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Catastrophic Effects of the Flash-Floods on Natural and Anthropic Environment in Quasi-Circular and Exposed Asymmetric Watershed - Case Study Vişeu River

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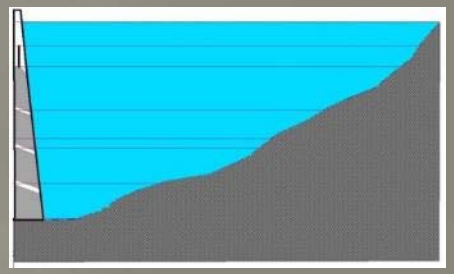
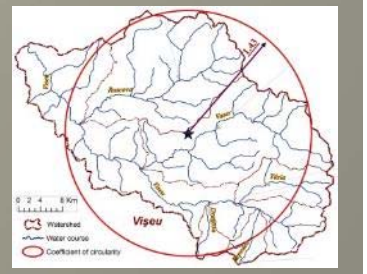


Key words: Vișeu, quasi-circular and torrential watershed, flash-flood, catastrophic flood, protected area, reservoir



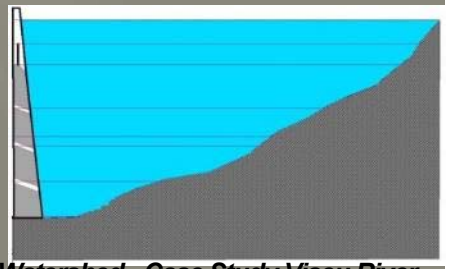
INTRODUCTION

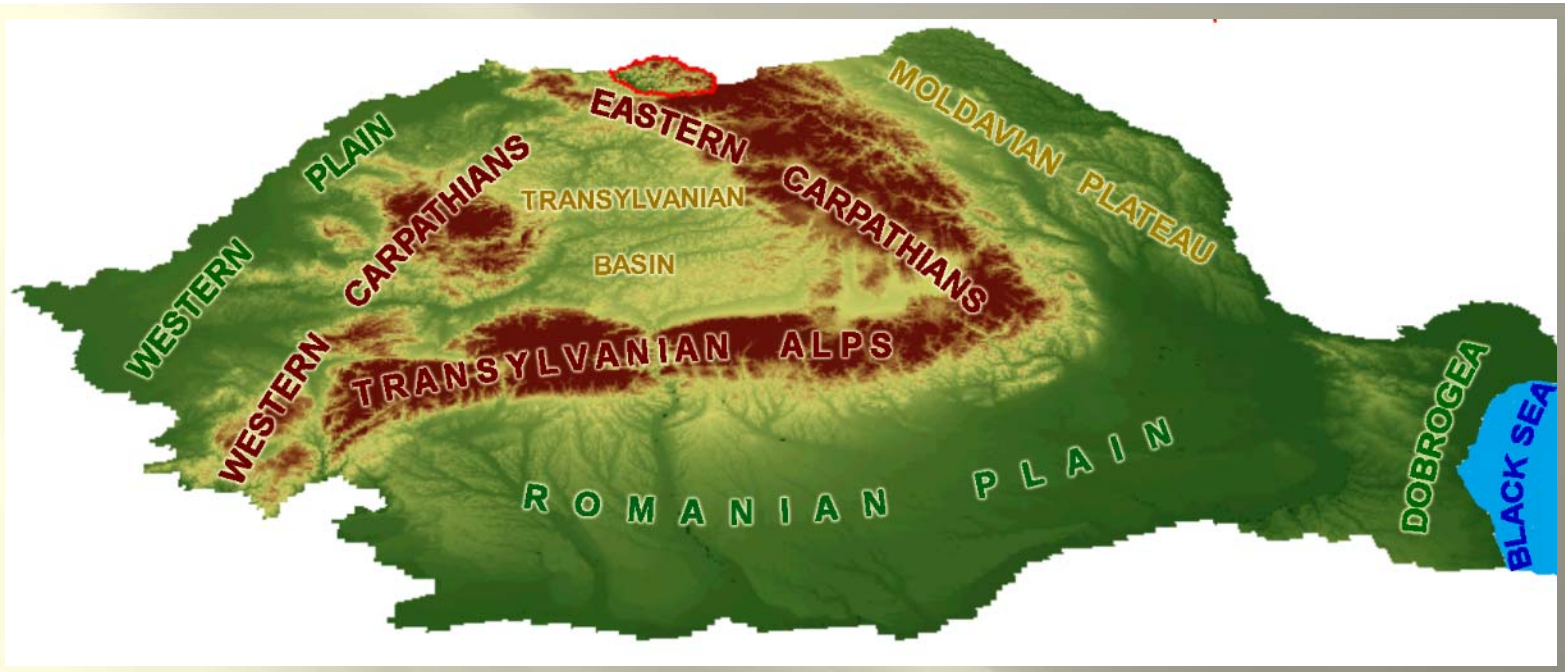
- flash-flood and its traumatic efects

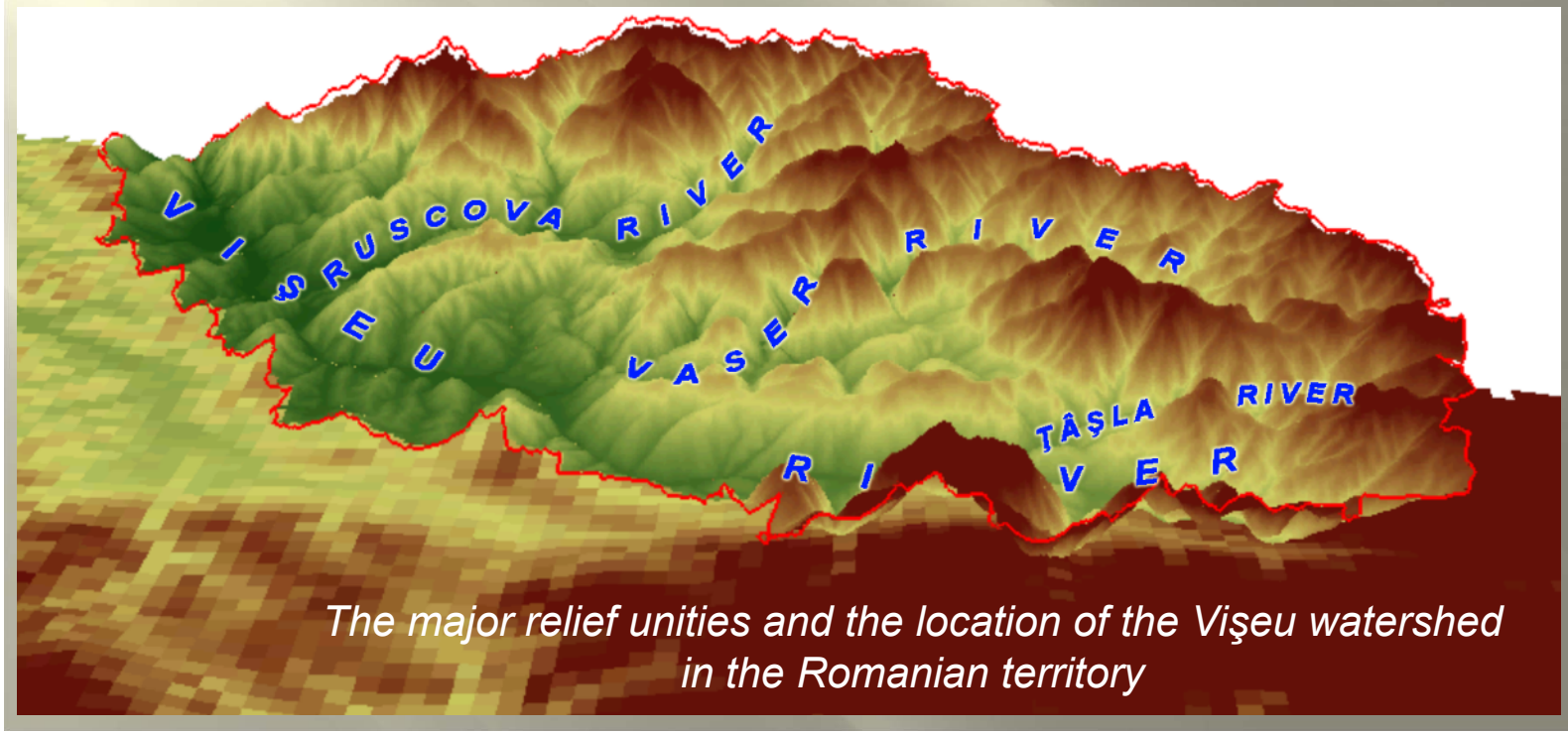
- local comunities are annualy spending high amounts of money (milions of euros) in the reconstruction and rehabilitation of the affected area

- the frequently declaration of protected areas without competent and professional documentation / simulation

