidrotehnica, nr. 7-8, 2005, p. 4.*
[9] *Idem, p. 5.*

barrage-bank area (for Timiş river)[10], on the Romanian territory it showed decreased water flow, increased water level, overstressing, erosion and finally, barrage breakage[11];
- anthropic interference amplification – in the catchment areas – massively interfering in adjusting the hydrologic circuit from the beginning of the XVIIIth century, in modifying the flow index of the beds and the expansion of the field usage, of the goods and some economic activities right in the river beds and not lastly, the land clearings, the massive cutting of the forests etc.;
- the subsidence areas given by the recent and actual subsiding tectonics, with the most lowered absolute altitudes (normally under 100 m)[12]. The active subsidence from Banat Plain happens slowly, being compensated by the accumulation processes, recent and actual alluviation is found in Timiş Plain, Aranca Plain, Mureş Plain, Timiş-Bega plains from Lugoj basin[13].

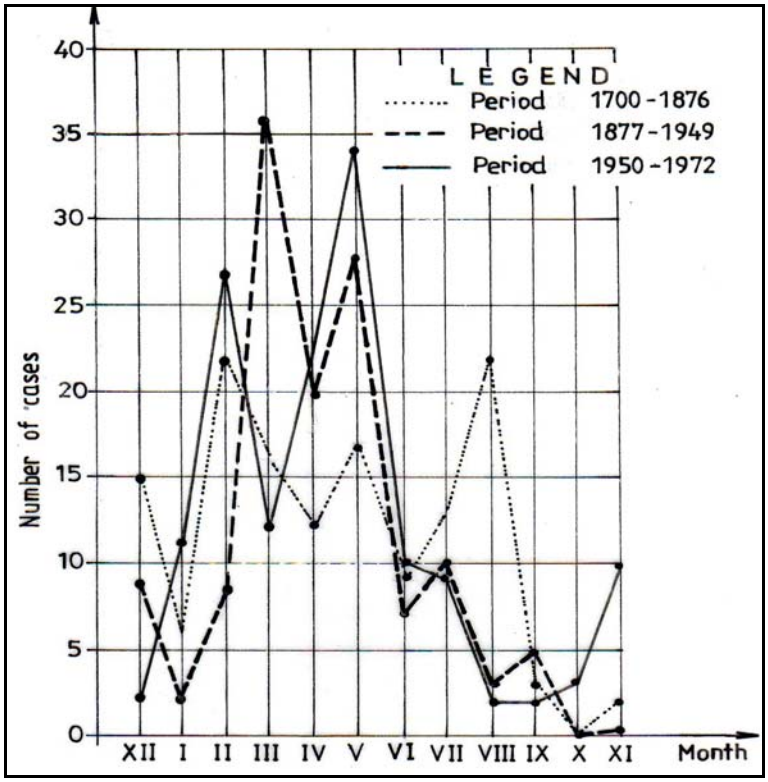

Fig.2. Monthly variation chart of the big waters frequency on the rivers from Banat (after A. Zărnescu, 1974, p.223)

[10] *Ibidem, p. 14.*
[11] *E. T. Man şi colectivul, Impactul inundaţiilor din aprilie-mai 2005, ... Iaşi, 2005, p. 81.*
[12] *Al. Ungureanu, Geografia podisurilor şi câmpiilor României, Iaşi, 1993, pp. 164-165.*
[13] *Gr. Posea, Câmpia de Vest a României, 1997, pp. 78 şi 299.*

The waters that circulate the geographic space of Banat – Mureş, Bega Veche, Bega, Timiş, Pogăniş, Bârzava, Caraş, Nera, Cerna and the Danube – totalize a surface of about 406.200 hectares, of which 60% comes to Banat plane, plain area that has to be defended against floods through banking systems with crucial role in social-economical development of the entire territory (fig. 1); many documents of the time clericals make references to this hydrographic situation and to the relationship between people, lands and waters.

