Forum geografic. Studii şi cercetări de geografie şi protecţia mediului
Volume 10, Issue 1 / June 2011, pp. 157 – 166
(www.forumgeografic.ro) **DOI**: 10.5775/fg.2067-4635.2011.034.i

Structural and Non-Structural Measures for Flood Risk Mitigation in the Bâsca River Catchment (Romania)

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Received on <December 6, 2010>, revised on <February 21, 2011>, accepted on <March 29, 2011>

Abstract

The most common natural hazards affecting the Bâsca River Catchment (extended over a surface of 785. 1 sq. km in the Curvature Carpathians) are floods and flooding. The purpose of this paper is to investigate and analyze structural and non-structural measures for flood risk mitigating in this catchment.

The study focuses on the main factors which generate and favour floods, as well as on flood characteristics (frequency, the largest floods and its consequences).

The main methods are the statistical analyze hydrologic and climatic data, field observations, expeditionary mapping and spatial analyses using Geographic Information Systems (GIS).

In order to analyse flood potential, there were processes processed maximum instantaneous monthly and annual discharges of the Bâsca River at the Bâsca Roziliei hydrometric station (1953 - 2007), Varlaam I (1956-2005), Comandău h.s. (1968-2005) and of the Bâsca Mică River at the Brebu h.s. (1959-1974) and Varlaam II h.s. (1973-2005).

Considerations on structural and non-structural measures for protection against floods are presented in the last part of the paper. An inventory of structural works in the middle and lower part of the catchment (hydrotechnical and erosion control works) and their condition was made.

Keywords: *floods, structural and non-structural measures, the Bâsca River Catchment*

Rezumat. Măsuri structurale şi nestructurale de diminuare a riscului inundaţiilor în bazinul hidrografic al râului Bâsca (România)

Cele mai frecvente hazarduri naturale care afectează bazinul hidrografic al râului Bâsca (extins pe suprafaţă de 785,1 km^2 în Carpaţii de Curbură) sunt viiturile şi inundaţiile. Prezenta lucrare are drept scop investigarea şi analiza măsurilor structurale şi nestructurale cu rol de diminuare a riscului indus de inundaţii în bazinul menţionat.

Studiul se concentrează pe principalii factori care generează şi favorizează viiturile şi caracteristicile acestora (frecvenţa, cele mai mari viituri şi consecinţe).

Principala metodă este reprezentată de analiza statistică a datelor hidrologice şi climatice, observaţia de teren, cartarea expediţionară şi analiza spaţială utilizând Sisteme Informatice Geografice (SIG).

În analiza potenţialului de producere a viiturilor au fost prelucrate debitele maxime instantanee, lunare şi anuale ale râului Bâsca de la staţiile hidrometrice Bâsca Roziliei (1953 - 2007), Varlaam I (1956-2005), Comandău (1968-2005) şi de pe râul Bâsca Mică de la Brebu (1959-1974) şi Varlaam II (1973-2005).

În ultima parte a lucrării sunt prezentate consideraţii asupra masurilor structurale şi nestructurale de protecţie împotriva inundaţiilor. Este realizat un inventar al lucrărilor structurale din sectorul mijlociu şi inferior al bazinului (lucrări hidrotehnice şi antierozionale) şi este analizată starea acestora.

Cuvinte cheie: *viituri, măsuri structurale şi nestructurale, bazinul hidrografic al râului Bâsca*

INTRODUCTION

Floods are natural hazards with complex consequences, both direct and indirect: geomorphological, economic, social and ecological. They hold about one third (34%) of the total number of natural disasters produced worldwide in the 1900-2007 period (Magdelaine, 2010).

Knowing that in the future flood risk is estimated to raise, due, on the one hand, to increasing frequency and amplitude of flooding, in the context of climate changes, and on the other hand to an increased vulnerability determined by the expansion of socio-economic activities in floodplains (Şerban and Gălie, 2006), measures and actions to limit and reduce floods negative impacts on society and the environment need to be effective. At the Union European level, the management of the floods risk is expected to be completed within a common framework for action set by the 2007/60/EC

Directive "On the assessment and management of flood risks" which requires Member States an integrated flooding risk management with emphasis on *actions of prevention, protection and preparedness*. These involve complex and diverse measures, both structural and non-structural, their judicious combination and adequate to local conditions being necessary.