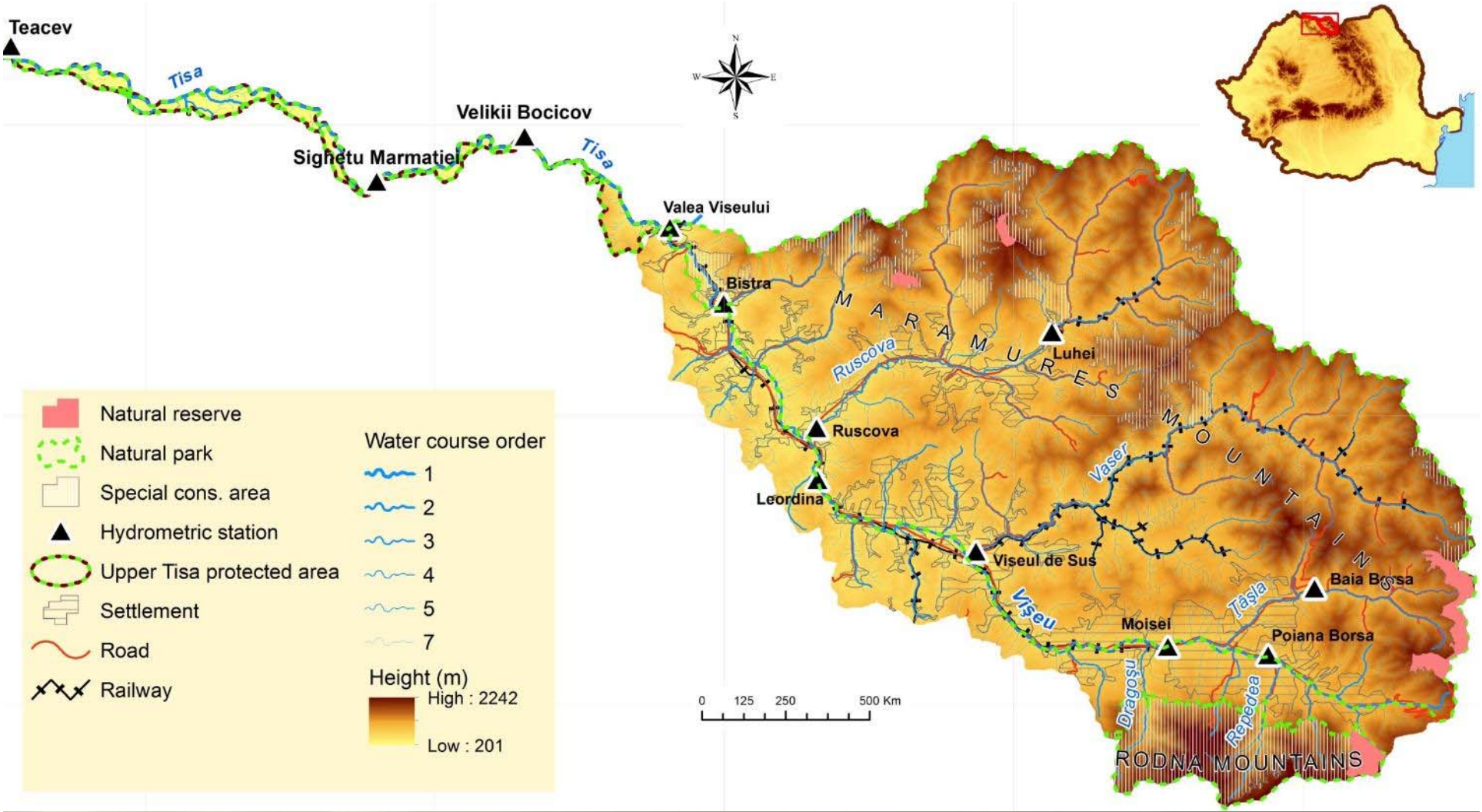
- the reservoir, dimensioned according the flash-flood volumes → frequently cvasitotal protection







The major relief unities and the location of the Vişeu watershed in the Romanian territory



No.	River	Hydrometric station	Starting of observations	Catchment average altitude (m)	Catchment area (km^2)
1	Vişeu	Poiana Borşa	1953	1284	133
2	Vişeu	Moisei	1952	1212	286
3	Vişeu	Leordina	1952	1054	937
4	Vişeu	Bistra	1900	1020	1547
5	Ţâsla	Baia Borşa	1961	1250	88
6	Vaser	Vişeu de Sus	1952	1090	410
7	Ruscova	Luhei	1961	1177	185
8	Ruscova	Ruscova	1952	1079	432

General map of Vişeu watershed

USED DATA AND METHODS

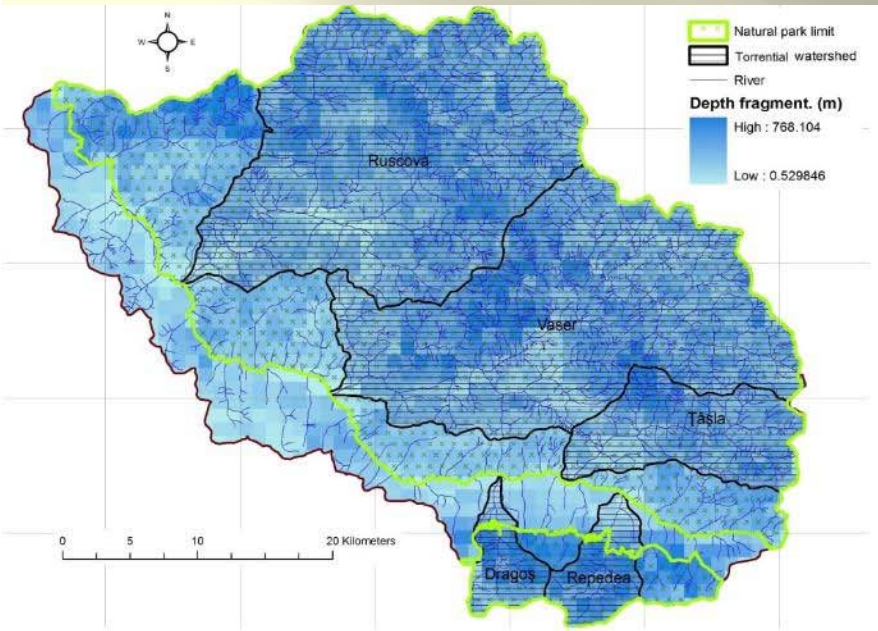
Technical data about flash-floods, floods and hydrological risk from the "Romanian Waters" National Administration, Bucharest & Regional Branch Cluj-Napoca. Study period 1968 – 2008.

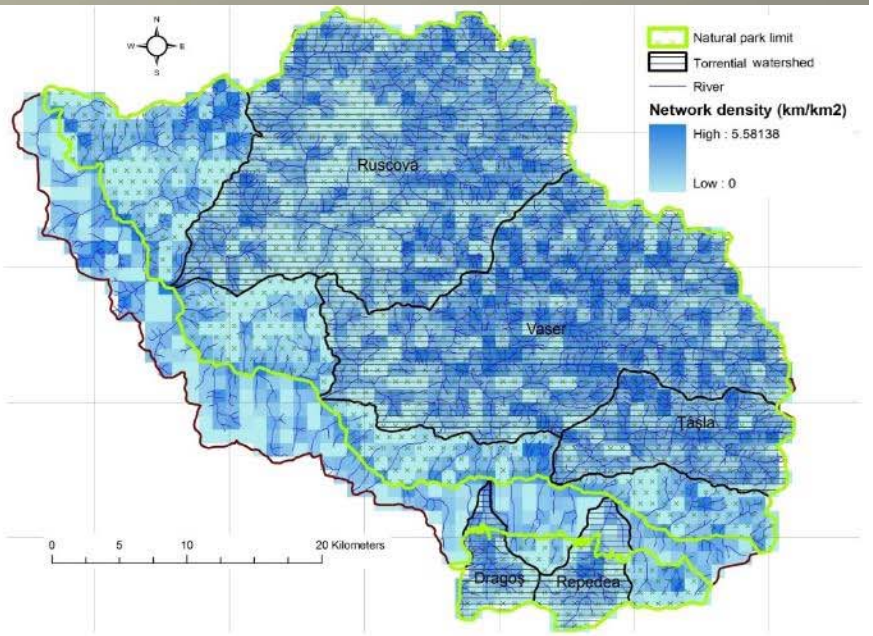
Maps, topo plans, satellite images from Babeş-Bolyai University, Faculty of Geography, Cluj-Napoca and "Romanian Waters" National Administration, Bucharest & Regional Branch Cluj-Napoca

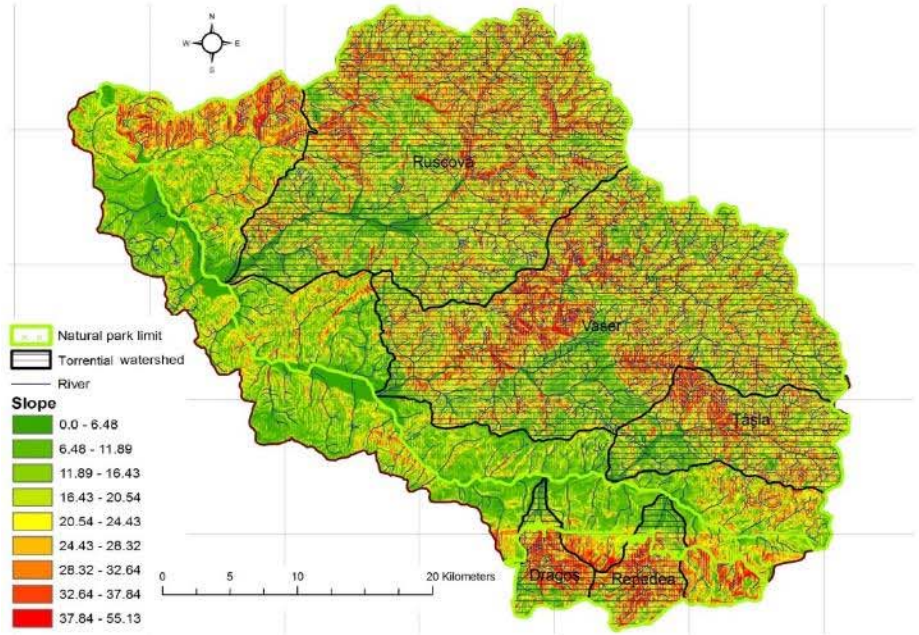
Rapports about floods and their effect from the "Romanian Waters" National Administration, Bucharest & Regional Branch Cluj-Napoca.