The great hydroameliorative works from Banat begin in the first decades of the XVIIIth century, and then continue in the XIXth and XXth century till now. The entire history of defending against floods, installing, controlling and holding the waters, the great hydrotechnic and shipping works rode, beginning with the XVIIIth century, more important stages[14]:

1. **the beginning of the XVIIIth century until the 1848-1849 Revolution;**
2. **from the 1848-1849 Revolution until 1871;**
3. **from 1871 until the World War I;**
4. **the inter-war period;**
5. **after the World War II until the December 1918 Revolution;**
6. **1990-2005;**

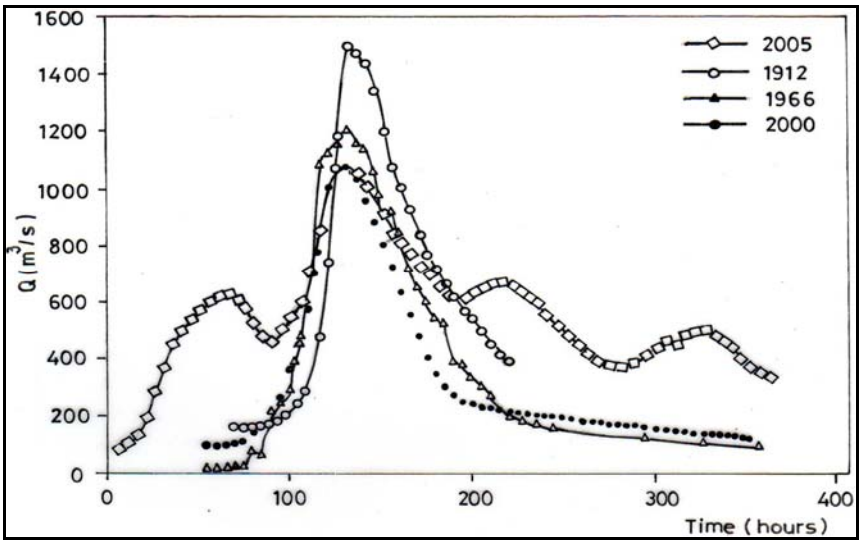

Fig. 3. The flood waves hydrographs from 1912, 1966, 2000 and 2005 top centered (after V.A. Stănescu, R. Drobot, 2005, p.13)

Until the beginning of the XVIIIth century we also have to mention the fact that the present course of Bega, in ascent from Timişoara in the Medieval Period, was called Timişel, branch of Timiş.

[14] *R. Nedelcu, E. Man, Lucrări de îmbunătăţiri funciare în spaţiul hidrotehnic Banat. ... Timişoara, 1998, pp. 842-845; L. Kakucs, Contribuţii la istoria agriculturii în Banat. ... p. 94.*

A document from 1228 mentions for the first time that the passing of the rivers was through installed fords. Also, the watermills are mentioned for the first time in the famous diploma to Bella the IVth from 1247. They are continuously developing and there were inventorized over 600 watermills in Banat, in 1880, plus the floating ones on Mureş until the middle of the XXth century, which were still in function[15].

The continuously growing number of these equipments that capitalize the fruitage from Banat granaries, proves us once again that this space was intensely cultivated in the analyzed periods and was not devoid of habitation as some try to sustain the depopulation thesis.

In the plain area of Banat large areas were occupied by lakes, mires or excessively wet land caused by the cutting of large wooded areas or the presence of watermills; around the citadel Timişoara, the Ottomans, from strategic reasons, let deliberately the meadows and the beds to clog, thus keeping the mires and contributing to the extension of unproductive areas.

1. The period from the beginning of the XVIIIth century until the 1848-1849 Revolution is characterized by the replacement of 164 years of Ottoman occupation with the Austrian domination in Banat in 1716. The prince Eugeniu de Savoya leads the Austrian army and reconquers Timişoara and the Court from Vienna entitles him military governor of Banat. The military governor puts as chief military commander of Banat the count Claudius Florimund Mercy, who among other important assignments will deal with mire drainage, main water courses regulation in Banat, sanitary conditions improvement and floods danger elimination.

By order of general Mercy, between the 1723-1725 begins the mapping of the entire territory of Banat and is elaborated a map on which appear large floodable areas; it is also singularized the four large mires, two north of Bega, between Timişoara and Becicherecu Mare – The Dry Mire, The Deep Mire, and the other two south of Timiş, at Ilandza and Alibunar (in Serbia); besides the water courses from Banat plane there are also areas with excess of humidity and the citadel of Timişoara was surrounded by mires and large areas were under the water. Thus, it is mentioned that on St. Marcu day (18 July for Roman Catholics) at the traditional procession no one could get out in the field to hallow the bounds because of the boggy grounds[16].

