RISKS INDUCED BY MAXIMUM FLOW WITH 1% PROBABILITY AND THEIR EFFECT ON SEVERAL SPECIES AND HABITATS IN PRICOP-HUTA-CERTEZE AND UPPER TISA NATURA 2000 PROTECTED AREAS

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ABSTRACT. – Risks Induced by Maximum Flow with 1% Probability and Their Effect on Several Species and Habitats in Pricop-Huta-Certeze and Upper Tisa Natura 2000 Protected Areas. The purpose of the paper is to identify and locate some species related to habitats from Pricop-Huta-Certeze and Upper Tisa Natura 2000 Protected Areas (*PHCTS*) and to determine if they are vulnerable to risks induced by maximum flow phases. In the first chapter are mentioned few references about the morphometric parameters of the hydrographic networks within the study area, as well as some references related to the maximum flow phases frequency. After the second chapter, where methods and databases used in the study are described, we proceed to the identification of the areas that are covered by water during flood, as well as determining the risk level related to these areas. The GIS modeling reveals small extent of the flood high risk for natural environment related to protected areas and greater extent for the anthropic environment. The last chapter refers to several species of fish and batrachia, as well as to those amphibious mammals identified in the study area that are vulnerable to floods (high turbidity effect, reduction of dissolved oxygen quantity, habitats destruction etc.).

Keywords: maximum flow, floods, flood risk, species, habitats.

1. INTRODUCTION

1.1. Morphometric data concerning catchment areas and water courses

The Upper Tisa, which forms a 62 km of natural border between Romania and Ukraine among the villages Valea Vișeului and Piatra, is composed by merging the two tributaries, Tisa Neagră (Black Tisa) and Tisa Albă (White Tisa), which have the springs in Păduroşi Carpathian mountains, respectively in Svidoveţ (1183 m) and Cernagora (2058 m) mountains. The Upper Tisa basin related to the Romanian territory, has an area of 4540 km^2, an average slope of 2 ‰ and collects 115 watercourses with catchment areas larger than 10 km^2 with a total length of 1557 km.

On the Romanian territory of Maramureş Basin and the sorrounding mountain area, the main watercourses collected by Tisa are Vişeu, with a catchment area of 1581 km^2 and total length of 82 km, Iza, with a catchment area of 1293 km^2 and a total length of 80 km, Săpânța and Șugatagul-Mare - latter less important tributaries from the left side of Tisa, which flow on a SE-NW direction (Fig. 1).

These rivers are characterized by a slope with average values between 0.2

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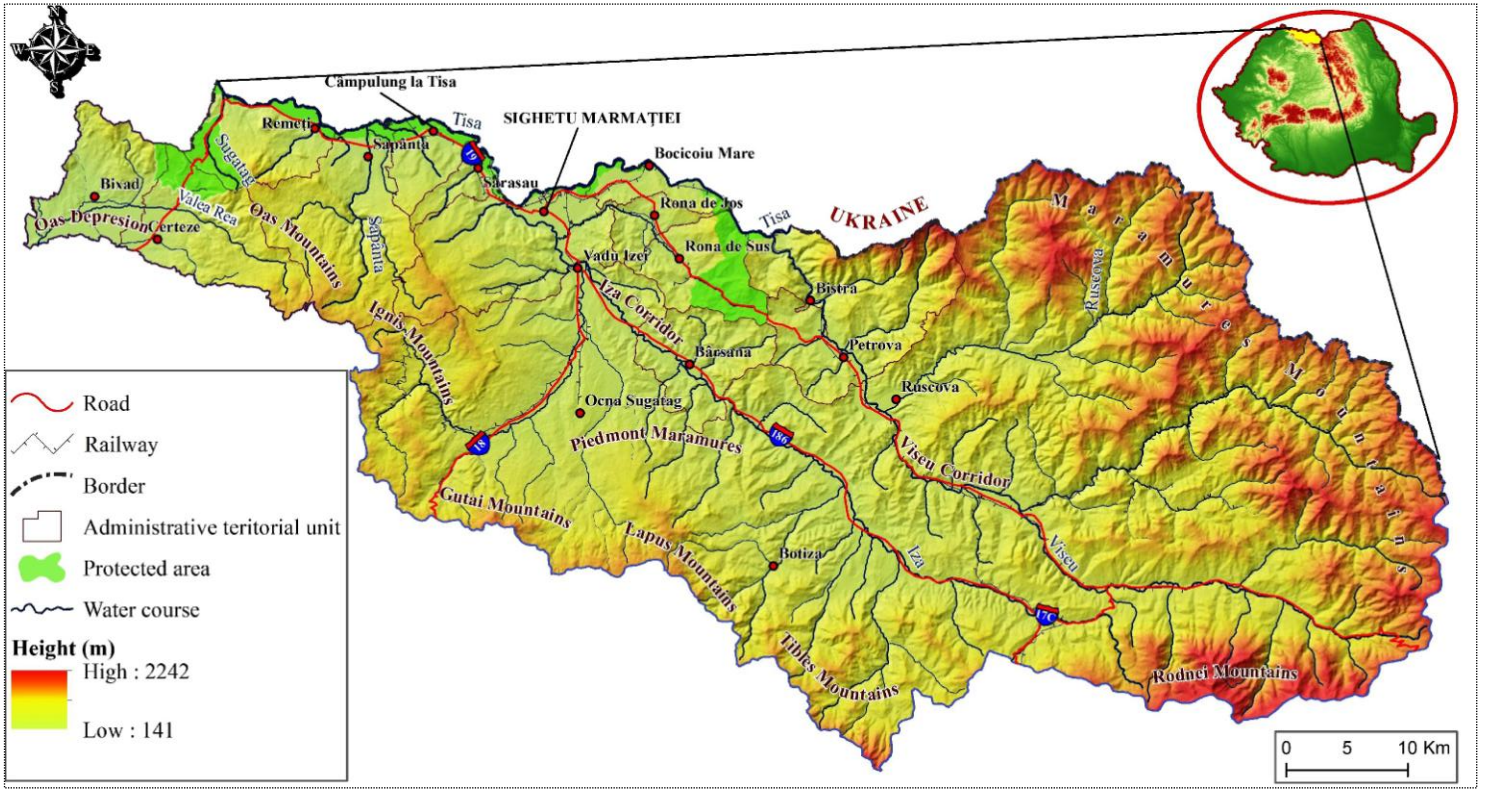

