THE EVALUATION OF THE RISKS FOR FLOODINGS ON THE TERRITORY OF BOTOSANI MUNICIPAL TOWN

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Cuvinte cheie: riscul la inundaţii, torenţi.

ABSTRACT:

The county of Botosani is not placed in an area of high risk for flooding, because most of the lands within the build-up area are situated on the ledge. Because of the increase of the population, some socio-economical objectives have been located in the high risk area on the basis of the ledge; it's necessary that the real insurance and that provided by the rules could be established, thereby, the following measures need to be established: the achievement of field works against floods, the gad of the buildings exposed to the major risk.

The real insurance of the buildings located on the four effluents (located at the base of the ledge), varies between 5 – 10 per cent, in comparison to 1 per cent as it is foreseen by the rules.

The dams built up on these valeys, made up of local materials and generally used for fishy needs, have large uploaders calculated under 1 per cent error, which might lead to dangerous waves of flood, in case of river burst.

The possible damages have both direct (material and human losses) and indirect results (traffic jams, coming up to normal conditions, and the price of the operative measures for preventing human victims)

The estimation of the damages to certain flood is inconclusive, the most important damage being the one afferent to the main class of the objective, without mentioning the ecological damages, as in case of extreme humidity, epidemic dangers, quick reproduction of mosquitos etc.

Considerations regarding the floods. The flash flood waves formed on permanent or torrential (temporary) water courses have an aleatory character. They must be treated probabilistically as the maximum flows and corresponding levels values are caused by an extremely complex causal chain, which does not allow their quantification with precision. Thus, on a watercourse (eg. the stream Sitna) may be combined rains and snows which to form flash floods higher than those known in the past. There can be also caused breaks in dams or agglomerations of ice, which can lead to catastrophic flash floods. For this reason it has been established by standards, such as the one regarding the class of importance for the endangered objectives (STAS 4273/83 republished), at what level of insurance must be protected the objectives from different classes of importance.

Thus, the municipalities are considered targets of class I of importance and they must be assured to flash flood with probability of occurrence of P = 0.1%, that is a stable frequency of the flash flood of once in a thousand years F = 1 / 1000. The main routes of communication must be provided with P = 1.5%, that is at the centenary flash flood frequency.

The agricultural goods, farms, crops, may be secured between P = 2 to 5%, that is to be flooded with an average frequency of once every 50 years or 20 years.

The temporary works (ballast pits, ditches, etc.) must be provided only with P = 10%, that is once to 10 years frequency of flash flood recurrence.

To dams and dikes there are also foreseen calculations in exceptional conditions of exploitation; they must resist for several hours at higher flows, with a class of importance, without being destroyed..

The standard mentioned above lays down the risk factors, admissible to various categories of objectives threatened by floods. In easily flooded ares there are no 100% assured objectives. The standard provides for the possibility that the beneficiary could reduce with one step the insurance of calculation on their own responsibility, through the introduction of some operational measures of prevention.

From the above it is obvious that not all the socio-economic objectives threatened by flooding must be insured equally, being allowed the differentiated factors of risk.

For Botosani municipal town there has been admitted the calculation probability of P = 1%, because the most of the territory occupied by a human settlement is on the terrace.

But some objectives are already located within the risk area and it is necessary that they be determined to the real insurance and the calculation required by rules, so as to establish the necessary measures, where necessary: the building of defence works against the floods; the displacement of the constructions exposed to the major risk, etc.. Regarding the damages caused by floods, it must be mentioned that they are: direct and indirect (physical and value)economic losses; negative social effects (casualties, evacuations, etc..); negative ecological effects.

For a correct quantification of the effects, all these damages must be taken into consideration. But the damage varies greatly from one flash flood to another and, therefore, the most correct is the calculation of the potential damages afferent to the flash floods, with the probability corresponding to the class of importance of the objective studied (P = 1%).