After the settlement of the Austrian administration in Banat, the province administration elaborated a project with a series of objectives, priorities in economic exploitation greately dependent on water courses regulation, works that were also included in a strategic plan of military roads and fortifications system maintenance; another priority was to remove the farmland from under the water and to exploit rationally the soil; mires extension created health problems among people, the number of deaths achieved alarming proportions[17].

In 1720, under the direction of the French engineer La Casse began the water regulation works around Timişoara, for military, economic and urban reasons; until 1727 were made four regulation canals of Bega, with an artificial bed; Timiş definitely flowing south of Timişoara.

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[15] *Al. Zănescu, Pagini din trecutul folosirii şi amenajării apelor din sistemul Timiş-Bega, pp. 40-41.*
[16] *L. Kakucs, op. cit., p. 87.*
[17] *Ibidem, p. 88.*

The main reason to regulate Bega was also water transportation, therefore, between 1727-1728 begin and finish the works at the cribbing canal between Făget and Timişoara, 70 km long[18], used to bring wood from the forests surrounding Făget, needful building materials to reconstruct the citadel and the city of Timişoara.

Along with the ascent canal also begin the works at the downstream waterway till the port Titel on Tisa (Serbia and Montenegro). The two canals digging was executed with much labour and a very big number of worked hours. Also now begin the banking works of the rivers and mires drainage, which are finished in 1733. In November 1732 a special event takes place – the opening of the inland navigation -, the first ship traverses the route Timişoara-Pancevo (Serbia).

By reason of mires drainage and sand production, a phenomenon that aggravated a lot the canal navigation in Timişoara-Titel zone, the Austrian military administration took the decision to dig south a new canal, parallel to the old one. The works started up and were executed rapidly between 8 October 1753 – 29 October 1754, under the direction of the engineer Johann Karl von Stockhausen sent by the Court from Vienna[19]. The old course of the canal became the bed of Bega Veche. All the right branches of Timiş are branches of Bega Veche, the canal intercrossing and closing the old courses of the beds to Timiş, which desappeared, being preserved only the canal Timişaţ, not far from the border.

Through Bega waterway, 92 km long, Timişoara city (32 km Timişoara-border) entered the European economic network.

The hydrotechnic engineer Maximilian Emmanuel Fremaut is brought to Banat, with his experience in Low Countries elaborated a project of regulation and construction of the water courses, works that were finished between 1758-1761 or continued by his disciples Carl Alexander Steinlein and Johann Theodor Kostka, like: the hydrotechnic nodes from Coştei and Topolovăţ, the improvement of Timiş bed, (Timiş bed was 3-4 m higher than Bega bed); the elimination of floods danger on Bega especially for Timişoara citadel, mires drainage etc. – for the period when all of these were fulfilled, they are integrated in technical works with special importance with positive impact on socio-economic development of Banat.

The hydrotechnic node Coştei – a strategic construction and the first work for the hydrotechnic system Timiş-Bega -, located on Timiş river, 9 km from Lugoj, the work was achieved between 1757 and 1758 to discharge the waters from Timiş into Bega. From Coştei to Chizătău (fig. 4) the feeder has a length of 9558 m, a width of 12,2 m and a water depth of 3,5 m, located on the right shore, fitted with a manually lock at first and now with an electric regulator device which has a grid and a water inlet. The hydrotechnic node Coştei had a channel spillway of ripraps in wooden cofferdams. The great flood from 1859, the catastrophic floods reached unheard of proportions up till then on Timiş, covering with water over half a million of cadastral land[20].

After these floods, in 1860, the lock and the lock house are rebuilt[21], and the spillway barrage is reconstructed in 1896-1900 from stone and concrete cofferdams, with a length of 130,6 m, coping width of 9,1 m and height of 2,6 m. When there were low waters Bega flow was supplemented with up to 10-15 m^3/s, being also the first construction on the

[18] *E. Preluschek, A. Jancso, Short history of Bega Hydrotechnic System, Timişoara, 2002, p. 201.*
[19] *L. Kakucs, op. cit., p. 90.*
[20] *Al. Zănescu, op. cit. p. 47.*
[21] *Emanuela I. Truică, Gh. Popa, Recondiţionarea barajelor vechi din spaţiul Banat, 2005, p. 42.*

defense line against floods, [22] the hydrotechnic node being integrated into Timiş-Bega double connection system. The purpose of constructing this node was, at first, to ensure the necessary flow of Bega river for complex services and in the second half of the XVIIIth century for cribbing, sailing and water supply of Timişoara citadel.