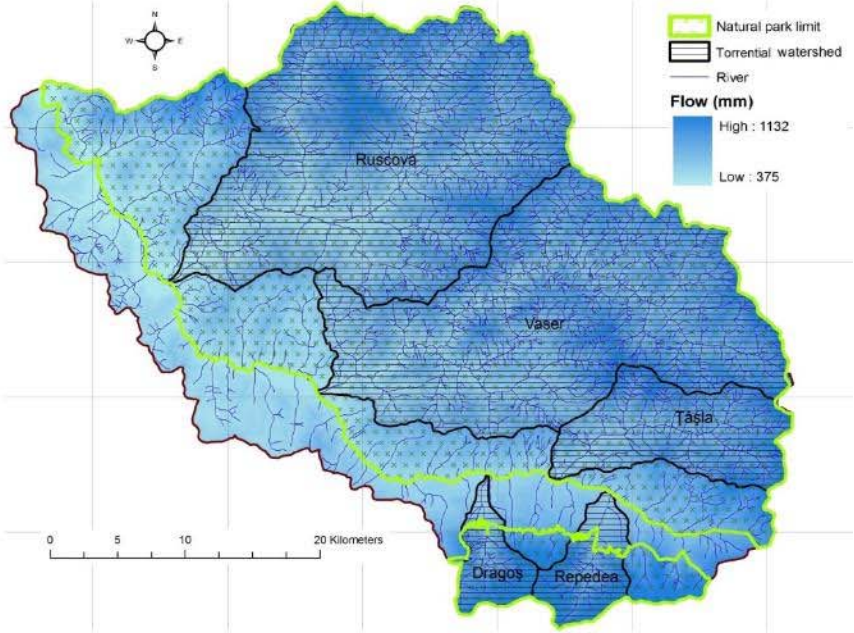
CAVIS software from the "Romanian Waters" National Administration, Bucharest and Statistic & ArcGIS software from Babeş-Bolyai University, Faculty of Geography, Cluj-Napoca

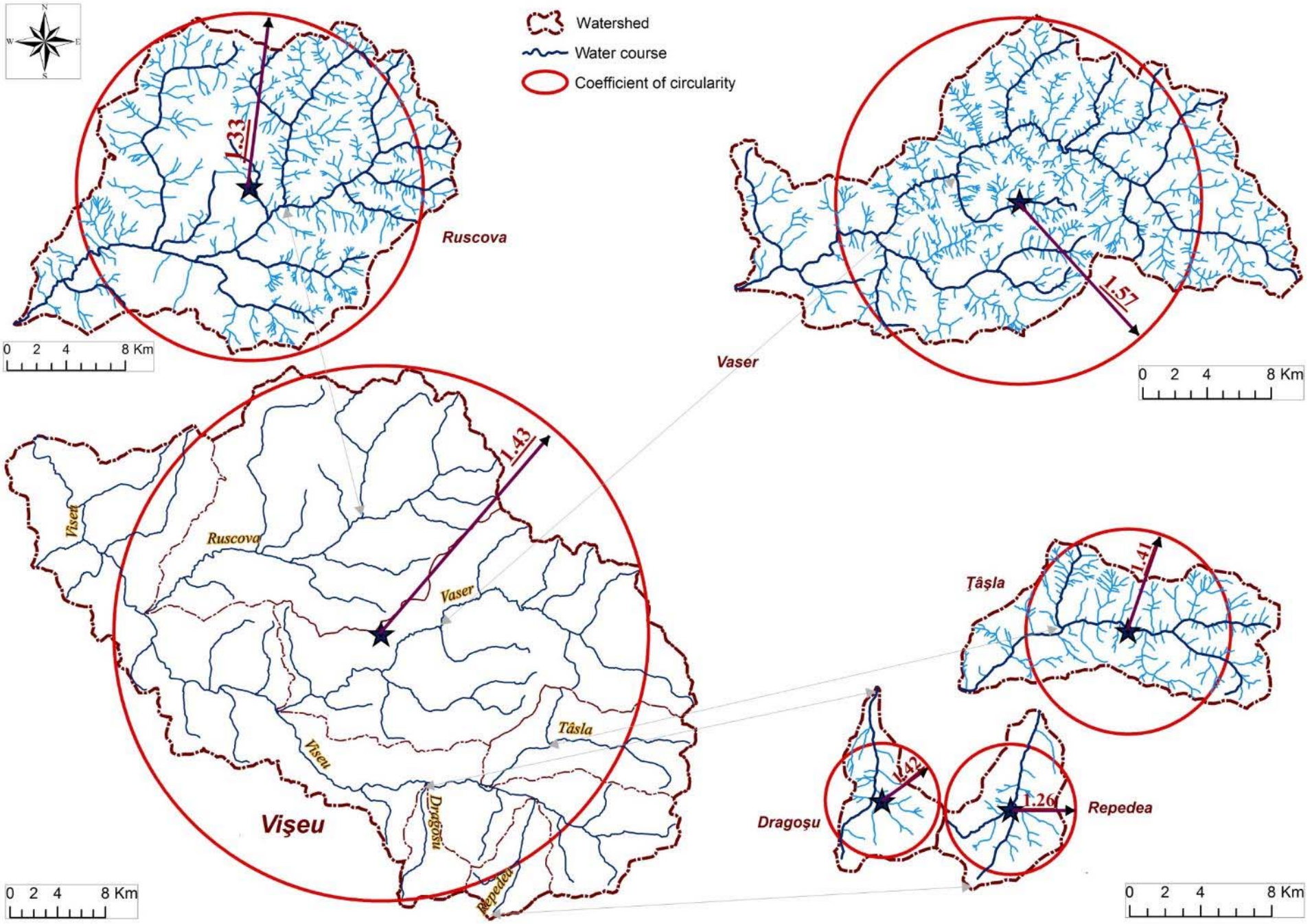
SEVERAL PHISICO-GEOGRAPHIC CONDITIONS IN THE VIŞEU WATERSHED







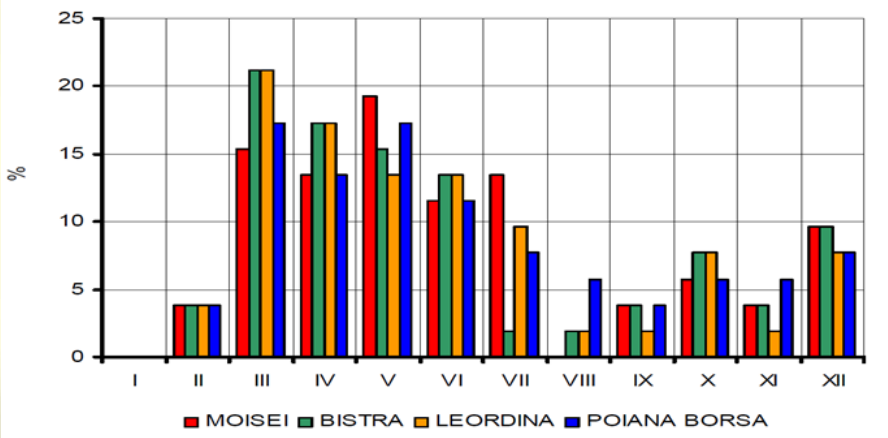


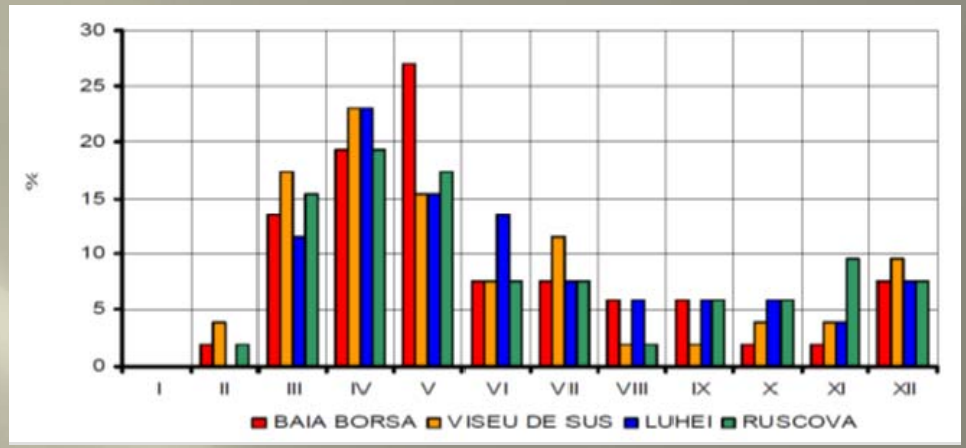


Coefficient of circularity for the most torrential watersheds from Vişeu drainage area

THE MOST IMPORTANT FLASH-FLOODS FROM THE VIŞEU WATERSHED

On studied rivers, **high waters** have the highest frequency during spring, with an average of 53%, followed by the summer season between 11 and 26%, the winter season, with 14% and the fall season with 12%.