Flooding sources of Botosani Municipality. On the territory of Botoşani municipal town and in his immediate vicinity, there are water courses (valleys and streams) that are part of the whole hydrographic basin of the river Prut, through the medium of the river Jijia. In Table 1 are presented the main features of the four water courses, such as: The Land Code, the river basin area (km \ water course length (km), the medium slope in the Municipality area (%), the area of the permanent accumulations of water (ha) and their volume (mil/m3), the maximum flows of calculation and the works of defence that may affect the territory of Botoşani City.

Table 1. The hydrographic situation of the water courses from the area of Botosani municipal town.

Crt. No..	The water course name	The code from The Water Register	The basin area S_b (km^2)	The water course length L (km)	The medium slope lg %	Maximum flow cu p = 1% (m^3/s)	The area of the permanent water accumulations/ha	The pemanent accumulations volume V_{ac}mil. m^3	The existing hydrotechnical and defensive works with local influence
1.	Sitna valley (Sitna)	XIII 1-1 5-18	940	78		480	1082	21,3	- Ac. Cătămărăşti - Regularization river bed 3 km (1,5 km unfinished)
2.	the stream Luizoaia (Lipca) main affluent the stream Alexandrescu	XIII 1-15-18-4	14	7	9	40 (27 +13 from sewerage)	15	5,0	- Piscicultural arrangement Lipca - Piscicultural arrangement Jalba - Piscicultural arrangement Luizoaia - Regularization river bed (5 km unfinished)
3.	the stream Dresleuca	XIII 1-15-18-6-1	135	27	5	95	39	8,5	- Piscicultural arrangement Curteşti - Regularization river bed on both banks with 12 km
4.	the stream Teascu	XIII 1-15-18-6-2	11	7	10	25	10	3,0	- Piscicultural arrangement Gavril - Regularization river bed with 3 km

The watercourses and their positions in relation with the Municipality of Botoşani and the existing hydrotechnical works are presented in figure 1.

In addition to these water courses with a permanent character, codified in the waters register, there are a number of local torrents, with temporary drainage, which are not encoded in the waters register, with areas smaller than the limit set (10 km2).

The location of Botoşani Municipality on a plateau (alt. 157m) is favorable in terms of flood protection, the water courses flowing to the basis of this plateau. However, the extending of the city has made that a series of social-economic objectives (houses, roads, warehouses, farms) to be located in the area with risk for floods, thus beeing necessary the settlement of the river beds of the main rivers from Botosani (Sitna, and partly of the brook Luizoaia) by the execution of at least 1.5 km settlement of the river beds and reshaping some sections.

