ACCIDENTAL FLOODS IN RECENT ROMANIA

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Abstract
In this paperwork the floods produced by dykes failure in the last years in Romania, on inland rivers and Danube River are analysed.
The floods occurred in numerous countries in the last years and their consequences led to a new approach such as flood risk management, approach where the awareness and the involvement of the human communities has a crucial role in avoiding the casualties and the damage reduction.
The high waters produced on the rivers from our country are generated by rainfall, snowmelt or/and the overlay of this phenomena. The 2005 flood volume was 3 times larger than the 1996 and 2000 floods volumes. The Timiş right bank dykes breach in April 2005 led to the flooding of important land surfaces because the big volume of the Şag high water.
In April 2005, on Banat Hydrographical Area Rivers the biggest levels from the observation string were recorded. Their effect was the Timiş şi Bârzava dykes overtopping. Numerous breaches appeared in the dykes defence systems which amplified through so called accidental hazards produced by natural hazards.
The water overtopped the Timiş right dyke for several hours in several places. So in the period 20 - 22 of April the flood wave spread over the area between Timiş and Bega rivers. It was estimated that de water volume entered in the defended area by the right dyke was about 250 millions m^3 and the flooded surface was about 25.000 Ha, situation which in plain and flat land would have corresponded to a medium depth of 1 m.
The 2006 April flood on Danube is the most important flood from the interval 1840 – 2006, the maxim discharge at Baziaş being of 15.800 m^3/s in comparison with the discharge registered until now, in 1895 of 15082 m^3/s.
The precipitations and the high temperatures in the beginning of April in most of the Danube River Basin which led to the melting of the snow layer caused the origin of this exceptional flood. The duration of this flood is the longest in the recording history leading to a total exceeding probability higher than 1/100.
The Danube dykes failed at the 2006 flood. At Isaccea the highest flood was registered in 2006, with a maximum computed discharge of 17 700 mc/s.
The flood analyzes effectuated in this paperwork for the inland river and Danube River distinguishes the main parameters of the failure dikes: the failure period, the anticipation period until de failure, the failure form, the failure hydrograph. These parameters allow the realization of the computation model for different breaching scenarioss of the dike.

Keywords: living with floods, dyke, accidental flood, probability, hazards

1. INTRODUCTION

The human society development has been and is deeply influenced by floods which from a geographical point of view are the most frequent disasters in the world and in the same time the biggest producer of damages and casualties. In the same time, the big floods have been the trigger and the catalyst of great changes in the approaching way of this phenomena, from accepting floods as a nature mood to the man's try to oppose to the nature by approaches such as „fighting against floods", to defending against floods and finally to preventing floods. [Snorrason A., Finnsdottir H, 2000]

The floods occurred in numerous countries in the last years and their consequences led to a new approach such as flood risk management, approach where the awareness and the involvement of the human communities has a crucial role in avoiding the casualties and the damage reduction. This approach is general and it opened the path to face future challenges by introducing new concepts such as: *" more room for rivers"," living with floods", "free way to the water"* and especially through the assimilation of the concept sustainable development in flood risk management.

2. ACCIDENTAL FLOODS ON INLAND RIVERS

The high waters produced on the rivers from our country are generated by rainfall, snowmelt or/and the overlay of this phenomena during the snow layer existence.

In the Timiş – Bega River Basin history we can enumerate the May 1912, July 1966 and April 2000 floods. [Stănescu V., Drobot R., 2005]. The May 1912 flood was the largest taking into account the peak discharge (estimate at approximate 1600 m^3/s. The high water was caused by a 3 days rainfall which covered the entire river basin exceeding 200 mm in Semenic and Poiana Ruscă Mountains. The April 2000 flood was caused by the combined effect of the rainfall and the snowmelt. The appearance probability of the April 2000 high water peak was close to 2%, causing the left bank dykes to breach near the border with Serbia.

The 2005 flood volume was 3 times larger than the 1996 and 2000 floods volumes. The Timiş right bank dykes breach in April 2005 led to the flooding of important land surfaces because the big volume of the Şag high water.