Monthly frequency of flash-floods occurrence on the Viseu River and its right tributaries. Hydrometric stations are according figure 1

Monthly frequency of **flash-floods** occurrence shows a maximum in March for Vișeu river (16-22% of the total selected flash-floods) as well as secondary maximum in April and May, while the tributaries from the right side of Vișeu (Țâșla, Vaser, Ruscova) shows a peak in April (18-24%), and a secondary maximum in March and May.

Monthly minimum frequency of flash-floods occurrence is recorded in January (0%) in the case of Vișeu catchment area.

Historical flash-flood from Vişeu catchment area May 12-15, 1970

River	Hydrometric station	Debit (m^3/s)		Duration (h)		Volume (mil.m^3)			pl (mm)	dl (mm)	α
		maximal	undergr.	total	growing	total	undergr.	drained			
Vişeu	Poiana Borsa	62	19.2	82	21	9.098	5.668	3.43	88.1	25.593	0.29
Vişeu	Moisei	124	30.5	82	26	17.87	10.199	7.671	85.1	27.011	0.32
Vaser	Vişeu de Sus	257	50.5	82	29	**38.838**	16.162	22.676	115	55.307	0.48
Vişeu	Leordina	684	114	72	16	83.419	30.326	53.093	116	56.663	0.49
Ruscova	Luhei	124	30.5	82	26	**17.87**	10.199	7.671	109	41.5	0.38
Ruscova	Ruscova	240	50	82	27	**32.727**	15.513	17.214	110	39.7	0.36
Vişeu	Bistra	1072	182	72	13	136.798	54.562	82.237	113.9	53.228	0.47

pl (mm) = precipitate layer; dl (mm) = drained layer; α = drainage quotient

No.	River	Hydrometric station	Starting of observations	Catchment average altitude (m)	Catchment area (km^2)
1	Vişeu	Poiana Borşa	1953	1284	133
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6	Vaser	Vişeu de Sus	1952	1090	410
7	Ruscova	Luhei	1961	1177	185
8	Ruscova	Ruscova	1952	1079	432

Flash-flood from Vişeu catchment area July 21-26, 1974

River	Hydrometric station	Debit (m^3/s)		Duration (h)		Volume (mil.m^3)			pl (mm)	dl (mm)	α
		maximal	undergr.	total	growing	total	undergr.	drained			
Viseu	Poiana Borsa	48.1	6.8	120	21	8.286	3.583	4.702	99.3	35.355	0.36
Ţîşla	Baia Borsa	42	3.78	120	20	**5.982**	2.739	3.243	91.8	36.9	0.4
Vişeu	Moisei	123	11.5	120	18	12.253	4.968	7.285	68.8	25.473	0.37
Vaser	Viseu de Sus	192	14.8	120	23	**25.653**	8.986	16.667	109.2	40.652	0.37
Viseu	Leordina	508	32.2	120	23	57.9	17.453	40.448	104.6	43.167	0.41
Ruscova	Luhei	69.3	7.63	120	18	**11.412**	5.19	6.222	85.2	33.6	0.39
Ruscova	Ruscova	134	19.2	120	23	**24.943**	11.794	13.15	81.6	30.4	0.37
Viseu	Bistra	651	56.2	120	25	83.634	30.11	53.523	90.4	34.643	0.38

No.	River	Hydrometric station	Starting of observations	Catchment average altitude (m)	Catchment area (km^2)
1	Vişeu	Poiana Borşa	1953	1284	133
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Flash-flood from Vişeu catchment area December 23-29, 1995

River	Hydrometric station	Debit (m^3/s)		Duration (h)		Volume (mil.m^3)			pl (mm)	dl (mm)	α
		maximal	undergr.	total	growing	total	undergr.	drained			
Viseu	Poiana Borsa	20.5	1.93	158	68	5.781	1.945	3.836	72.3	28.624	0.4
Ţîşla	Baia Borşa	5.9	1.12	216	38	**2.965**	1.555	1.41	43.5	16	0.37
Vişeu	Moisei	34	2.82	192	96	11.746	3.47	8.277	87.8	29.143	0.33
Vaser	Viseu de Sus	72.4	3.6	202	24	**25.176**	7.137	18.039	93	43.997	0.47
Vişeu	Leordina	224	12	130	94	52.665	9.547	43.118	112.5	46.017	0.41
Ruscova	Luhei	49.8	4.06	154	82	**13.284**	7.002	6.282	87.3	34	0.39
Ruscova	Ruscova	151	9.02	178	24	**42.531**	11.573	30.958	153.1	71.3	0.47
Viseu	Bistra	355	18.7	168	26	120.901	29.212	91.689	127.1	59.345	0.47

No.	River	Hydrometric station	Starting of observations	Catchment average altitude (m)	Catchment area (km^2)
1	Vişeu	Poiana Borşa	1953	1284	133
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Flash-flood from Vişeu catchment area November 03-09, 1995

River	Hydrometric station	Debit (m^3/s)		Duration (h)		Volume (mil.m^3)			pl (mm)	dl (mm)	α
		maximal	undergr.	total	growing	total	undergr.	drained			
Viseu	Poiana Borsa	26.4	6.88	154	34	7.454	6.484	0.97	16.3	7.24	0.44
Ţîşla	Baia Borsa	9.1	3.02	168	48	**3.218**	1.826	1.391	52.5	15.8	0.3
Vişeu	Moisei	42.9	10	178	60	15.479	10.894	4.585	40.1	16.1	0.4
Vaser	Vişeu de Sus	61.3	8.6	130	24	**12.291**	4.407	7.885	40	19.2	0.48
Viseu	Leordina	156	45.6	144	48	44.168	26.003	18.165	46.7	19.4	0.42
Ruscova	Luhei	250	20	98	34	**33.466**	11.642	21.823	199.2	118	0.59
Ruscova	Ruscova	307	24.1	168	30	**51.076**	19.127	31.949	152.8	73.6	0.48
Vişeu	Bistra	446	89.6	168	34	113.917	54.19	59.727	80.5	38.7	0.48

No.	River	Hydrometric station	Starting of observations	Catchment average altitude (m)	Catchment area (km^2)
1	Vişeu	Poiana Borşa	1953	1284	133
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Flash-flood from Vişeu catchment area March 05-12, 2001

River	Hydrometric station	Debit (m^3/s)		Duration (h)		Volume (mil.m^3)			pl (mm)	dl (mm)	α
		maximal	undergr.	total	growing	total	undergr.	drained			
Viseu	R)iana Borsa	53.6	1.73	103	58	9.131	2.759	6.372	118	48.6	0.41
Tîsla	Baia Borsa	14	0.525	86	59	**2.61**	1.08	1.53	110	23.8	0.22
Vişeu	Moisei	80	4.42	104	61	13.86	4.54	9.32	117	33.3	0.28
Vaser	Vişeu de Sus	280	2.46	103	61	**42.84**	10.44	32.4	169	80	0.47
Viseu	Leordina	411	8.48	103	62	68.4	18	50.4	140	54.2	0.39
Ruscova	Luhei	181	2.45	84	59	**18.071**	1.905	16.166	230	118	0.51
Ruscova	Ruscova	417	7.17	86	61	**53.424**	13.464	39.96	198	92.1	0.47
Viseu	Bstra	902	21	110	53	146.644	30.492	116.152	192	75.2	0.39