The purpose of the paper is to highlight the flood potential and also to investigate and analyze the structural and non-structural measures for reducing the flood risk in the Bâsca River Catchment.

The results of the present study complete and update specific information in the uncertain parameters of maximum discharge and floods from the Bâsca River Catchment, published in papers and hydrologic synthesis carried throughout Romania (*Râurile României. Monografie hidrologică*, 1971; Ujvári, 1972) and at regional scale (*Monografia hidrologică a bazinului hidrografic al râului Siret*, 1967; Diaconu, 2005; Zaharia, 2004, 2005; Chendeş, 2007 etc.).

Information concerning terminology and case studies regarding hydric risks were found in papers by: Şelărescu and Podani (1993), Kundzewicz (2002), Sorocovschi (2003, 2004), Armaş (2008), etc.

An inventory of the damages caused by these phenomena has been published by Zăvoianu and Podani (1977) at regional scale and FRMI (1994) and Aquaproiect (2006) for the Bâsca River Catchment.

A model of economic management of negative effects caused by floods in a catchment is developed by the Tennessee Valley Authority even since in 1933 (www.tva.com).

STUDY AREA

Positioned in the external region of the Curvature Carpathians (subunit of the Eastern Carpathians), the Bâsca River Catchment (Fig. 1) has a surface of 785,1 sq km. It lies at a medium altitude of 1081 m between Lăcăuţi Peak (1777 m a.s.l.) and the confluence with the Buzău River (385 m a.s.l.). The Bâsca River (length = 81 km), is one the main tributaries of the Buzău River.

From a demographic point of view, the Bâsca River Catchment is situated in an area with low density (8.35 inhabitants/km^2). In this catchment, there are two communes: Comandău (1,042 inhabitants) and Gura Teghii (3,884 inhabitants) and two villages appertaining to the town of Nehoiu: Bâsca Roziliei (1,428 inhabitants) and Vineţişu (206 inhabitants[1]). The majority of the inhabitants is concentrated in the lower part of the Bâsca River Catchment, especially along the valleys. In the upper part of the catchment, the population is concentrated in Comandău Depression (Comandău Commune).

The humanization of the valleys and the presence of urban and road infrastructure increase flooding vulnerability of these areas.

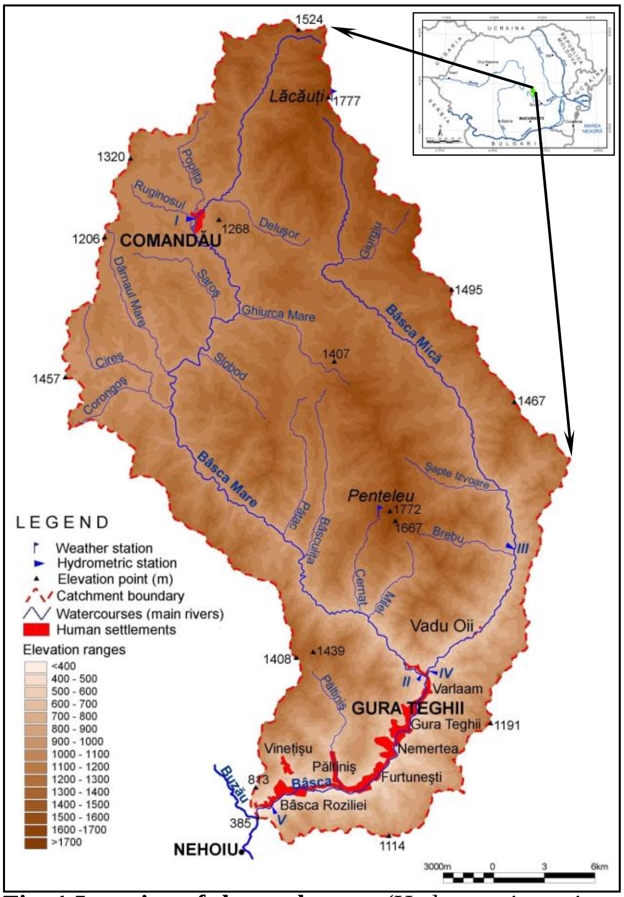

Fig. 1 Location of the study area (Hydrometric stations: I. Comandău; II. Varlaam I; III. Brebu; IV. Varlaam II and V. Bâsca Roziliei**)**

Data source: information processed from topographic maps, scale 1:25,000

DATA AND METHODS

The present analysis in based on the following types of data:

- cartographic data (topographic maps scale 1:25,000 by Military Topographic Department -MTD-, 1982);
- climatic data: precipitations (maximum amounts fallen in 24, 48 and 72 hours and monthly averages) at the Lăcăuţi (1961-2000) and Penteleu (1988-2007) weather stations (w.s.), situated at 1776 m a.s.l. and

[1]The inhabitants number are according to The National Institute of Statistic, Romanian census data, 2002.