In the last few year in Romania took place several dangerous and unusual meteorological phenomena with special intensity. Thereby, in April 2005, at Timişoara, the largest amount of rainfall from all the observation string (1874-2005) was recorded – 154,4 l/m^2 in 24 h, and in July it was recorded 243 l/mp at Herăstrău, in Vrancea county, 206 l/mp at Halos, in Bacău county, 193 l/mp at Sendreni, in Galaţi county, 168 l/mp at Văleni, in Teleorman county, but also 73 l/mp in 3 hours at Casimcea, Constanţa county.

Rainfall with high intensity affected in September Constanţa county and Ialomiţa River Basin. They reached an amount of 222 l/mp (from which 155 l/mp in 3 hours) at Biruinţa in Constanţa county, up to 169 l/mp Dâmboviţa and Călăraşi counties and up to 127 l/mp (from which 102 l/mp in 12 hours) at Mălureni in Argeş county.

In April 2005, on Banat Hydrographical Area Rivers the biggest levels from the observation string were recorded. Their effect was the Timiş şi Bârzava dykes overtopping.

Figure 1 – The 2005 high water on Bârzava River

Figure 2 – The 2005 high water on Trotus River

The Ialomiţa high water produced in September was the second in the chronologic string of the annual maxim discharges, after the one produced in 1975. Historical discharges were recorded in April also on Caraş and Nera Rivers, in June on Putna and Râmnicu Sărat Rivers, and in September on Cricovul Sărat Rivers.

Although in the last 50 years important high waters occurred in most of the River Basins, they never expand in the last 100 years on an interval that long such as the one in 2005. Also the previous high waters, especially the ones produced in 1970 and 1975, spread on much more restraint surfaces that the ones produced in 2005. The dangerous hydrologic phenomena were amplified by the deforestations effectuated in the last years, which led to fast runoff with sediments carrying towards the streams, the populated areas and the agricultural lands.

In the last years, numerous breaches appeared in the dykes defence systems which amplified through so called accidental hazards produced by natural hazards.

April 2005 was characterized by a very high humidity generated by the large amount of rainfall registered.

Precipitation regime was abundant in Banat, so the largest amount of precipitation for April was exceeded, over 200 mm at Oravița (226.4 mm), Reșița (205.3mm), Lugoj (201.2 mm) and Caransebeș (200.6 mm) meteorological stations.

It was exceeded the maxim precipitation amount in 24 hours, for April at: Reșița (79.2 mm), Caransebeș (67.6 mm), Bozovici (66.4 mm), Timișoara (63.0 mm) meteorological stations. On Banat Hydrographical Area rivers the highest levels from all the observation string were registered at most of the existing gauging stations, having as an effect the Timiș river dyke overtopping, downstream of Lugoj and Lugoj municipal and Bârzava river dyke overtopping in Gătaia area.