No.	River	Hydrometric station	Starting of observations	Catchment average altitude (m)	Catchment area (km^2)
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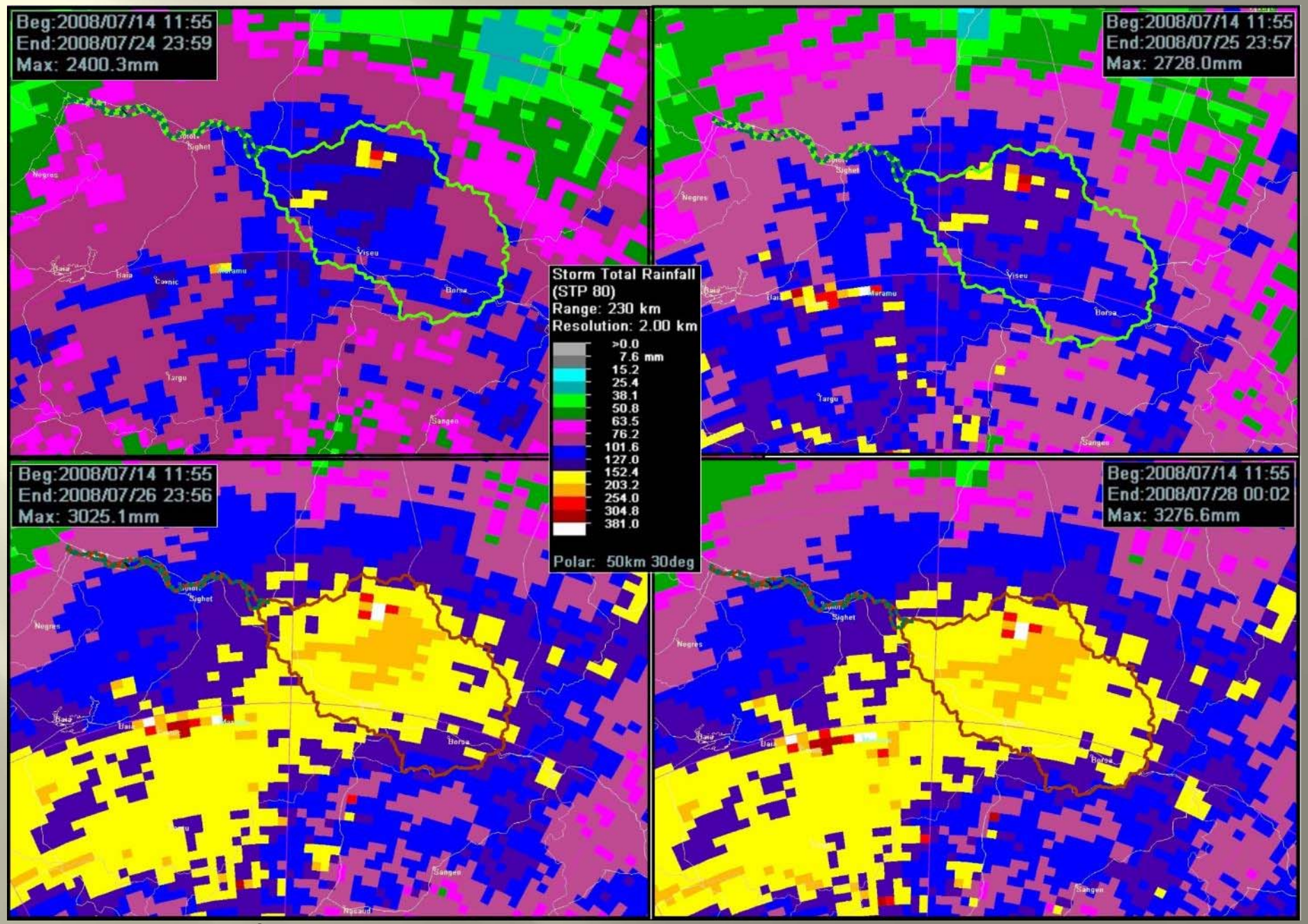
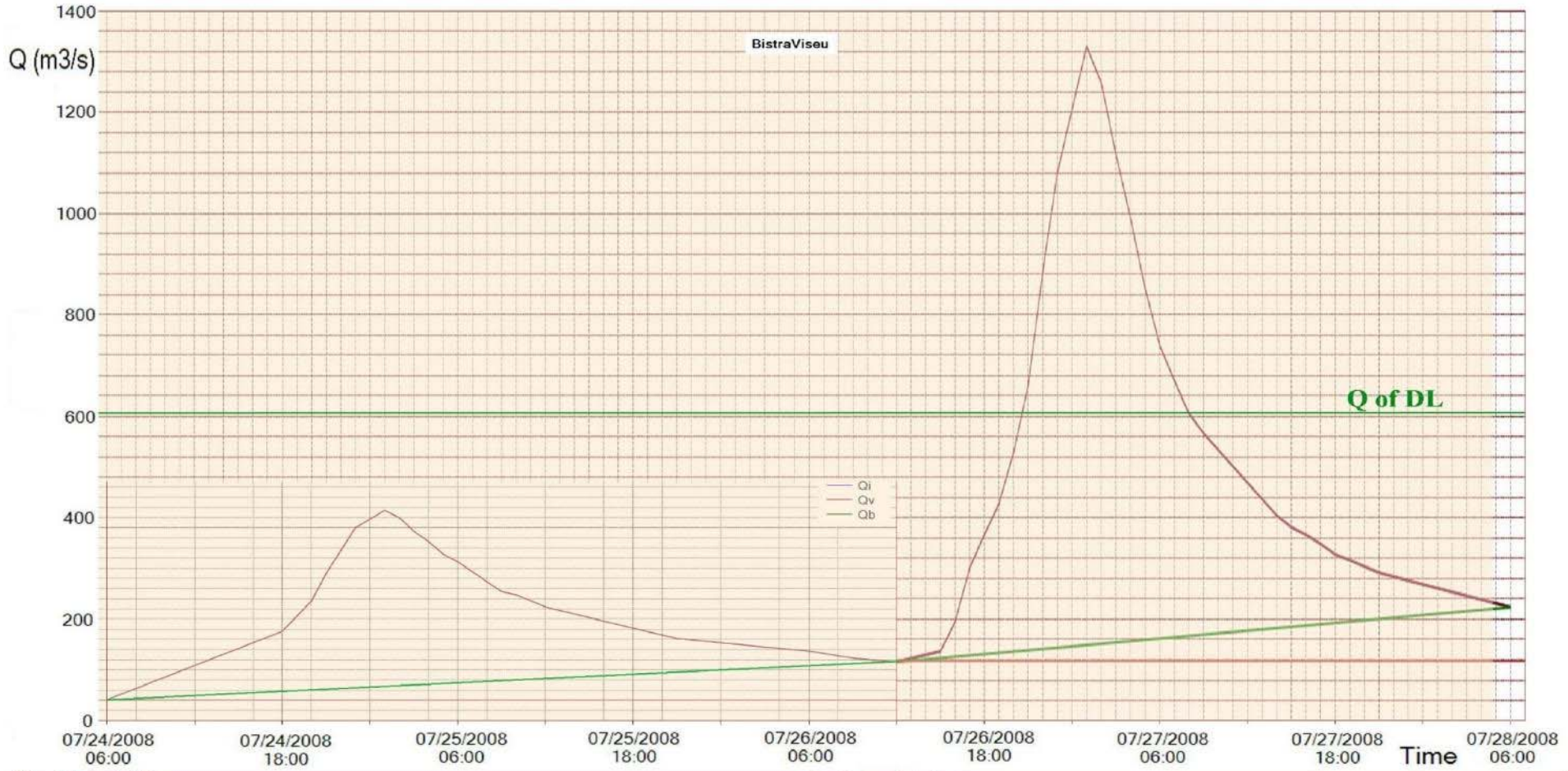
Flash-flood from Vişeu catchment area July 24-28, 2008



The estimated heavy rainfalls in Vișeu river basin during this period were comprised between 120 – 240 mm, and even more, the rainfalls' volume exceeding the monthly average (in 6 days it rained three times more than in a normal month of July).



Flood Characteristics

QmaxV:	346.547	m3/s	Qmax:	414	m3/s	QmaxTime:	07/25/2008 01:00	QmaxV:	1180.577	m3/s	Qmax:	1330	m3/s	QmaxTime:	07/27/2008 01:00		
WcV:	8.677246	mil.m3	Wc:	12.38976	mil.m3			WcV:	18.1557	mil.m3	Wc:	24.3666	mil.m3				
WdV:	14.42558	mil.m3	Wd:	25.983	mil.m3	Tc:	19	hours	WdV:	32.09266	mil.m3	Wd:	51.5844	mil.m3	Tc:	13	hours
WtV:	23.10283	mil.m3	Wt:	38.37276	mil.m3	Td:	35	hours	WtV:	50.24836	mil.m3	Wt:	75.951	mil.m3	Td:	29	hours
HsV:	14.95329	mm	Hs:	24.83674	mm	Tt:	54	hours	HsV:	32.52321	mm	Hs:	49.15922	mm	Tt:	42	hours
GammaV:	0.342931		Gamma:	0.4767892					GammaV:	0.2814983		Gamma:	0.3776853				
			Qbi:	41.1	m3/s	QbiTime:	07/24/2008 06:00					Qbi:	116	m3/s	QbiTime:	07/26/2008 12:00	
PK 1			Qbf:	115.9981	m3/s	QbfTime:	07/26/2008 12:00	**PK 2**				Qbf:	223.982	m3/s	QbfTime:	07/28/2008 06:00	

Flash-flood hydrographer to the Bistra hydrometric station, Vişeu river July 24-28, 2008

THE LOSSES OF THE FLASH-FLOODS FROM THE VIŞEU WATERSHED

Flash-flood	Victims (no)	Animals (no)	Houses (no)		Households (no)	Agrarian terrains (ha)	Street network (km)	Roads (km)		Bridges and footbridges (no)	Economic objectives (no)	Total ($)
			broken-down	distroyed				communal	counties			
December 1995	-	-	91	-	261	1069.85		48.56	0.1	16	5	180.629
November 1995	-	-	190	-	209	-	1.12	13	1.3	51	5	2.795.189
March 2000	-	-	-	-	1133	-	-	40.1	27	15	2	374.579
April 2000	-	-	-	-	-	1723	-	15.97	-	26	3	779.151
May 2001	-	90	367	18	475	2181.5	9225	1.5	2245	211	-	849.317
Total	-	90	648	18	2D78	4974.35	93.38	119.13	26.55	319	15	6.633.363