The body of the spillway barrage was built from raw stone coated with concrete bays but was repeatedly damaged, even during repair works (1981-1985 and 1988-1999) by the floods from 1998, 1999, 2000 and 2005.

To supplement the water supply of Timişoara municipality it is envisaged to increase the flow through the supply canal from 18-20 m^3/s to 38-40 m^3/s, keeping the hystoric character of this hydrotechnic node, concomitently with the execution, downstream of the barrage, at 3,8 km of the defense works, stopping the bank erosion. Casa Stăvilarului was also redone, a construction since 1758, reconstructed in 1860, now being conserved and reconditioned, and included on the historic monuments list from the technical patrimony category.

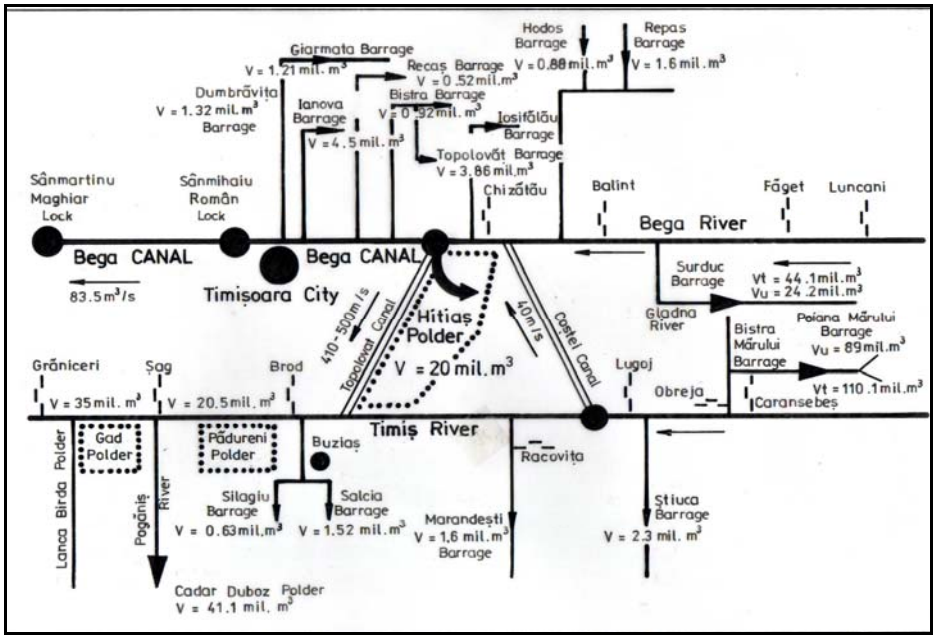

Fig. 4. Construction scheme with accumulation of the Timiş-Bega basin (after V. A. Stănescu, R. Drobot, 2005, p.3)

The hydrotechnic node Topolovăț. The water discharge from Bega into, from the right bank of Bega, has a lock. Between Topolovăț and Hitiaș on Timiș (fig. 4) the canal has a length of 7600 m and a width of 13 m, built between 1758 and 1765. When the big floods from 1859 happened, it was proved that this canal was not sufficiently adjusted.

[22] *D. Herescu, Rodica Preluschek, Unele considerații privind gospodărirea apelor mari în sistemul de conexiune Timiş-Bega, p. 98.*

Between 1909 and 1912 a metallic lock was built at Topolovăț, with an opening of 10 m, being able to evacuate from Bega a maximum flow of 40 m^3/s. It was also installed a bottomsill on the canal, with a length of 64,6 m, which has the role to obstruct the low waters flow from Bega into Timiş. More ample repairs were performed in 1955, at the nergy chute of Topolovăț lock[23]. The hydrotechnic works from the double connection Timiş-Bega: the feeder Timiş-Bega between Coştei and Chizătău and the high waters discharge canal from Bega into Timiş between Topolovăț and Hitiaş have a significant importance for the downstream space and Timişoara municipality: defense against floods, discharging a flow of 370 m3/s into Timiş river; increases the water supply; the irrigated area - 5387 hectares; ensures the necessary water for the functioning of the hydrotechnic factory from Timişoara, with a power of 1630 horsepower; the water level on Bega channel when it will become navigable again; nautical recreation and fluvial tourism etc.