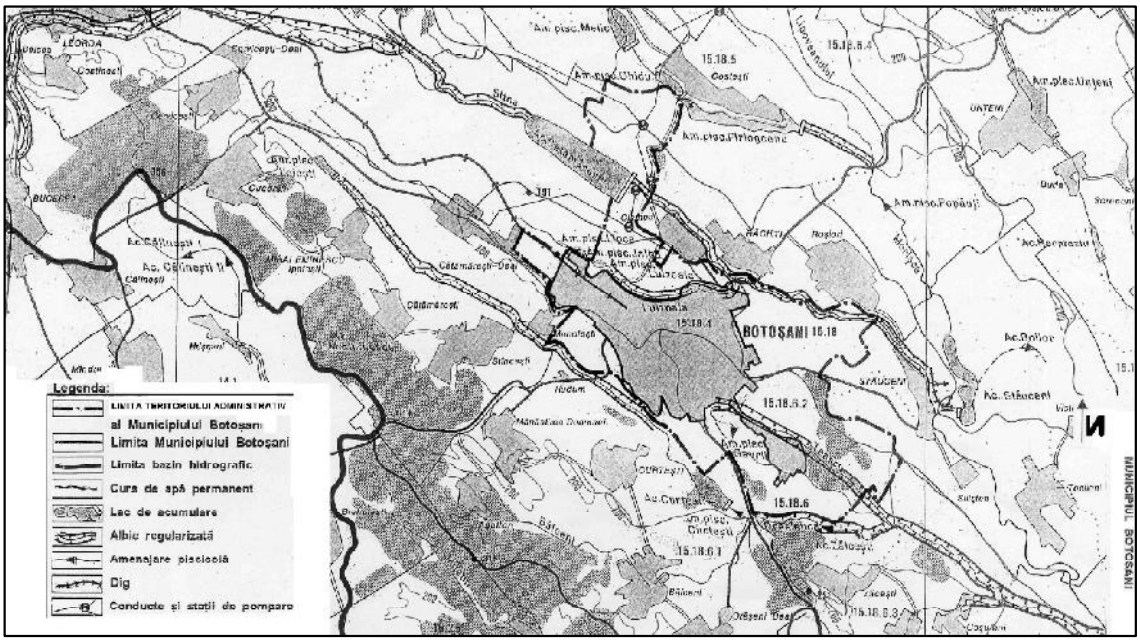

Fig.1. The watercourses and their positions in relation with the Municipality of Botoşani and the existing hydrotechnical works.

Next we will present the features of the main rivers that cross or surround Botosani and that are the main actors in the case there will be some floods outside Botosani. ***The brook Luizoaia*** is the right affluent of the valley Sitna, having an hydrographic area of 14 km^2 and a length of almost 7 km. It is a semitorrent, with an average slope of almost 9% and with a maximum flow with the probability of 1% of almost 27 m^3/s, hereupon it is added the flow from the sewerage of the industrial zone of Botosani of almost 13m^3/s when it is raining, so the river bed must carry a flow of almost 40 m^3/s. In upstream of Botosani the brook Luizoaia is arranged with three piscicultural lakes: Lipca, Jalba and Luizoaia, with a total volume of almost 5 mil. m^3 at a maximum level. In the '80 decade the valley was settled on a length of almost 5 km, but the work wasn't finished, downstream being, on almost 1.5 km, some kind of puddle with reed and no capacity for transportation. The main affluent is the torrent Alexandrescu that carries massive calcareous material, from the area of ravening with a big slope, from the inside plateau to the brook Luizoaia.

The piscicultural lakes are administered by A.G.V.P.S.. The tippers of these lakes are undergauged, with the danger that more special freshets (rains of over 1001/m3 in 6 hours) will break the dams and will flood the area.

There are 3 (three) bridges, and one of them is improvised.

The main lakes have an insignificant role to mitigate, they being maintained full for piscicultural exploitation. Downstream, the river bed is settled for almost 5 km, but there is also a length of 1.5 km that wasn't settled inside, in the bottom, towards the confluence with the valley Sitna. This situation creates floods when the rains exceed 251/ m2 in three hours.

The most special floods in the last years were the ones from 10 – 15 June and 5 -9 July 1997; 22 – 24 April 2001, 15 – 20 August 2003.

Also, in 19 May – 21 June 2005 and 15 – 20 August 2008, the dangerous phenomena repeated in the area, with two deceased people.

As a result, the connection between the damages and the negative effects (table 2) with a certain surge isn't relevant, because is necessary the evaluation of the potential damages at the surge of calculation, in our case the surge with p = 1% (the centenary frequency) according to the legal acts in force. In this way, the damages evaluation isn't random and irrelevant.

Table 2. Objectives affected by the floods in the basin of the river Luizoaia.

The name of the affected objective	**U.M.**	**Physical damages**	**Valorical damages (millions lei)**	**Notes:**
Loss of human lives	no.	2	-	-
Households	no.	80	40	Damages for the excess of moisture
Apartments	no.	-	-	-
Social-economic objectives	no.	3	5	-
Street networks	km	10	10	The temporary interruption of the traffic
Technical local networks	km	0,5	2	-
Areas in town	ha	18	17	The puddling of the spaces between the buildings
Areas outside the town	ha	24	12	Agricultural fields
Other hydrotechnical constructions	pieces	-	-	-

The mentioned floods took place in an area that wasn't arranged, by flow on both banks, to the high terrace area.

Other factors that helped producing these floods were the collected flows from the pluvial waters from the area of Botosani that added to the natural waters of the brook Luizoaia and its affluents exceeded the flowability that was also diminished by the presence of the reed in the unfinished area of the river bed. At present there haven’t been taken any measures.