Fig. 1. Pricop-Huta-Certeze and Upper Tisa Natura 2000 protected areas, overlapping the corresponding administrative-territorial units and the catchment areas related to Tisa`s romanian tributaries

and 5.5‰ and a sinuosity coefficient between 1.04 and 2.16. The catchment areas larger than 100 km^2 are in number of 11, and their average altitudes are relatively high, which indicate a high theoretical hydro-power potential in Rodnei, Maramureş, Ţibleşu and Gutâi mountains (Water Cadastre Atlas from Romania, 1992).

Hydrographic network density in the studied area has values between 0.5 km/km^2 in the lower area of the basin and 0.8 km/km^2 in the mountain area. Tisa has a Western Carpathian hydrological regime type (after Romanian classification), with a maximum flow volume in April and minimum flow volume during winter.

1.2. References concerning the maximum flow frequency

Hydrologic analysis in this study, concerning flood risk, will be focused mainly on the Romanian space drained by Tisa's tributaries, where there's enough hydrometric activity in order to achieve hydrological synthesis and regionalizations (Fig. 2).

Due to difficulties with the Ukrainian side, only water levels were monitored on the collector until recent years, when it became possible to establish a correlation between water level and discharge value, and also activities related to the water quality and discharge values.

Referring to the maximum flow periods frequency, analyzed for the interval 1968 to 2005, stands the high proportion of **high waters**, but also of the **flash-flood**, which is more significant for our study. Thus, 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% (Cocuţ, 2008).

Monthly frequency of **flash-floods** occurrence shows a maximum in March for Vişeu 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 Vişeu (Ţâşla, Vaser, Ruscova) shows a peak in April (18-24%), and a secondary maximum in March and May. The Iza River basin stands out through a maximum frequency of flash-floods occurrence in March on both the main course and tributaries from the left (14-20% of all cases), as well as secondary maximum in April and June (Cocuţ, 2008).

Monthly minimum frequency of flash-floods occurrence is recorded in January (0%) in the case of Vişeu catchment area and in the months of January and September in the case of Iza catchment area.

2. MATERIALS AND METHODS

Data on water catchment areas and water courses, which formed the basis of the brief morphometric analysis, were partially taken from the Water Cadastre Atlas from Romania, 1992, partly from Someş-Tisa Regional Water Branch (*STRWB*) statistics or have been determined in GIS software (ArcGIS 10. x).

Elements relating to the frequency of maximum flow in the hydrometric-controlled basins from the studied area were calculated in statistical programs (Microsoft Office 2013, SPSS), and also taken from synthesis and studies of the above-mentioned regional institution.