  DOI: 10.5775/fg.2067-4635.2011.034.i

respectively 1632 m a.s.l; these data were provided by the Regional Meteorological Center Muntenia, Buzău and *Clima României*, 2008;

- hydrological data: maximum instantaneous monthly and annual discharges of the Bâsca River at the Bâsca Roziliei hydrometric station (h.s.) (1953 - 2007), Varlaam I h.s. (1956-2005), Comandău h.s. (1968-2005) and of the Bâsca Mică River at the Brebu h.s. (1959-1974) and Varlaam II h.s. (1973-2005) (Table 1); discharges during the main floods; the hydrological data were provided by the "Romanian Waters" National Administration, Buzău – Ialomiţa Water Basin Administration (BI BWA), and the National Institute of Hydrology and Water Management (NIHWM);
- qualitative data: physical status of hydrotechnical works (from the Forest Research and Management Institute - FRMI) and
- quantitative data: number of hydrotechnical works (by the Aquaproiect and FRMI).

Table 1 Data about the hydrometric stations from the Bâsca River Catchment

River	Hydrometric station	A* (km^2)	H_B** (m)	Stream length (km)	Analysed period
Bâsca Mică	Brebu***	185	1240	36	1959-1974
	Varlaam II	235	1171	43,7	1973-2005
Bâsca	Comandău	111	1252	24	1968-2005
	Varlaam I	440	1142	53,5	1956-2005
	Bâsca Roziliei	759	1110	72	1953-2007

* - Catchment's area (upstream the hydrometric station),
** - Catchment's mean altitude (upstream the hydrometric station)
***- Hydrometric station was out of service in the years 1974.
Morphometrical data are according to Diaconu, 2005.

The main methods were represented by statistical analysis of the hydrologic and climatic data, field observations, expeditionary mapping and spatial analyzes using Geographic Information Systems (trial software, extensions of the ArcGis 10).

Factors generating and favouring floods

Floods generation is a highly non-linear process that depends on genetic and favourable factors such as the pluviometric regime, geological and morphometrical features (e.g. elevation, slopes, energy relief and drainage density), vegetation, soils and antecedent conditions of the catchment (e.g. land use) (Minea and Zaharia, 2010).

Precipitations

Precipitations represent the main factor generating floods in the Bâsca River Catchment.

Although in the catchment region, the mean annual amount of precipitation are relatively low (827.3 mm at Lăcăuţi w.s. and 664.3 mm at Penteleu w.s.), rainfalls can trigger floods especially during summer, when the rains have a torrential character. In the morphological features of the catchment, these rains can generate flash-floods.

At annual time scale, the highest average amount of annual precipitation was recorded in June at Lăcăuţi w.s. (130.2 mm in the period 1961-2000) (Fig. 2) and in July at the Penteleu w.s. (117.4 mm, in the period 1988-2007).

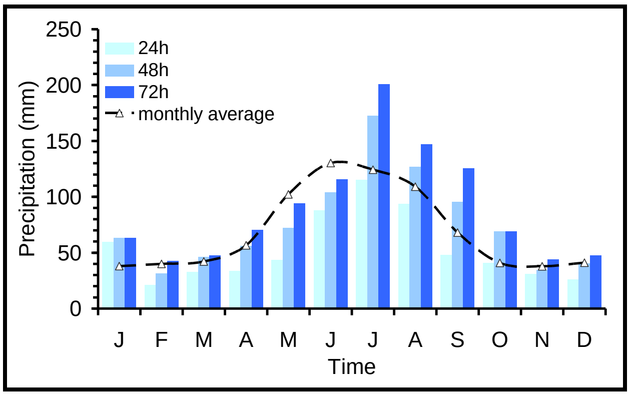

Fig. 2 Maximum precipitations (rain and snow) in short periods reached at Lăcăuţi w.s. (1961–2000)
Data source: *Clima României,* 2008

The maximum amounts of precipitation fallen in 24, 48 and 72 hours, at Lăcăuţi were recorded in July (Fig. 2). On July 12th 1969, at Lăcăuţi w.s. it was recorded: 115.4 mm in 24h (88.6% of monthly multiannual average), 172.8 mm in 48h (132.7% of the monthly multiannual average) and 200.7 mm in 72h (154.1% of monthly multiannual average) (Fig. 2).