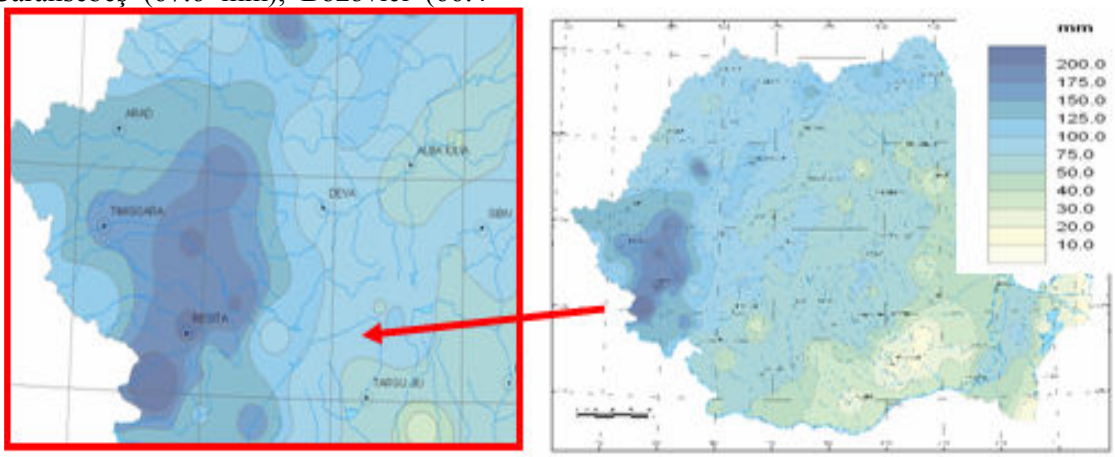

Figure 3 – Monthly amount of precipitation, April 2005

At the beginning of the period 14-26 April 2005, in an time interval of 24 - 36 hours, in entire Banat Hydrographical Area were registered rainfalls of 60-95 l/mp, their effect overlapping the snowmelt in the mountainous area (Țarcu mountains – Timiș River Basin) which resulted in a precipiations equivalent of 169-473 l/mp, the runoff being eased towards the river beds by the soil saturation because the previous precipitations.

The heavy rainfalls between 19-22 April led to new flood waves overlapped to the first ones causing the reaching of the maximal levels on Timiș river. On April 17 2005 up to 40 l /m^2 precipitations warnings are received and on April 19 a new hydrological forecast is sent previewed by a warning regarding the possibility of dyke overtopping and breaching on Timiș River in the border area.

Because the flood wave was extraordinary (with a probability of appearance less than 1% as volume) the Timiș flood plain transport capacity was exceeded due to the fact that the dykes were built for a flood with a probability of appearance of 5%. The impact was inevitable, so that on April 20 2005 around 12.00 o'clock the dykes collapsed causing two breaches (unified subsequently) (fig.4).

Figure 4 – Timiș River – two breaches

The water overtopped the Timiș right dyke for several hours in several places. So in the period

20 - 22 of April the flood wave spread over the area between Timiş and Bega rivers.
It was estimated that de water volume entered in the defended area by the right dyke was about 250 millions m^3 and the flooded surface was about 25.000 Ha, situation which in plain and flat land would have corresponded to a medium depth of 1 m. [Badaluta-Minda C., 2008]
The breach occurred on April 20 in Cruceni area (km 6+000) with a length of approximate 160 m through the unification of the two marginal breaches, did not presented a strong erosion of the foundation ground of the dyke, the water depth in axis being established at approximate 1.5-1.6 m. For this breach was realised a temporary earth dyke having a foundation made by earth and sand bags, and on May 03 2005 the breach was closed.
Upstream, (figure 5) the breach situated at km 8+250 (Crai Nou area) with a length of 120 m occurred on April 21. This breach had a different configuration in comparison with the downstream breach (Cruceni area), with a rectangular opening, the dyke being cut by the water current after a vertical plan direction, and the water depth along the dyke axis was 6-7 m. the breach was closed with a rock ring dyke on May 09 2005.
In Crai Nou – Grăniceri area on Timiş river some 750 m of dike were rebuilt.

Figure 5 – Flooded plain as a result of dyke breaching

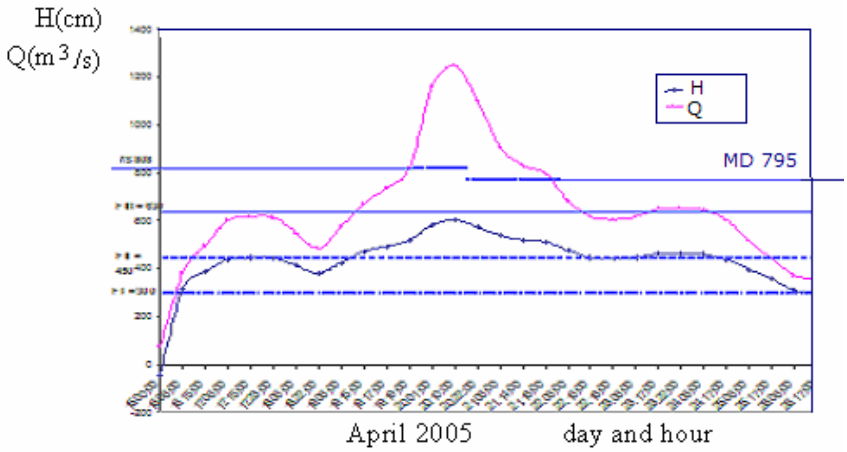

Figure 6 - The levels and discharges hydrograph on Timiş river at Şag for 15 - 26.04.2005