The losses induced by the July 24-28, 2008 flash-flood

Locality	Borşa		Moisei		Vişeul de Sus		Vişeul de Jos		Leordina		Petrova		Bistra		Poienile de sub Munte		Repedea		Ruscova	
Direct effects	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)	Unit.	Loss (RON)
Human loss	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Distroyed houses	1.00	8950	-	-	7.00	65006	-	-	2.00	3479	6.00	56273	1.00	1418	15.00	256912	10.00	71750	7.00	7145
Broken-down houses	-	-	1.00	2128	3.00	7124	-	-	-	-	-	-	8.00	10421	27.00	26124	11.00	2390	1.00	2460
Affected houses	-	-	5.00	9708	68.00	56117	42.00	35671	81.00	27091	70.00	36746	36.00	28148	-	-	-	-	-	-
Agricultural spaces (ha)	19.00	110000	34.00	111000	-	-	46.50	260000	330.00	750738	178.00	926000	34.00	61000	39.00	335000	-	-	20.00	100000
Grasslands (ha)	-	-	270.00		-	-	44.00		-	-	50.00		-	-	80.00		-	-	-	-
National roads (km)	-	-	-	-	-	-	-	-	4.00	400000	-	-	-	-	-	-	-	-	-	-
County roads (km)	-	-	-	-	-	-	-	-	-	-	4.50	360000	1.40	760000	0.65	160000	0.50	250000	0.10	40000
Communal roads (km)	6.00	2400000	-	-	-	-	-	-	-	-	3.50	280000	7.30	428000	-	-	-	-	-	-
Main streets (km)	6.40	5808000	-	-	4.05	4781577	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Landslides (ha)	-	-	-	-	132.25	2274900	-	-	-	-	-	-	0.42	2000	-	-	3.00	80000	2.00	200000
Local roads (km)	-	-	4.65	3321904	2.00	479000	19.50	1215000	7.00	210000	5.00	300000	7.00	499000	15.00	900000	4.80	790000	5.00	300000
Forestry roads (km)	50.00	1354000	-	-	6.50	487500	5.00	300000	9.00	270000	-	-	7.10	506000	5.00	300000	-	-	-	-
River bank consolidation (km)	2.50	11005000	12.50	13750000	1.48	5279600	-	-	-	-	-	-	0.80	907000	3.00	3300000	3.10	3756084	2.55	2013000
Dead domestic birds	-	-	170.00	1700	-	-	-	-	170.00	5000	270	12000	-	-	-	-	-	-	-	-
Bridges	20.00	4832000	4.00	180000	1.00	4000	-	-	1.00	234500	1	295000	4.00	1606000	1.00	10000	1.00	1100000	3.00	840000
Footbridges	12.00	295000	8.00	200000	-	-	96	1248000	-	-	8	47000	-	-	18.00	210000	13	78000	7	63000
Pietonal footbridges	2.00	59500	7.00	191000	-	-	3	122500	-	-	-	-	4	132000	-	-	3	100000	-	-
Kindergarten	-	-	-	-	-	-	-	-	-	-	1	35000	-	-	-	-	-	-	-	-
Dead animals	-	-	-	-	-	-	-	-	-	-	-	-	60	900	-	-	-	-	-	-
Water supply network (km)	4.20	1400000	-	-	-	-	-	-	1.80	60000	0.90	35500	-	-	-	-	-	-	-	-
Fountains	-	-	-	-	-	-	-	-	-	-	-	7500	-	-	-	-	-	-	-	-
Ponds	-	4200000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Power network (km)	-	-	0.90	70000	-	-	-	-	15.00	50000	-	-	-	-	-	-	-	-	-	-
Water supply intakes	-	-	-	-	-	-	-	-	1.00	50000	-	-	-	-	-	-	-	-	-	-
Schools	-	-	-	-	-	-	-	-	2.00	30000	-	-	-	-	-	-	-	-	-	-
Dikes (km)	-	-	-	-	-	-	-	-	4.00	6000000	-	-	-	-	-	-	-	-	-	-
Railways (km)	-	-	-	-	-	-	-	-	4.00	1500000	-	-	-	-	-	-	-	-	-	-
Phone networks (km)	-	-	-	-	-	-	-	-	5.00	150000	-	-	-	-	-	-	-	-	-	-
Others	-	-	-	70000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL 98 361 464 RON 26 709 062 EUR		31472450		17907440		13434824		3181171		9740808		2391019		4941887		5498036		6228224		3565605

Gheorghe ŞERBAN, Daniel SABĂU, Florin STOICA, Sorin RÂNDAŞU-BEURAN, Răzvan BĂTINAŞ, Simion NACU

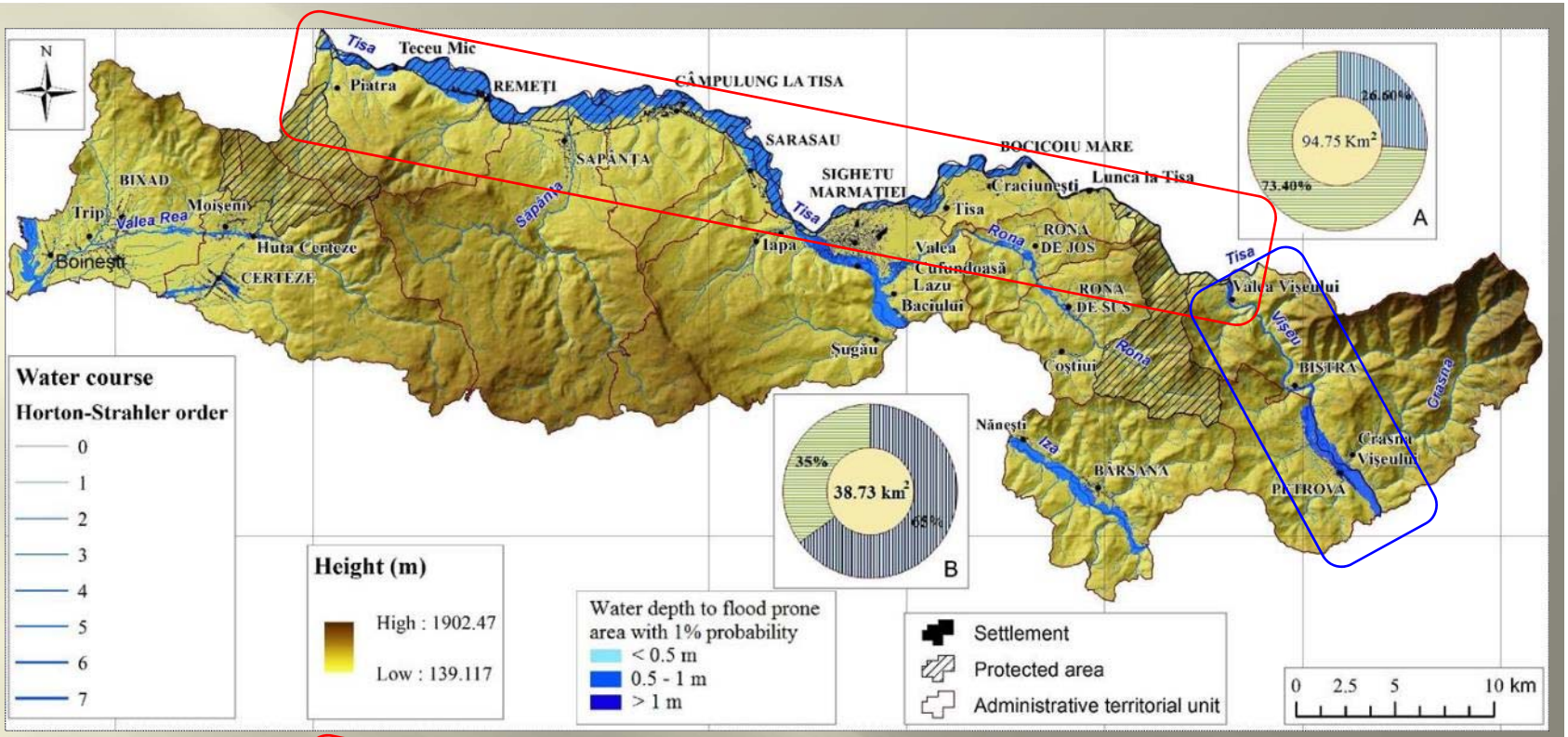
Effects induced by the July 24-28, 2008 flash-flood on anthropic and natural environment in Vişeu catchment area ...