At Penteleu w.s., on July 18th 1991, there were registered 155.5 mm in 24h (132.4% of monthly multiannual average), and notably 145.3 mm fell in only 6 hours, as it is mentioned in the "Special phenomena" rubric, of the Penteleu w.s. registry.

Morphometrical factors

Bâsca River catchment is drained by a network of torrential organisms, channels and valleys, with an average drainage density of 3.69 km/km^2.

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Basic morphometrical characteristics of the Bâsca River catchment and its main sub-catchments inventoried in the Bâsca Catchment are synthetically exposed in Table 2.

Table 2 Morphometrical features of the Bâsca River Catchment and its main sub-catchments

River	River	Sub-catchment	
	Length (km)	Surface (km^2)	Shape
Ruginosul	5.14	11.8	C
Corongoş	5.32	12.8	
Slobod	6.18	9.22	Qc
Milei	6.43	15.8	C
Giurgiu	6.48	16.2	
Brebu	6.55	11.1	
Şapte Izvoare	6.62	15.6	Qc
Cernat	6.69	11.1	
Deluşor	6.88	20.9	C
Saroş	7.84	14.9	Qc
Popliţa	9.29	22.4	C
Ghiurca Mare	9.59	23.3	Qc
Păltiniş	9.69	25.1	
Pătac	10.0	18.5	E
Dârnăul Mare	10.6	21.5	
Cireş	11.1	19.6	Qc
Bâsculiţa	11.5	40.0	
Bâsca Mică	46.5	238	E
Bâsca Mare	64.2	440	
Bâsca	**81.0**	**785.1**	**E**

E= Elongation; Qc= Quasi-circular and C= Circular
Data source: Morphometrical data are obtained from processed GIS after Romanian Topographic Map, MTD, 1982 (scale 1:25,000).

The catchment's elongation degree was calculated with the shape ratio (Formula 1) proposed by Diaconu and Lazărescu (1965) quoted by Zăvoianu (1985). Transformation of the numeric ratio in qualitative estimation was made after the method specified by Diaconu (2005).

$$F_r = \frac{\sqrt{A}}{L_b} \qquad (1)$$

where: A is catchment area and
L_b is the mean catchment length.

Considering the qualitative aspect, 35% from sub-catchments have a shape tending to circular (e.g. Brebu, Păltiniş), 35% a circular shape (e.g. Giurgiu, Corongoş) and 26% are elongated (e.g. Bâsculiţa, Pătac).

The shape of the catchments can have a profound effect on the stream behaviour, especially in relation to the direction of storm movements, e.g. time of concentration (Black, 1991).

Orientation of sub-catchments with quasi-circular and circular shape to the main drainage axis of the Bâsca and the Bâsca Mică River is predominantly transverse. But the elongated shape and large area of sub-catchments (e.g. the Bâsca Mică), determine *"a diminution of floods because tributaries flow into the main stream at greater intervals in time and space"* (Zăvoianu, 1985).

Maximum flow and floods. Their consequences

We know that particularities of maximum flow present a major socio-economic interest, because they allow the identification and establishment of appropriate measures for flood risk mitigation.

General features

In the Bâsca River catchment, maximum instantaneous discharges have exceeded in many years the alert stages. Fig. 3 exemplifies the situation from Varlaam II h.s. on the Bâsca Mică River, where maximum annual discharge exceeded in 12 years the discharge corresponding to the attention stage[2].

Maximum instantaneous discharge (Q_{max}), on the Bâsca River, which caused major floods and flooding, occurred in the years: 1994 (212 m^3/s) and 1975 (204 m^3/s) at Comandău h.s.; 1975 (598 m^3/s) and 1969 (447 m^3/s) at Varlaam I h.s., and 1975 (960 m^3/s), 1969 (697 m^3/s), 1971 (586 m^3/s), 1991 (530 m^3/s) and 1985 (515 m^3/s) at Bâsca Roziliei h.s.