The navigable Channel Bega is part of the international interconnected system of channels **D.T.D.** (Dunăre-Tisa-Dunăre).

All the works regarding water management designed and executed after 1750 are characterized by a high level of arrangement and great complexity in the hydrotechnic domain: 120 km of barrages, 54 reservoirs, 8 hydrotechnic nodes, branch pipes etc.

The hydrotechnic system Roviniţa Mare – Balnoc from Bârzava. In 1801 on the right shore of Bârzava bed it is constructed a bottomsill which will direct the water through the Italian Channel, which crosses and irrigates the cultivated land with rice of the Italian settlers. It is also built a second barrage at Roviniţa Mare which involves also the mill for rice decortication. The Italian Channel, finished in 1880, has a length of 8,7 km and a flow of 3 m^3/s, discharging and evacuating the waters from Bârzava, irrigating about 600 hectares of rice plantation[24].

2. The stage that passes from the 1848-1849 Revolution until 1871

The main problem of this stage remains the supply of drinking water to Timişoara inhabitants, the sailing modernization on Bega Channel and water management through "The society for water regulation in Timiş" in 1841. In 1858 the land owners from Torontal Shire set up the stock company "The banking association from the superior Torontal", which had as a goal complex hydro-amelioration works and to defend from floods the 458.901 hectares of agrarian land.

3. The period between 1871 and the World War I

In 1871 it is set up "The association of Timiş-Bega waters regulation", changed later into "Timiş-Bega Union" (1924) having as a goal maintaining the defense walls against the floods, extension and improving the hydrotechnic constructions. The first project was elaborated by the royal engineer Képessz Jozsef in 1871, improved in 1890-1891 by Kovacs Sebestyén Aladar, after the impact of the big catastrophic floods from 1853, 1859, 1871, 1887 and 1888. The main merit regarding the project achievement was to obtain state credits that Timişoara Chamber of Commerce and Industry had. The project elaborated by Kovacs in 1890 calculated among other works also installing other four linking canals and some polders between Timiş and Bega to take over a certain flow during

[23] *Emanuela I. Truică, Gh. Popa, op. cit., p. 42.*
[24] *Gh. Creţu, Refacerea sistemului hidrotehnic Roviniţa Mare – Banloc, pp. 21-22.*

the big floods[25]. The canals were not finished but the other works from the project were fulfilled up to 1912 when a new flood tested their quality and resistance.

In the period 1911-1915 on Bega Channel were built 4 hydrotechnic nodes, some of them with locks downstream of Timişoara; the double connection Bega-Timiş was rebuilt and modernized – the hydrotechnic nodes from Coştei and Topolovăț; the barrage cross section was elevated, consolidated and increased; retaining the flood waves from the superior and middle basin of Bega on the 21 valleys[26].

The insurance of optimal conditions for sailing on Bega Channel is done by cleaning the channel, the activity being started at the end of the XIXth century, downstream to ascent, from Titel to Timişoara were built six hydrotechnic nodes: *Titel (Kničanin), Ečka, Klek* and *Ittebe* (all four in Serbia and Montenegro) and *Sânmartinul Maghiar* (**Uivar**) and *Sânmihaiu Român* (in Romania). At all the nodes were installed locks to adjust the levels and at Sânmihai also gates.

The hydrotechnic node Sânmartinul Maghiar (**Uivar**) began to function in 1914. It has a drain section of 21,25 m, with a fall of 2,8 m, well-kept over the time[27].

The hydrotechnic node Sânmihaiu Român – constructed between 1912 and 1915 with the intention to maintain the optimum level for sailing and a constant level of water for ecologic needs. The gate is provided with three openings, operated manually, devices provided with cogs and wheels. The construction is in danger because of soakage and high bed erosion which lead to the degradation of the entire system[28].

These hydrotechnic nodes also have to be declaired monuments of the technical history.