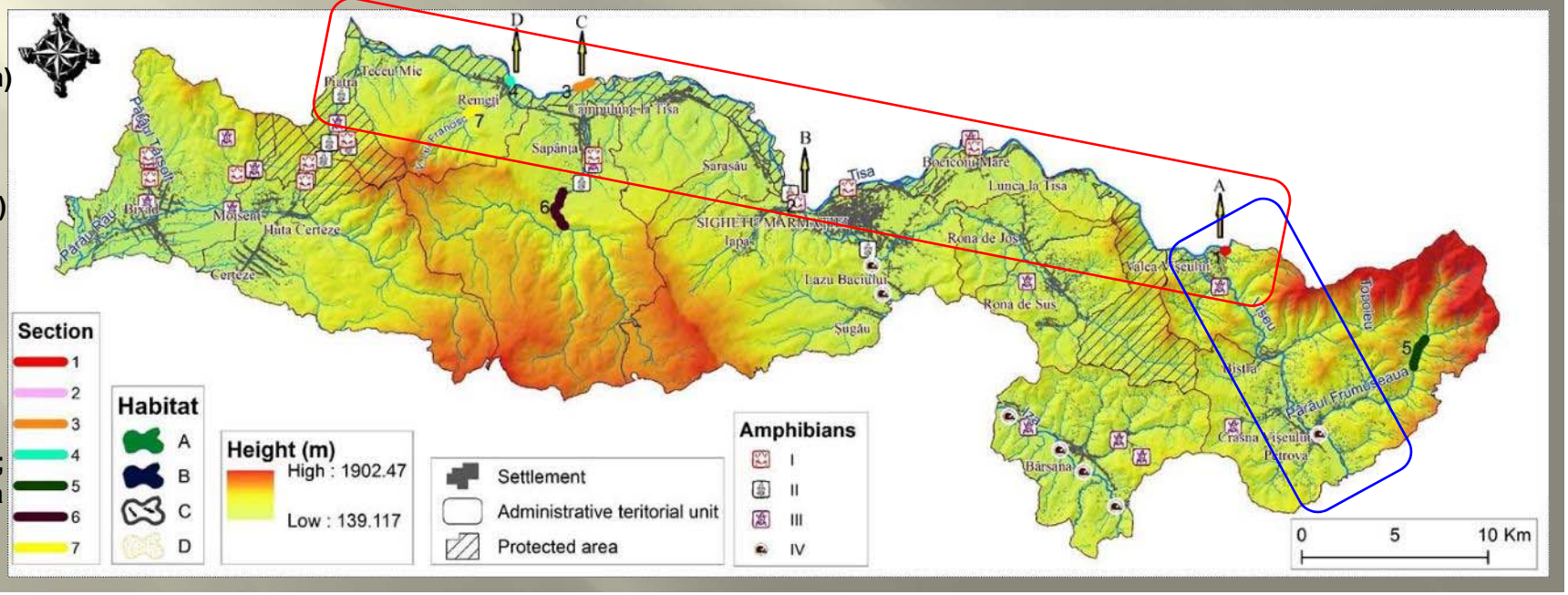





... and on its collector, Tisa river → → →

The flood prone areas with 1% probability





Species and habitats identified in the administrative-territorial units and Pricop - Huta-Certeze and Upper Tisa Natura 2000 protected areas (by different sources and own research) I, , Triturus cristatus (Northern crested Newt) ; II, Triturus mentadoni (Carpathian Newt) ; III, Bombina variegata (Yellow-bellied toad) ; IV, Lutra lutra (Eurasian Otter)

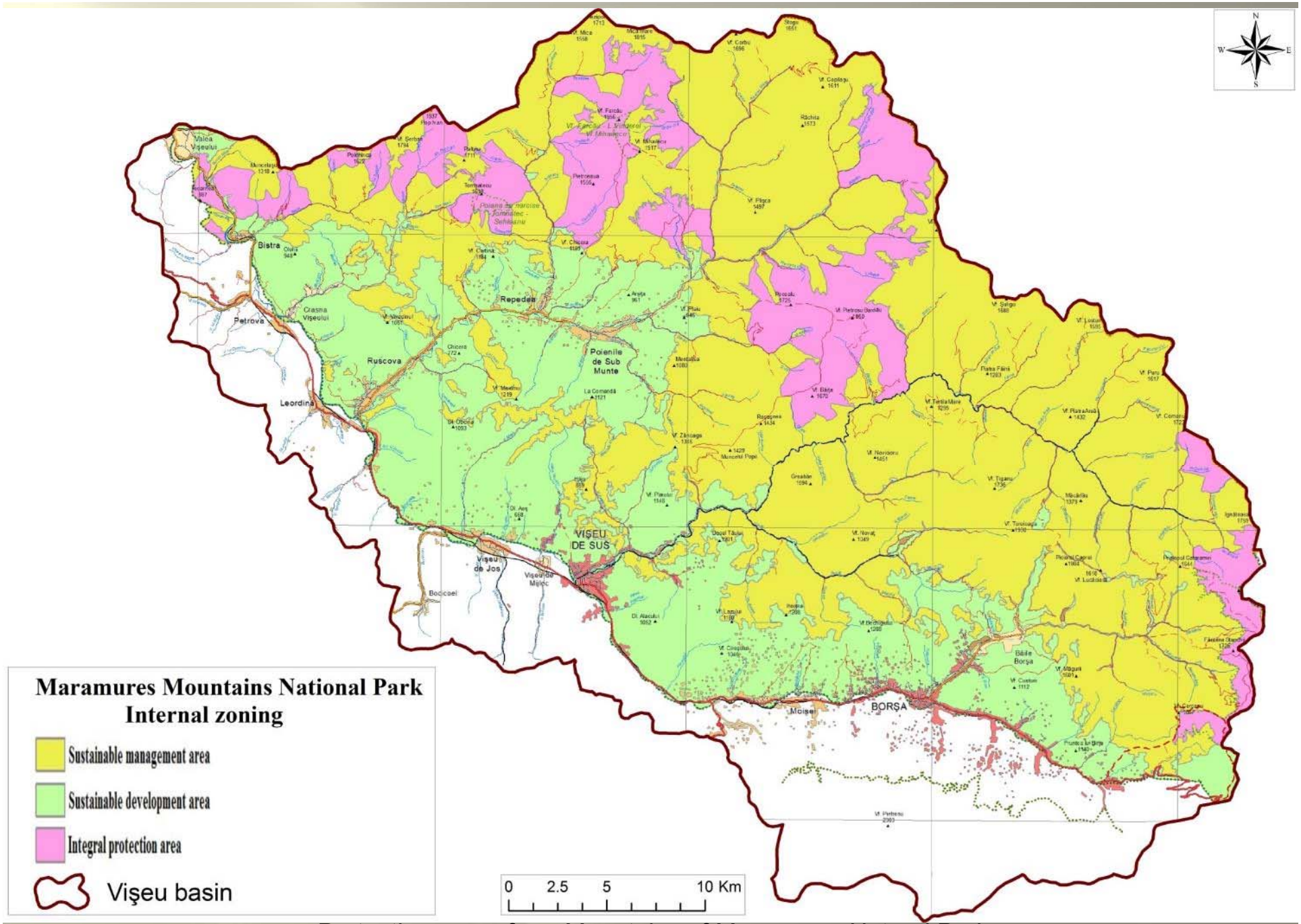
PROTECTED AREAS IN THE VIŞEU WATERSHED

In *Rodnei Mountains* were designated a protected area in 1932, when through The Journal of the Ministries' Council nr: 1949/1932, and reconfirmed through Law nr. 137/1995, the Pietrosul Rodnei Scientific Reservation was created (182ha). In 1979 this reservation was designated a Biosphere Reservation thought the Man and the Biospehere-Paris program under the supervision of the UN's organization for education, science and culture. On this nucleus, trough Law nr 5/2000, the Rodnei Mountains national park was founded, which is a protected natura area of national and international importance and is classified as a category 2, national park-biosphere reservation, SIT NATURA 2000 (SCI and SPA) according to the I.U.C.N.

The Rodnei national park is the largest protected area in the northern part of the Eastern Carpathians, spanning a total of 46339 ha. The importance of the area is due to the geology and geomorphology of the area and to the fauna and flora that is found within.

The Ministry for Environment and Durable Development, in charge of safekeeping Romania's protected areas, entrusted the management of the area to ROMSILVA for a period of 10 years. As a result of the management contract nr. 732/22.05.2004 the Rodnei Mountain national park management office was set up headquartered in Rodna, Bistrita-Nasaud county.

The Marmureşului Mountains Natural Park is situated in the north of Maramures County covering the areas sorounding Borşa, Moisei,Vişeu de Sus, Vişeu de Jos, Leordina, Ruscova, Repedea, Poienile de Sub Munte, Petrova and Bistra including the Marmureşului Mountains all the way to the border with the Ukraine. The borders of the area were established though governmental decree H.G 2151/2004 and it includes a number of multipurpose areas of land and is divided amongst several Forestry Service local offices like Borşa, Vişeu, Ruscova and Poienile de Sub Munte. As a result the below references use markings and infrastructure points from the area.



Protection areas from Mountains of Maramureş Natural Park (after http://www.muntiimaramuresului.ro/index.php/ro/galerie/harti).

Specific legislative framework in protected areas

The coexistence of protected areas and hydrotechnical infrastructure is well known and it currently exists in Romania without having major repercussions on the landscape or the natural environment (ex. Natural Apuseni Parc).

The current legal framework allows, under special conditions, human intervention in natural parks. According to Art 3, paragraph 5 g) of H.G. 2151/2004 intervention in natural parks is permitted in order to prevent natural disasters.

We won't insist on this subchapter since the problem has been analyzed in detail in the above mentioned paper published in the volume of a anniversary national conference for experts in the field (*"Romanian Waters" National Administration, Bucharest, Romania, 2009)*.