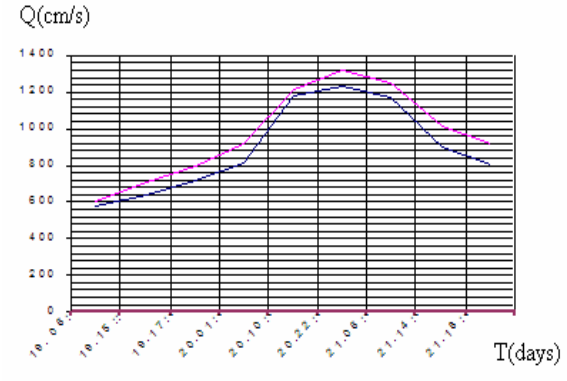

Figure 7 – The discharges hydrograph at Şag – Grăniceri

After the discharges input from April 19 – 21 2005 (fig.7), the following V_{19}, V_{20}, V_{21} discharged volumes will result.

V_{19} = 27.540 mil. cm
V_{20} = 127.159 mil. cm
V_{21} = 77.616 mil. cm

V_t = 232.86 mil. cubic meter as against with real volume V_t = 250 mil. cubic meter

3. ACCIDENTAL FLOODS ON DANUBE RIVER

The 2006 April flood on Danube is the most important flood from the interval 1840 – 2006, the maxim discharge at Baziaş being of 15.800 m^3/s in comparison with the discharge registered until now, in 1895 of 15082 m^3/s.
The precipitations and the high temperatures in the beginning of April in most of the Danube River Basin which led to the melting of the snow layer caused the origin of this exceptional flood. The rainfall events from 11 - 13 April 2006 in Serbia, Bulgaria and South-Western Romania arrived during maxim discharges on Danube in the sector Baziaş – Bechet.
The duration of this flood is the longest in the recording history leading to a total exceeding probability higher than 1%.
The Black Sea level rose between 1840 and 2006 with approximate 30 cm which led through the modification of the hydraulic slope to additional level rising on the Romanian territory.
The maximal levels recorded and reconstituted in different sections of the Danube for the 2006 April – May floods in comparison with the biggest levels recorded after the embankment of the Danube and with dykes design levels are shown in the following table.[Serban P.et al. 2006]
In order to reduce the downstream discharges the Călăraşi – Râul şi Făcăieni – Vlădeni enclosures were flooded. The effect of the controlled flood and the upstream uncontrolled flood together with dykes heightening/consolidation measures led to the protection of Oltenița, Călăraşi, Brăila (fig.8) and Galați (fig.9)cities.[http://www.mmediu.ro]