Like proposed measures we mention: the readmeasurement of the big waters discharge from the three piscicultural dams of A.G.V.P.S., so that it avoids their chain breaking with severe effects downstream, around the town and on the valley Sitna; the end of the settlement of the river bed of Luizoaia at the initial dimensions approved by C.N.A.; restoring the 3 (three) undersized bridges, according to the project; speeding up the end of the thoroughfare of sewage and

the replace of the ones that were obturated, to avoid the flooding of the streets; drying almost 32 ha field with puddles out of the city; layout the torrents adjacent to the floods and accidents at the hydrotechnical constructions.

The river Sitna is a right affluent of Jijia, having an hydrographic basin with a surface of 940 km2 and a length of almost 78 km, an average slope of almost 2%, the maximum flow with the probability of 1% of almost 480 m3/s.The river bed of Sitna is settled for a flow of almost 300 m3/s, and at the bottom is partially not finished.

On the valley of Sitna and on its affluents are some small accumulations, and also accumulation Catamarasti with a volume of almost 22 mil. M3. This accumulation can diminish the maximum flow with 1% probability in proportion of up to 50%, if there is a rational exploitation, that is emptying before the surge.

The lake surface is 1.082 ha, and the volume 21.3 m/s.

The damage of the dam can produce catastrophic floods, being necessary the calculation of the breaking wave and the assembling of the warning sirens.

The valley of the river Sitna is settled upstream and downstream of Botosani, with an unfinished sector at the confluence with the brook Luizoaia, the right affluent in the area of Botosani.

Special floods were in the same time with the floods in the basin of Luizoaia. And in this case connecting the material and value damages by a single surge is random and irrelevant. These floods took place by flows and by the torrents from the hydrographic basin of the brook Luizoaia, in the not settled area, existing also other causes: the failure of the sewerage network to take the rain leaks from the town area and also the damage of the dam Catamarasti.

Table 3. Objectives affected by the flood in the basin of the river Sitna.

The name of the affected objective	**U.M.**	**Physical damages**	**Valorical damages** millions lei	**Notes**
Households	no.	20	10	Combined with the stream Luizoaia
Social-economic objectives	no.	2 farms	15	
Street networks	km	2	3	
Technical local networks	km	-	-	
Areas in town	ha	6	2,3	
Areas outside the town	ha	12	2,4	
Bridges and footbridges	no.	-	-	
Railways (in and out of the locality)	km	-	-	

In the river basin Sitna there are not works of planning and reconciliation in progress, although there have been proposed several solutions such as: the

restoring of the regulation of defense for Cătămărăşti accumulation so as to increase the safety of the operation taking into account the hydrometeorological information system and the capacity of the large water discharges of the dam; the calculating of the dam breaking wave, on the instructions of the Central Commission for Defense against flooding and mounting a sound siren to warn people in case of accident at dam; the completion of the regularization works at the confluence with the stream Luizoaia; the implementation of a direct link between the radar Barnova and the Municipal Commission of defense for alerts with a maximum of anticipation.

The stream Dresleuca has a catchment area of 135 km2 and a length of approx. 27 km, with an average slope of approx. 5%, with a maximum flow with p = 1% of 95 m3 / s. It is set upstream of the municipality Botoşani until the piscicultural accumulation Loieşti, on a length of approx. 12 km. In the area of Botoşani municipal town there is arranged the accumulation Curtesti with an area of 39 ha and a volume of approx. 2.5 mil.m3. Downstream the accumulation up to the confluence with the brook Teascu, the riverbed is partly set on approx. 2 km.

The stream Teascu has a catchment area of 11 km2 with a length of 7 km and an average slope of 10% (semi-torrential leakage). Maximum flow with p = 1% 25 m3 / s. In the area upstream of the confluence with the brook Dresleuca is arranged the piscicultural accumulation Gavril with an area of approx. 10 ha and a volume of approx. 3 mil.m3 with an undersized large waters discharger.

Table 4. Objectives affected by the flood in the basin of the river Dresleuca.