The hydrotechnic node The hydrotechnic waterworks Timişoara. The hydroelectric power plant on Bega, located at the entrance of the channel in Timişoara, dates from 1909 and has top hydroenergetic equipment from that time[29]. The power plant is still functioning nowadays, having an educational purpose, a monument of hydrotechnic history and a tourist objective on the map of Timişoara city.

4. The inter-war period

In this period repeated floods happened in 1919, 1920, 1925, 1926, 1932, 1938, 1940 and those from 1942 affected 240883 hectares of land, 572 km of roads and 4785 homesteads in Timiş county[30].

The Union Timiş-Bega founded in 1924 took over the available financial funds from the old society, spent for maintaining and elevating some barrage sections which were affected by the last floods.

5. The period after the World War II until December 1989 Revolution.

On Bega Channel barge sailing up to 650 tdw decreased and since 1956 (1959) or from other sources 1960 it was stopped. The channel comes not to be navigable due to the alluvium deposited in the bed, the port Timişoara is out of service and the node from

[25] *E. Preluschek, A. Jancso, op. cit., pp. 202, 205.*
[26] *R. Nedelcu, E. Man, op. cit., p. 844.*
[27] *E. Preluschek, Rodica Preluschek, Starea nodurilor hidrotehnice ... de pe canalul Bega, 2005, pp. 34-35.*
[28] *Idem, pp. 36-37.*
[29] *I. Anton, E. Sisak, Profesorul Aurel Barglazan şi sistemul hidrotehnic Timiş-Bega, 1982, p. 6.*
[30] *E. T. Man şi colectivul, 2005, op. cit., p. 73.*

Sânmihaiu Român is not functional. Both parts, Romanian and Serbian wish to continue the sailing on Bega Channel, especially because Timişoara became an important developing pole inside of the Euroregion Dunăre-Criş-Mureş-Tisa (D.K.M.T.), the biggest urban centre – also with the biggest entrepreneurial activity from Romania's cities, after Bucharest.

The barrier lake Surduc is realized between 1972 and 1975 and is brought into service in 1976, having an available storage of water of 24 million m^3, at first stage and about 50 million m^3 in the second stage (1985), with an area of 357 hectares, the barrage located on Gladna Plain has a height of 35 m, a length of 130 m and a width of 6 m. Its main role is to supplement the flows of Bega river, to supplement with drinking water Timişoara city and to combat the floods.

The floods attenuation on Timiş is possible by creating some non-permanent plane accumulations – polders at Hitiaş (ascent of the hydrotechnic node Topolovăţ), the polder Cadar-Duboz, the polder Pădureni and polders on the right branches of Bega (fig. 4).

6. The period between 1990 and 2005 is marked by a series of historic floods (1998, 2000, 2002 and 2005) and by the reconstruction of the hydrotechnic node from Coştei, repeatedly affected by inundations, and the node from Sânmihaiu Român. In 2001 a Workshop Conference on the Bega Channel was organized at Subotica (Serbia and Montenegro), where were continued the discussions about the opening of the navigable Bega Channel on the Romanian sector.

Between 1920 and 1995 in the water management system of Banat were made the following hydrotechnic works: 12 barrier lakes with a total volume of 244 million m3, 11,3 derived km, 3 catchment areas, 265 km of banking works, 222 km of adjustment works, which protected against floods 29000 hectares of farmland, 28 localities, 25000 homesteads, 140 km of roads and 45 km of railroads[31].

Banat, but especially the hydrotechnic system Bega-Timiş, is characterized by original hydrotechnic constructions with an age of 300 years – the cradle of some old traditions in managing and using the water -, which entered the technical patrimony with special priorities and top achievements, as moments and monuments in the history of the global technics and hydrotechnics. Here, in this geographic space, the relationship land – people – water gets another dimension. It is so powerful, becoming an essential condition of the social and economic development, in the past, present and future.

In Banat, like in the majority of the countries from the center and west Europe, that came to grips with big floods lately, must be applied the new conception: "*more space for the rivers*", giving the river more space between the barriers, putting them at greater distances. Only this way the frequency and ampleness of the floods are decreased in the inferior basin.

[31] *F. Pisărău, D. Purdea, Strategia dezvoltării economice şi sociale a spaţiului Banat...Timişoara, 1995, pp. 120-121.*

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