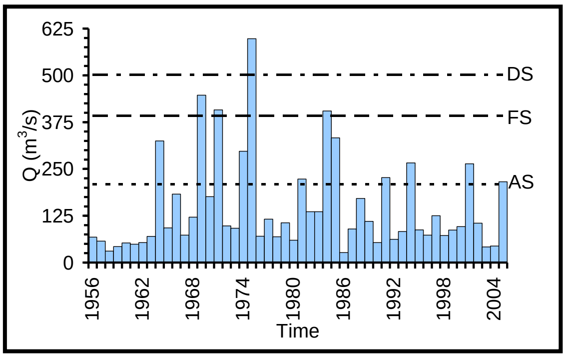

Fig. 3 Variability of the maximum annual discharge and alert thresholds (AS = 209 m^3/s; FS = 392 m^3/s; DS = 502 m^3/s) at Varlaam I h.s (1956-2005)
(Data source: BI BWA, 2009 and NIHWM, 2010

On the Bâsca Mică River, due to the small reception area, there were lower values of annual maximum instantaneous discharges. Thus, at the Brebu h.s., the highest annual maximum discharges were recorded in 1960 (150 m^3/s), 1961 and in years 1962 (87.2 m^3/s) and 1975 (392 m^3/s) 1991 (359

[2]Alert stages are gradual avertization forms, with local defence caracteristics. They are three stages of alert in Romania: attention stage (AS), flooding stage (FS) and danger stage (DS).

  DOI: 10.5775/fg.2067-4635.2011.034.i

m^3/s), 2005 (240 m^3/s) and 2001 (167 m^3/s) at Varlaam II h.s.

The analysis of the occurrence frequency of the maximum annual discharges exceeding the alert stages (in the periods mentioned in Table 1), shows that the most numerous overruns of the three alert thresholds were recorded on the Bâsca Mică River (Table 3).

Monthly frequency analysis of the largest floods indicates that the greatest potential for flood occurrence is encountered in June and July, respectively: July 2nd 1975 (960 m^3/s), July 13th 1969 (697 m^3/s), July 2nd 1971 (586 m^3/s), July 18th 1991 (530 m^3/s) and June 19th 1985 (515 m^3/s).

Table 3 Occurrence frequency of the maximum annual discharges higher than the ones equivalent to the AS, FS and DS in the Bâsca River Catchment

River	Hydrometric station	AS	FS	DS
Bâsca Mică	Varlaam II	18	6	4
	Comandău	18	9	-
Bâsca	Varlaam I	12	4	1
	Bâsca Roziliei	2	1	-

AS = attention stage; FS = flooding stage; DS = danger stage.
Data source: BI BWA 2009 and NIHWM, 2010

Floods and inundations produced in the Bâsca River Catchment caused socio-economic damages and environmental disturbances.

Such examples are the deterioration of some hydrotechnical works, partial destruction of the embankment and road elements (41 km of roads have been damaged by the flood and inundation from July 2nd 1975 and 51.2 km in July 18th 1991), bridges and road culverts (2 bridges and 10 platforms were destroyed in 1975 and 12 road culverts in 1991), houses and annexes (200 in 1975 and 45 in 1991). Between 1969 and 2002 there were recorded 16 human deaths due to these phenomena[3].

These are added to the biological consequences: significant implication for the "succession dynamics of riparian ecosystems" (Pautou and Decamps 1985 quoted by Richter and Richter, 2000).

Floods risk mitigation measures

Protecting areas vulnerable to inundation induced by floods require applying a set of structural measures[4] in interaction with non - structural measures[5] (Sorocovschi, 2004).

Structural measures

In the category of structural measures for flood risk mitigation floods, in the Bâsca River Catchment, there can be distinguished:

- stabilization of slopes (afforestation, correction of torrents);
- works for channel regulation and riverbank protection.

Slopes Arrangement

Slopes arrangements in the Bâsca River Catchment consists of afforestation, erosion control works, torrent correction (Table 4) and road culverts (Moţoc *et al.*, 1975). They aim at to:

- ensure water drainage on versants and access to road circulations;
- retain sediment load during the floods;
- reduce runoff velocity;
- strengthening versants without natural support (Arghiriade, 1953).