The name of the affected objective	**U.M.**	**Physical damages**	**Valorical damages** millions lei	**Notes**
Households	no.	8	5	suburban area
Social-economic objectives	no.	1 storage	3	suburban area
Street networks	km	2.5	1,8	
Technical local networks	km	-	-	
Areas in town	ha	1,5	15	
Areas outside the town	ha	7	18	
Bridges and footbridges	no.	2	4	
Railways (in and out of the locality)	km	-	-	

The brook Teascu is regulated from downstream by the piscicultural accumulation Gavril on approx. 3 km with interruptions.

These streams produce floods through overflows at the exceeding of the river bed flowing capacity, which, in the case of both streams, has got a clogging tendency.

In this hydrographic basin there aren't works of arrangement and regulation in progress but i tis desired the reshaping of the two streams river beds with the making of some submersible thresholds, especially on the stream Teascu, for diminishing the ravining effect; the reinspection of the large waters dischargers at the three existent accumulations on the two streams in order to avoid their breaking at flash floods lower than 1% probability; the adjacent torrents arrangement; the laying down of the material removed from the river beds on the banks.

Another source of flooding of the objectives located at the basis of the plateau are the torrential formations which activate themselves with the occasion of the intense rains or the rains mixed with the snow layer.

These torrents position is illustrated in fig.2.