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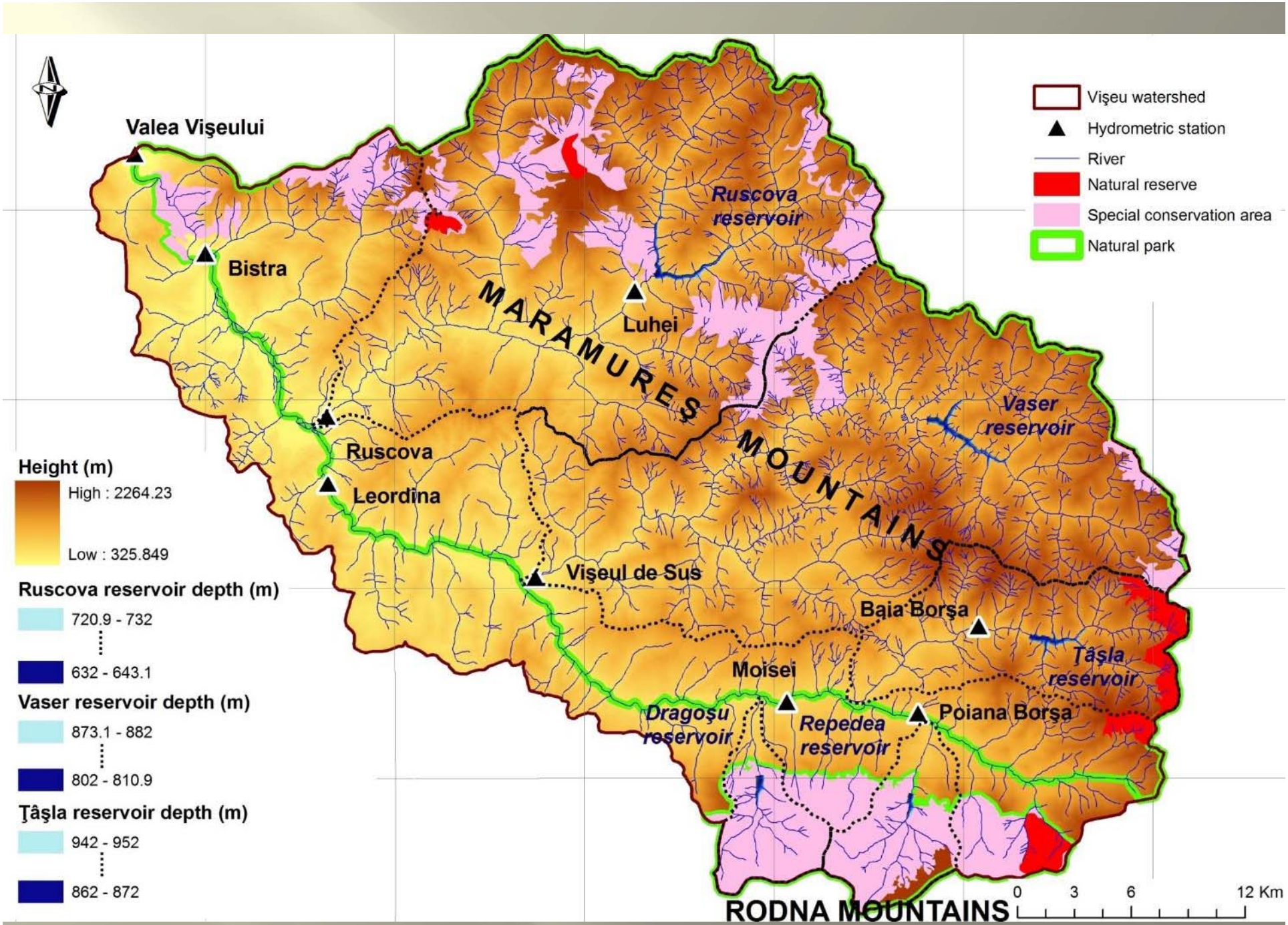
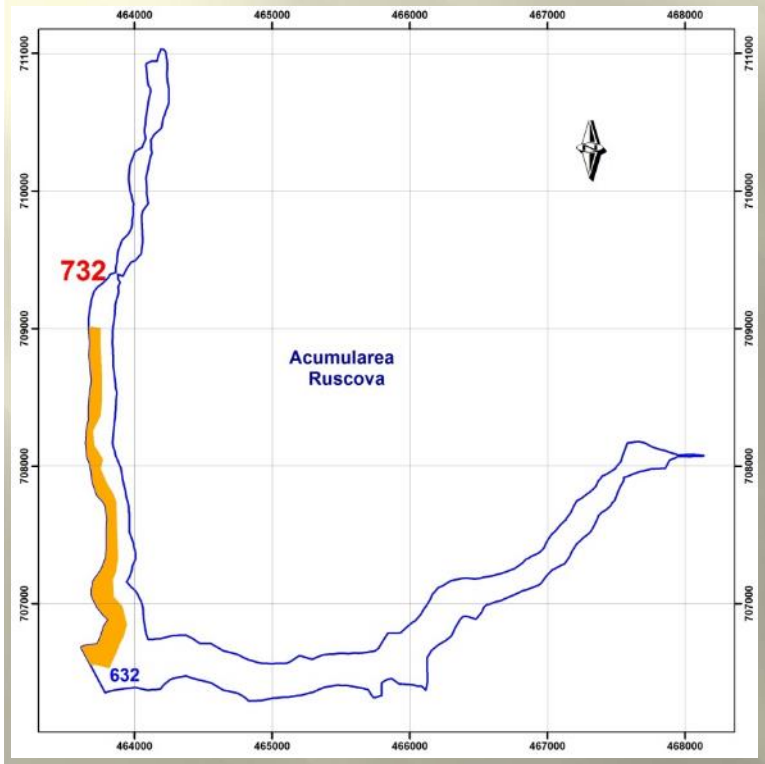


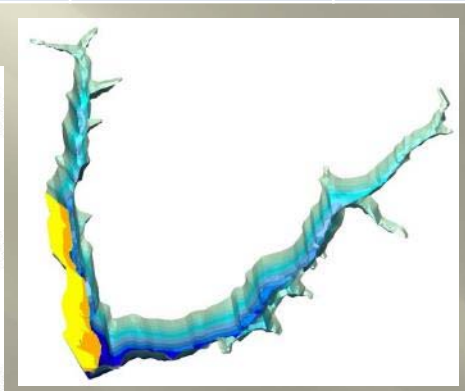
The proposed reservoirs

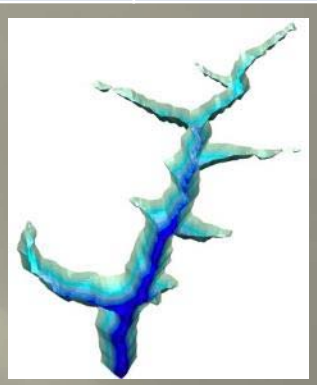
36th edition of the "DIMITRIE CANTEMIR" International Geographic Seminar
21-23 October, 2016, Iaşi, ROMANIA

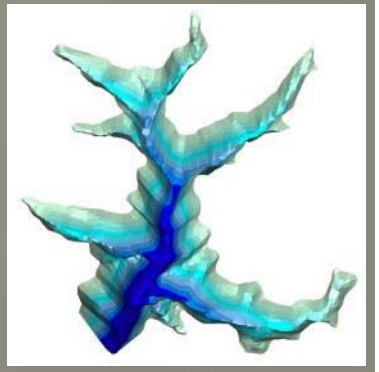
Surface and volume parameters of the proposed reservoirs

Reservoir	Maximum level of retention (m-BS)	Surface area (ha)	Real surface (ha)	Volume (mil. m3)	Historical flood wave maximum volume (m3)
Ruscova	732	1925324	2125365	57,586,124	53,424,000
Vaser	880	1785605	1919849	48,742,859	42,840,000
Ţâşla	950	863715	933452	25,245,012	5,982,000









The superposition of Ruscova reservoir on a special conservation area

Ruscova	Perimeter	Surface
Superposition area	5.529 m	265.842 m^2

Advantages and disadvantages of the proposed reservoirs and their caracteristics

Advantages	Disadvantages
When acting to reduce peaks in flow volume a rebalancing of the water resources is achieved	Reservoirs and dams includes higher costs and thus require a larger investment.
Reservoirs act on the entire spectrum of flood waves and are just as effective against the frequent ones as they are against the more rare ones	
Reservoirs offer a far reaching solution to flooding and the benefits can be seen far downstream .	Dam building is more complex and more technically challenging than any other flood prevention solution.
On rivers in narrow valleys, like the Vişeu, reservoirs are more economical than dikes.	
Reservoirs do not cause larger flooding downstream like dikes do.	
Reservoirs allow for a better use of the land surrounding the river eliminating idle land.	In case of a dam failure the damage is a lot higher than in the case of any other flood prevention solution.
The risk of a dam breaking is lower than that of a dike or breaking or overflowing.	
Reservoirs have multiple uses, the flood wave stopping one being a secondary	

CONCLUSIONS

The coexistence of hydrotechnical installations and protected natural areas is possible as long as the advantages are substantial and the negative impacts are minimal. The people and the local authorities need to be aware of the importance of such installations especially in high risk areas like the Vişeu basin.

It is obvious that the contruction of the hydrotechnical installations would have some negative impact on the two natural parks but through careful studies and using the latest building techniques these negative impacts will be greatly reduced. The socio-economic benefits of these installations are considerable and the local communities and departments would no longer have to spend money on flood cleanups.

A plus to this solution is that the local infrastructure would be brought up to date which could increase the flow of tourists and the extra income can be used to fund nature conservation projects and durable development projects.

& ... ACKNOWLEDGMENTS

This work was made possible by the financial support obtained in the project RO02 – 0013 - Integrated study concerning the contribution of ecosystems from the Pricop-Huta-Certeze and Upper Tisa Natura 2000 protected areas: to the sustainable development of local communities (SIENPHCTS) ", funded through a grant awarded by Iceland, Liechtenstein and Norway, RO02-, Biodiversity and ecosystem services", the call for projects proposals No. 1, whose Programme Operator is the Ministry of Environment, Waters and Forests.

Thank you and we inviting you to

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