Culverts roads are used for crossing small courses of water ($Q_{max} = 0.3 \div 0.5$ m^3/s).

The slope from the Bâsca River Catchment generally has a high ratio of forestation (83.4%), constituting a moderating factor for superficial runoff.

Hydrotechnical works for torrent correction in the Bâsca River Catchment has a total length of 33.3 km. They are 28 longitudinal and 241 transversal pices (FRMI, 2007). The hydrotechnical works in the middle and lower parts of the Bâsca Catchment, where human settlements are positioned (Vadu Oii, Varlaam, Gura Teghii, Nemertea, Furtuneşti, Păltiniş, Vineţişu and Bâsca Roziliei Villages), are degraded in a proportion of 65%.

The Păltiniş River sub-catchment arrangements

The Păltiniş River sub-catchment (F = 25.4 km^2, L = 9.69 km), has a high forest cover, of over 70.7% (FRMI, 1994) and linear settlements on a length of 2 km in the lower third sector (Păltiniş Valley Village). Maximum flow of the river Păltiniş with 10% exceeding probability is 77 m^3/s, with 5% exceeding probability is 114 m^3/s, and with 1% exceeding of probability is 210 m^3/s (Aquaproiect, 2006).

On June 29th 1991, at Nehoiu w.s. (adjacent to the Bâsca Catchment) considerable amounts of precipitation were recorded (108.9 mm in 24h), which generated a severe flood in the Păltiniş River Catchment, causing:

- total destruction of works for torrents correcting from the Păltiniş;

[3]Data regarding social and economic losses have been provided by Aquaproiect (2006).

[4]Structural measures refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure. (UNISDR, 2004).

[5]Non-structural measures 'concern reducing damages induced by inundation without hydrotechnical works (structures)' (Şelărescu and Podani, 1993).

DOI: 10.5775/fg.2067-4635.2011.034.i

- damage to the forest roads and settlements (FRMI, 1994).

After the hydrotechnical works restoration in 1995, a new strong flood was occurred on Saturday 20th of July 2002, with important geomorphological and socio-economic effects:

- landslide reactivatation and destabilization of slopes;
- destruction of some hydrotechnical works (Photo 1);
- affecting sections of the local road DC75;
- homes flooded in the area of the confluence with the Bâsca River and
- one human death.

Photo 1 Hydrotechnical work destroyed by the flood from July 20th 2002 (near the confluence of the Păltiniş with the Bâsca River)

These consequences are probably due also to the fact that the works were in most cases hydrologically (exceeded by flood values and channel shifting) and lithologically (alternating layers with hard resistance with friable rocks), limited.

River channel training (correction) works

Channel correction aim to the reduce land flooding (Podani and Şelărescu, 1993).

Hydrotechnical works for channel training (frequent on the Bâsca River and in smaller proportion on the Bâsca Mică River) are:

- dry-stone pitching/riverbanks (such works have been identified on the left bank of the Bâsca River, in Varlaam and Gura Teghii villages and in Vadu Oii village, on the Bâsca Mică River);
- embankments made by gabions on the right riverbank of the Bâsca River, between Păltiniş and Furtuneşti villages;
- groynes, on the Bâsca Mică River in Vadu Oii village and on the Bâsca Mare River, upstream of Varlaam I h.s.;
- bridges crossings the river they have the drawback that the pier from the river's channel may generate riverbed jams with wood materials and determine inundations).

The analysis of the physical state of the engineering works indicates that some are degradated by destructuration (groynes) and erosion at the base (brick riverbanks).

In the middle and lower part of the Bâsca river catchment, hydrotechnical works for protection against flooding have degraded in a percent of 65%, requiring rehabilitation, and development of new hydrotechnical works (Minea and Zaharia, 2010).

After 2007, in the lower sector of the Bâsca River, new longitudinal hydrotechnical works (dykes from gabion mattress) are started (Photo 2). On the Bâsca River the project "Hydropower Siriu – Surduc Development", has been developed (being now in construction stage). This project includes a permanent water reservoir "Cireşu" on the upper part of the Bâsca River and an underground derivation "Surduc - Nehoiaşu", from Cireşu Accumulation, The Bâsca River towards the „CHE Nehoiaşu II" hydroelectric power station. This reservoir will mitigate the water volumes contributing to flood effects diminution.