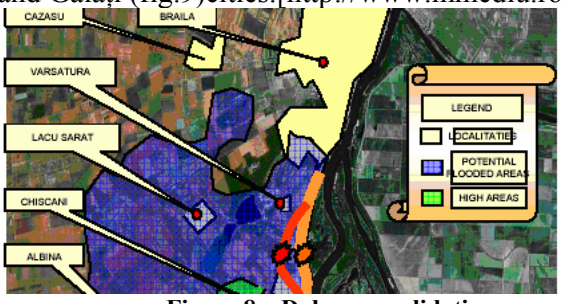

Figure 8 – Dykes consolidation

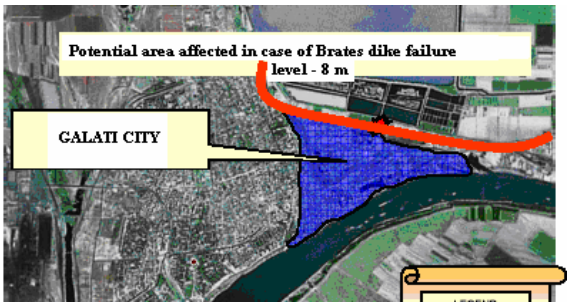

Figure 9 – Areas potentially affected

The breaches with an important influence to the Danube's levels and maximal discharges (fig.10) were the Modelu and Făcăieni controlled breaches, the Rast uncontrolled breach and the Rasova dyke overtopping. The other uncontrolled breaches from Bechet and Bistreț, Oltina and Spanțov had an important influence to the decreasing of the discharges and the levels hydrograph.
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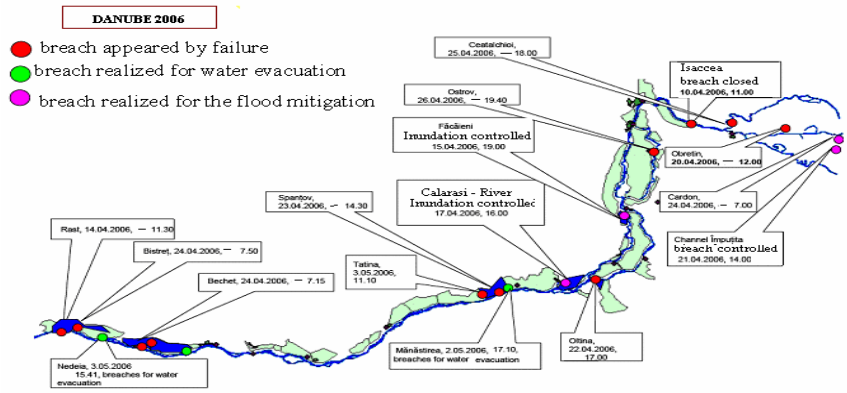

Figure10 – The breaches produced on Danube

Table 1 - Maximal levels on Danube

Section	Quote desined (cm)		Maximum level canned before 2006 (cm)	Level in 2006 (cm)			Difference between the level from 2006 and maximum level 1970/1981	Difference between the 2006 level – the designing level (cm)	
	1	5 %		Canned	Reconstituted	Difference	(cm)	1 %	5 %
Gruia			862 / 1981	899	899	0	+37		
Calafat	782	734	802 / 1981	861	865	+4	+59	+79	+127
Bechet			787 / 1981	845	857	+12	+58		
Corabia	773	711	756 / 1970	801	812	+11	+45	+28	+90
Giurgiu	804	750	795 / 1970	822	830	+8	+27	+18	+72
Oltenita	794	741	772 / 1970	809	815	+6	+37	+15	+68
Călăraşi			703 / 1970	737	765	+28	+34		
Cernavodă	690	644	708 / 1970	736	760	+24	+28	+46	+92
Hârşova	678	641	727 / 1970	764	792	+28	+37	+86	+123
Brăila	678	619	639 / 1970	699	724	+25	+60	+21	+80
Tulcea	458	411	435 / 1970	438	450	+12	+3	-20	+27

The first breach had natural causes and it was recorded in Isaccea city dyke on April 10 2006 at one month after the dyke entered under pressure. The breach was sealed in 24 hours without any damage to the houses.

The Rast breach occurred in the defence longitudinal hydro technical work on Danube in April 14 2006, 12.00 hours influenced also the levels in the upstream section, Calafat, up to 4 cm. the Bistreț area dyke breached on April 24 2006 at 7.50 hoursThe Danube dykes failed at the 2006 flood. Several breaches occurred at Rast, Spanțov on April 23, 14.30 hours (figure12), at Bechet on April 24, 07.15 hours (figure13), Oltina and Ostrov because the exceeding of the designed levels up to 123 cm and because of long time of the dykes exposure to these levels.