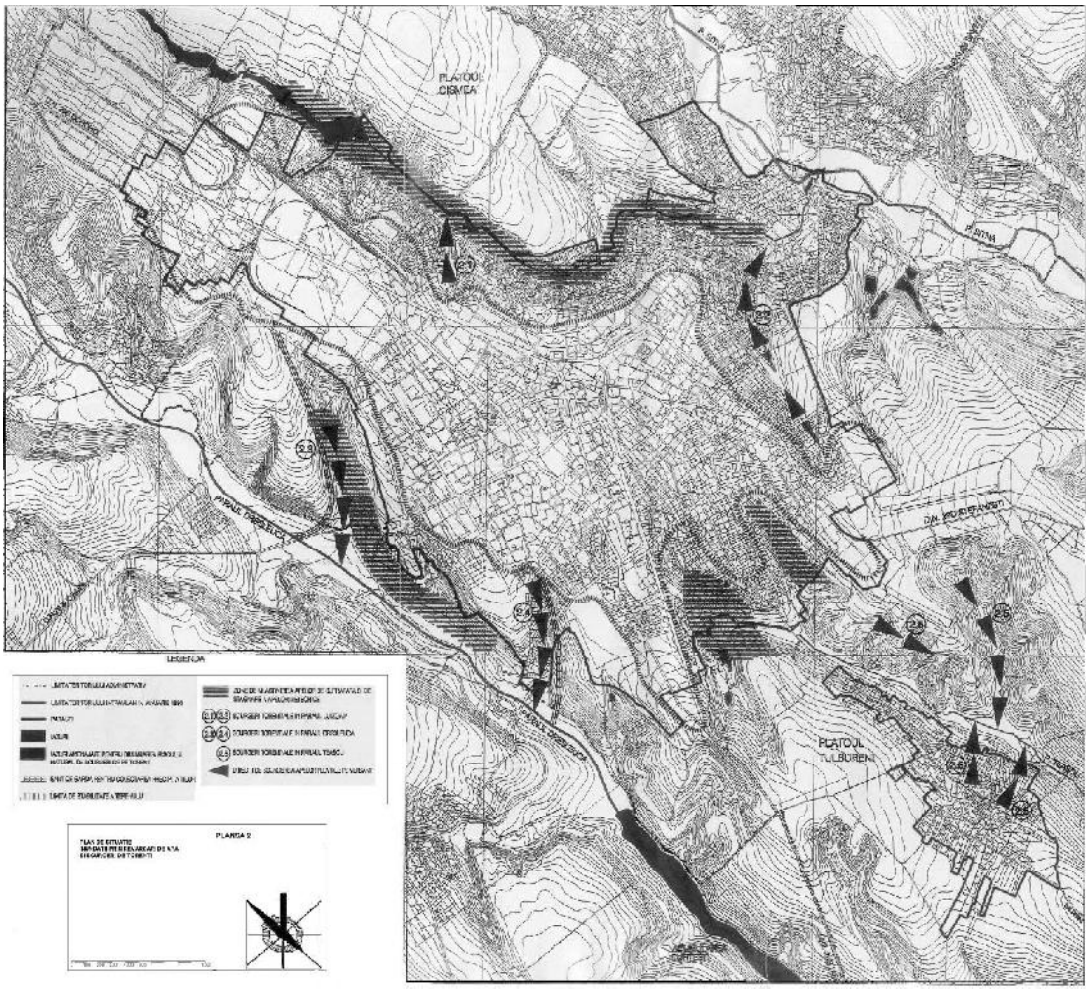

Fig. 2. The location of the torrential formations, which present risk of flood through overflow, at the basis of the plateau in Botosani.

Thus, there are four of such torrents that emerge on the right bank of the brook Luizoaia and five torrents that emerge on the left bank of the streams Dresleuca and Teascu from which only five are really dangerous at floods. The 5 main torrents are generated by the leakage of pluvial waters from the town platform situated on a high terrace. The uncommonly large slopes make that around the terrace on which is situated Botosani Municipality to get shape deep ravines with massive transport of material during the rainfalls and the alluvia laying down at the basis of the slope (alluvial cones) and also in the four water courses.

Over the time there has been made a series of local works to stabilize the torrents (extinctions of torrents), but they are insufficient and the ravines depth led to landslides processes. The works for extinguishing the torrents were made by the municipality with the support of the forest officials.

Table. 5. Objectives affected by the floods produced by torrents.

The name of the affected objective	**U.M.**	**Physical damages**	**Valorical damages** (millions lei)	**Notes**
Loss of human lives	no.	-	-	-
Households	no.	26	60	affectations through landslides
Apartments	no.	-	-	
Social-economic objectives	no.	2	7	
Street networks	km	2	2	affectations through alluvia sediments
Technical local networks	km	-	-	
Areas in town	ha	6	2,8	
Areas outside the town	ha	28	13	
Bridges and footbridges	no.	3	3	affectations through clogging
Railways (in and out of the locality)	km	-	-	
Dams	no.	-	-	
Dikes	km	-	-	
Other hydrotechnical constructions	pieces	-	-	
NOTE:The damages are cumulated for the five main torrents.				

The floods calculation in the torrential basins was made at the flash floods with 1% probability, taking into consideration: the flood type, the precipitations

volume (local rains with values of over 125 l/m2; the rain duration (aprox.180 minutes), the existence or nonexistence of some damages at the constructions for torrents extinguishing (thresholds). But also are taken into account other causes such as the inability of the sewerage network for the satisfactory intercept of the pluvial water on the territory of Botosani municipal town, meteoric waters that are leaking to the slopes and partly infiltrating into the soil with the formation of landslides.

To counteract the effects of the possible future floods there has been proposed the making of torrents extinguishing works, together with those of the slopes stabilization in the areas with landslides phenomena. It is also necessary the vegetation protection with resistant shrubs that adapt themselves to the type of loesoid-loamy soil in the area, therewith also imposing the restoration of the sewerage network for pluvial waters from the level of Botoşani municipal town, especially in the preurban areas.

REFERENCES

Vladimirescu I. (1978), *Hidrologie*, Edit. Didactică şi Pedagogică, Bucureşti.

*** * *** *Cadastrul apelor*, Ediția 2001.

*** * *** *Raporturile Comisiei Locale de Apărare Împotriva Dezastrelor*, Botoşani, Ediția 2000,…. 2008.

*** * *** *Raport anual privind starea mediului în România 2000,....2008*, Ministerul Apelor, Pădurilor şi Protecției Mediului, Bucureşti 2000.

*** * *** *Regulamentul de apărare împotriva inundațiilor şi accidentelor la construcțiile hidrotehnice*, aprobat prin HG nr. 615/2001.

*** * *** *Studii hidrologice efectuate de filiala Iaşi a Regiei Apele Romane*, Proiectul nr.207/1975 al OIFPCA – Botoşani.

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