Photo 2 New hydrotechnical arrangements (gabion baskets) on the Bâsca River (august 10th 2010)

Non-structural measures

Non-structural measures are an alternative complementary to structural measures that may reduce the loss of human life and economics. These include: legislation, catchment managements, land and administrative urban planning, education, insurances, hydrologic forecasting and warning.

Legislation

Romania is currently in the process of implementing the existing UE legal framework on water resources and inundation risk management.

The most important EU legislation on this subject are the *Water Framework Directive*

  DOI: 10.5775/fg.2067-4635.2011.034.i

60/2000/EC (consolidated), which establishes a framework for Community action in the field of water policy, and the Directive on the *assessment and management of flood risks* 2007/60/EC (http://eur-lex.europa.eu).

In accordance with the previsions of the Water Framework Directive and with the Romanian legislation on water (Law no. 112/2006, Law no. 310/2004 for Water Law no. 107/1996 amendment), the main instrument for implementing integrated water resources management in Romania is *The Scheme for Water Settling and Management*, including a qualitative component, materialized in the *River Basin Management Plan* and a quantitative one, concretized by the *River Basin Arrangement Plan.*

The national policy of prevention, mitigation and flood risk management is coordinated by the government, the authorities and the subordinate institutions.

Regarding the Romanian legislative framework on inundation risk and its management, the following documents should be mentioned:

- *National strategy for flood risk management on medium and long time*;
- Law no. 107/1996 - *Law of waters,* (amendment);
- Law No. 575/2001, concerning the approval of the *National Territory Arrangement Plan – Section V, Natural Risk*;
- Emergency Ordinance of the Romanian Government (EOG) no. 21/2004, on the *National System for Urgency Situations Management;*
- Government Decision (GD) no. 1491/2004 *for the approval of the frame Regulation on the structure, attributions, functioning and endowment of the committees and operative centres for emergencies;*
- Common Order no. 638/420/2005 of Ministry of Administration and Interior and Ministry of Environment for approving the *Regulations regarding the management of emergency situations produced by floods, dangerous weather events, dam breaking accidents and accidental pollutions;*

According to the Appendix no. 5 – *Administrative territorial units affected by flooding* - of the Law no. 575/2001, Gura Teghii Commune as well as Vineţişu and Bâsca Roziliei villages are assigned to the type of fluvial flooding.

At local scale, in the Bâsca River Catchment, the *management of emergency situations* is provided by the *Local Committees for Emergency Situations* (LCES)[6]. In this catchment, hierarchically, LCES of Nehoiu town, Gura Teghii and of Comandău communes are subordinated to the *County Committees for Emergency Situations* (CCES) from Covasna and Buzău counties.

The main attributions of LCES are[7]:

- to establish measures and specific actions for emergency situations management and track their implementation;

- to declare with the Prefect's agreement, *alert status* in the administrative-unit area;

- to analyze and approve the local plan for assuring human, material and financial resources necessary to manage the emergency situation, etc.

The legal act under which the LCES of Gura Teghii Village manages risk situations is defined by the *Analysis and convergent scheme of risk* (ACSR). It facilitates Gura Teghii Commune LCES choosing solutions - regarding material and human resources management – for risk management. ACSR contains tables with families and number of houses to be evacuated in case of flooding (Table 4), means of transport which can be used for peoples and goods evacuation.

Table 4 Number of houses which have to be evacuated in case of flooding in the Gura Teghii Commune

Locality (village/zone)	Affectability houses (no.)
Vadu Oii	5
Varlaam (Vişani)	6
Gura Teghii (Prund)	9
Gura Teghii (Brăgăi)	3
Furtuneşti (Bâsca Colţi)	4
Păltiniş (Vascu)	2
Păltiniş (Gura Păltinişului)	24

Data source: Gura Teghii Commune Hall, 2010

The Gura Teghii LCES is composed of 10 members and it is led by the mayor. In its structure, the Operational Centre for Emergency Situations and Technical Secretariat are included. It is served by Voluntary Service for Emergency Situations (Department of Prevention and different teams, e.g. Intervention Teams at Inundation), according to Gura Teghii Commune Hall, 2010.