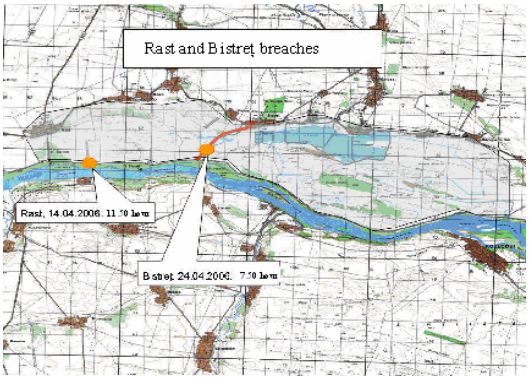

Figure11 - Rast and Bistreț breaches

Rasova dike was overtopped at 3 o'clock on 16th April and there were flooded: Baciu agricultural area, Baciu locality and Vederoasa locality were flooded. At Isaccea the highest flood was registered in 2006, with a maximum computed discharge of 17 700 mc/s.

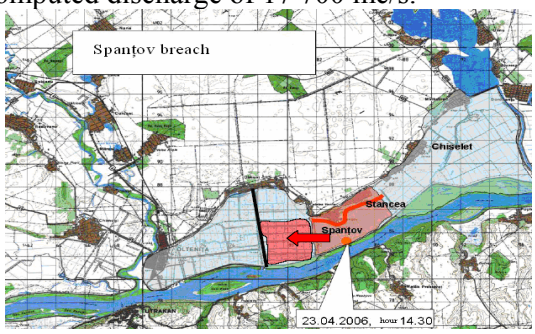

Figure12 - Spanțov breach

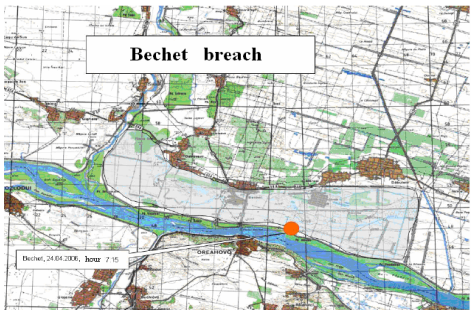

Figure 13 – Bechet breach

The dikes failed because of water pressure, especially in the areas where Danube dead branches are.

The following scheme analyses the risk produced in this case:

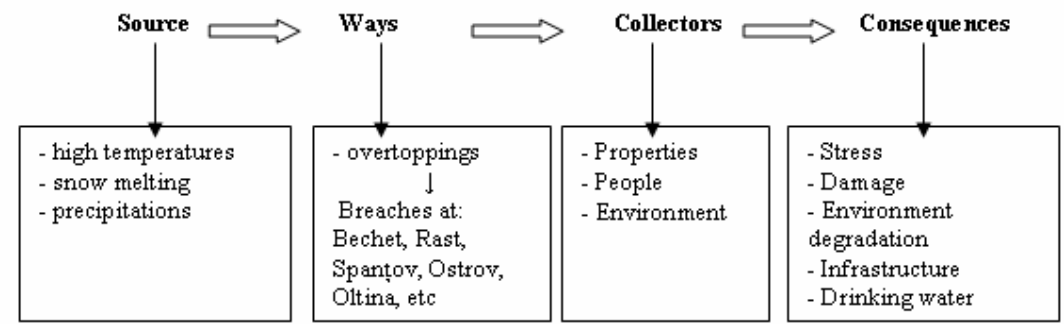

Figure 14 - „Hazard - risk" Scheme, Danube

After analysing Danube flood from April - May 2006, were identified some affected objectives: houses and house holdings, socio - economical objectives, bridges and culverts, agricultural land fields, water intakes, gas network distribution, sewerage network, infrastructure and other damages.

4. CONCLUSIONS

The flood analyzes effectuated in this paperwork for the inland river and Danube River distinguishes the main parameters of the failure dikes: the failure period, the anticipation period until de failure, the failure form, the failure hydrograph. These parameters allow the realization of the computation model for different breaching scenarioss of the dike.

5. REFERENCES

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Date base from ANAR – floods 2005 - 2007