Catchment management

For water resources management, BI ABA establishes the *Management Plan of River Basin*

[6]According to art. 4 (4) corroborated with art. 9 (3), (4), d) from GD no. 1491/2004 *for the approval of the frame Regulation on the structure, attributions, functioning and endowment of the committees and operative centres for emergencies.*

[7]According art. 24 let. a)…f) from the EOG No. 21/2004, regarding the *National System for Urgency Situations Management.*

(APRB) part of *The scheme for water settling and management.*

The APRB concerns quantitative management of water resources by reducing negative effects of extreme hydric phenomena (floods, drought, excess moisture, soil erosion). In the Bâsca Catchment APRB foresees hydrotechnical works for channel correction and Cireşu Dam Reservoir. In addition BI ABA elaborates the *Plan of defence against floods*[8]. It details the warning phases according to alert thresholds.

Warnings are successive started for h.s. from the river catchments, in relation to the alert stages and to precipitation thresholds for the sites without hydrometric stations.

Land and urban administrative planning

One of the reasons amplifying the negative effects of floods is human settlements exposure due to their location in the floodplains (Photo 3).

Photo 3. Houses located in the floodplain on the right river bank of Bâsca, downstream Păltiniş Village (August 10th 2010)

Urban planning policy, as an instrument for reducing associated effects of hydric risk is expressed by:

- zoning flooding areas and discouraging constructions in floodplains and
- technical advices regarding the land use.

The role of local public administration is to restrict approvals of new construction[9] in flooding areas and resettlement.

Insurances

An important factor for reducing the financial risk for individuals, enterprises, and even whole societies in case of natural hazards is the insurance (Kron, 2005).

In Romania, compulsory insurance of *dwellings* against the negative effects of *earthquakes, landslides or flooding* is a mandatory financial instrument binding from July 1st 2010. Insurance - stipulated by Law no. 260/2008 *regarding compulsory insurance of dwellings against earthquakes, landslides or flooding* (amended) - covers for obligatory insurance of € 10 or €20, depending on the type of construction and on the type of natural hazards (earthquakes, landslides and flooding). Cover limit is € 10,000 or € 20,000.

In the rural space, specifically to the Bâsca River Catchment, the basic problem in flood insurance is low financial power, underestimation and floods traditional cohabitation (a divine premonition).

Forecasting and hydrologic warning

Forecasting and warning systems must advance information allowing the population preparedness for the flood occurrence.

Monitoring of the Bâsca River flow regime is provided by 3 h.s. and of Bâsca Mică River by 1 h.s. Nowadays (2010), they are automated and integrated into the DESWAT (Destructive Water) project[10]. Thanks to flood forecasting and warning systems, it is possible to save human lives (Kundzewicz, 2002).

Hydrological warning at national scale is done through mass-media announcements. Informative Bulletins, Hydrologic newsletters (daily and monthly) and Warnings are elaborated by the NIHWM.

Pre-warning local systems and population warning in case of floods requiring evacuation consist of the audible alarm and church bells acting.

CONCLUSIONS

Floods are the most common natural hazard in the Bâsca River Catchment. Their genesis is mainly pluvial and it is favoured by geographical physical features of the catchment, mainly by the morphometrical parameters.

The lithological structure, consisting predominantly of impermeable rocks, plays an important role. Flooding risk is magnified by anthropogenic intervention (construction in floodplains, improper land use etc.).

In order to reduce the flood risk in the Bâsca River Catchment, especially in its lower and middle part, where there is the most concentrated

[8] Posted on the website of the "Romanian Waters" National Administration (http://www.rowater.ro).

[9] For a new construction *is mandatory* to obtain the *Construction Authorisation* according to Law No. 50/1991 (amended and supplemented), regarding the authorising and measures for construction.

[10] DESWAT aims diminishing the flood impact by assuring permanent hydrologic monitoring and floods prognosis.

  DOI: 10.5775/fg.2067-4635.2011.034.i

population, both structural and non-structural measures have been initiated.

Structural measures include anti-erosion and hydrotechnical works. Due to their relatively advanced status of degradation, many of them require rehabilitation and extending works.

Non-structural measures represent a complementary support to the structural ones. They need to be developed so as to allow the population's adaptation to the flood risk and *living with them.*

For this, an increased attention should be given to: extending insurances, proper use of floodplains, training and educating of the population, improving hydro-meteorological monitoring and alert systems.

ACKNOWLEDGEMENTS

The research was accomplished within the doctoral training programme and supported by a POSDRU grant, financed by the Social European Fund (SEF).

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  DOI: 10.5775/fg.2067-4635.2011.034.i