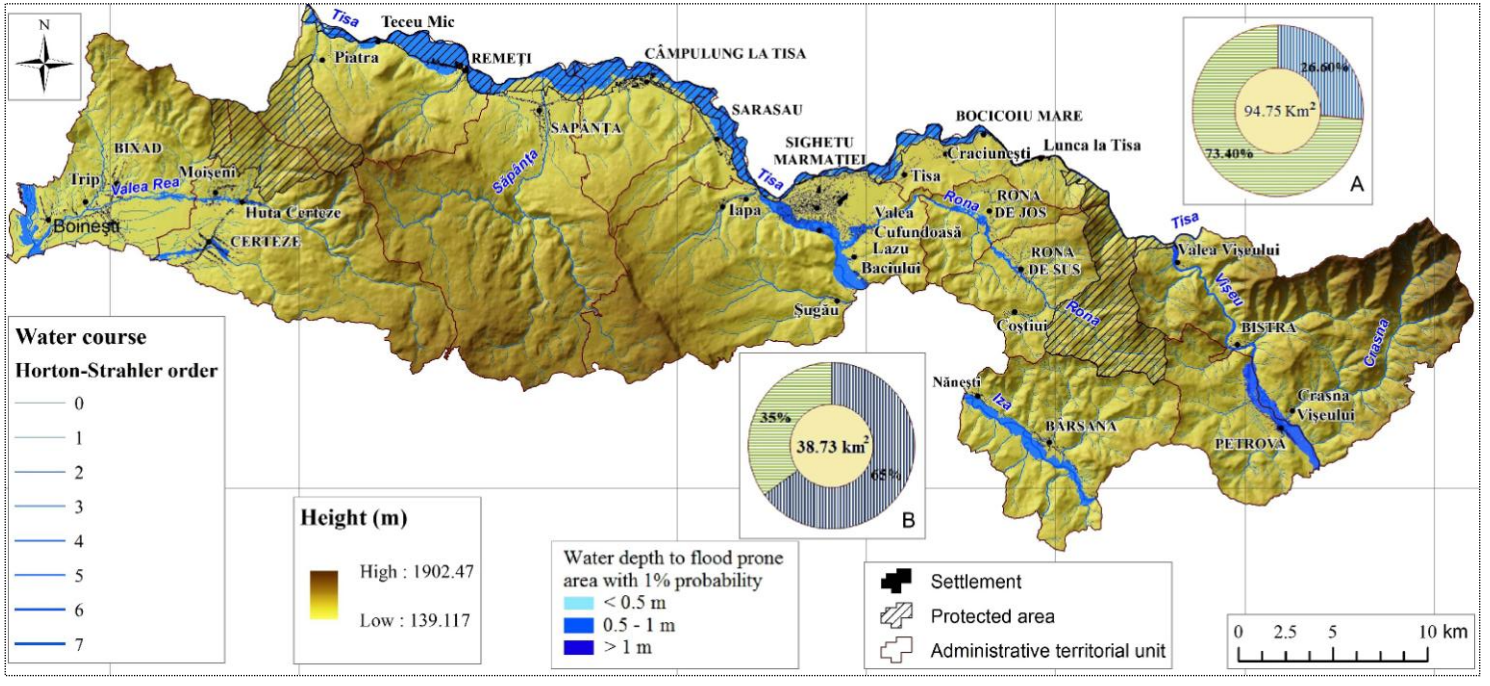

Fig. 2. The flood prone areas with 1% probability overlapping administrative-territorial units and Pricop - Huta-Certeze and Upper Tisa Natura 2000 protected areas (composite processed starting from the Floods Directive – "Romanian Waters" National Administration)

Information and charts which led to the achievement and interpretation of composite fields, relating to flood prone areas and flood-risk (flow with 1% probability) overlapping protected areas, resulted from: the Plan for prevention, protection and mitigation of the floods effects in the Someș - Tisa catchment area, Flood Defence Plans (*STRWB*), Directive 2007/60/EC on the assessment and management of flooding risk - Hazard and flood risk maps, The "Romanian Waters" National Administration, (*RWNA*) and flood risk management with related documentation, The Ministry of Environment and Climate Change (*MECC*).

The component relating to the habitats was composed from several printed and virtual sources and GIS database, located on the site of the Ministry of Environment and Climate Change and NATURA 2000 websites.

Support for GIS modeling was made up of 1:5000 plans, 1:25.000 topographic maps, ortophotoplans and other satellite images, Hazard and flood risk maps (*RWNA*), coordinates and GPS files from different sources (field trips and references). Digital mapping and files conversion were achieved with specific softwares (GPS Utility, Global Mapper, ArcGIS 10. x).

3. FLOOD PRONE AREAS WITH 1% PROBABILITY OVERLAPPING PROTECTED AREAS

Creating flood prone areas related to water courses in Romania has been initiated by <<"Romanian Waters" National Administration >>, under 2007/60/EC Directive on the flood risk assessment and management - Hazard and flood risk maps. The program has targeted in the first phase the most important water courses and severely affected areas by hydrological risk phenomena. Smaller rivers, although generating significant hydrological and associated local risks, were not targeted yet by the undertaken activities (Fig. 3).

In the study area, the composite map reveals important spaces covered by water flow rates with 1% probability. Generally, these are located in the floodplain areas of the basins individualized at the confluence, or in large areas of the valleys (Fig. 2). Otherwise, Tisa-Iza confluence (near Sighetu Marmației municipality and the Valea Cufundoasă village) and Tisa-Vișeu confluence type (in the vicinity of the Valea Vișeului village, or some basins located upstream of the defiles (Petrova), give water depths that can reach up to 1 meter. The areas of defile type, related to water courses, are not presenting important flood prone areas, because of the deepening of minor river beds and of valleys in the tougher rock structures.

Regarding the statistics derived from the GIS modeling, note that from the total of 94.75 km^2, representing the protected areas spatial extension (including Huta-Certeze and Ronișoara Forest areas), only 26.60% present flooding vulnerability.

If we limit the reference area only to the Upper Tisa Protected Area, the situation changes radically. In this sense, from the 38.73 km^2 related to the

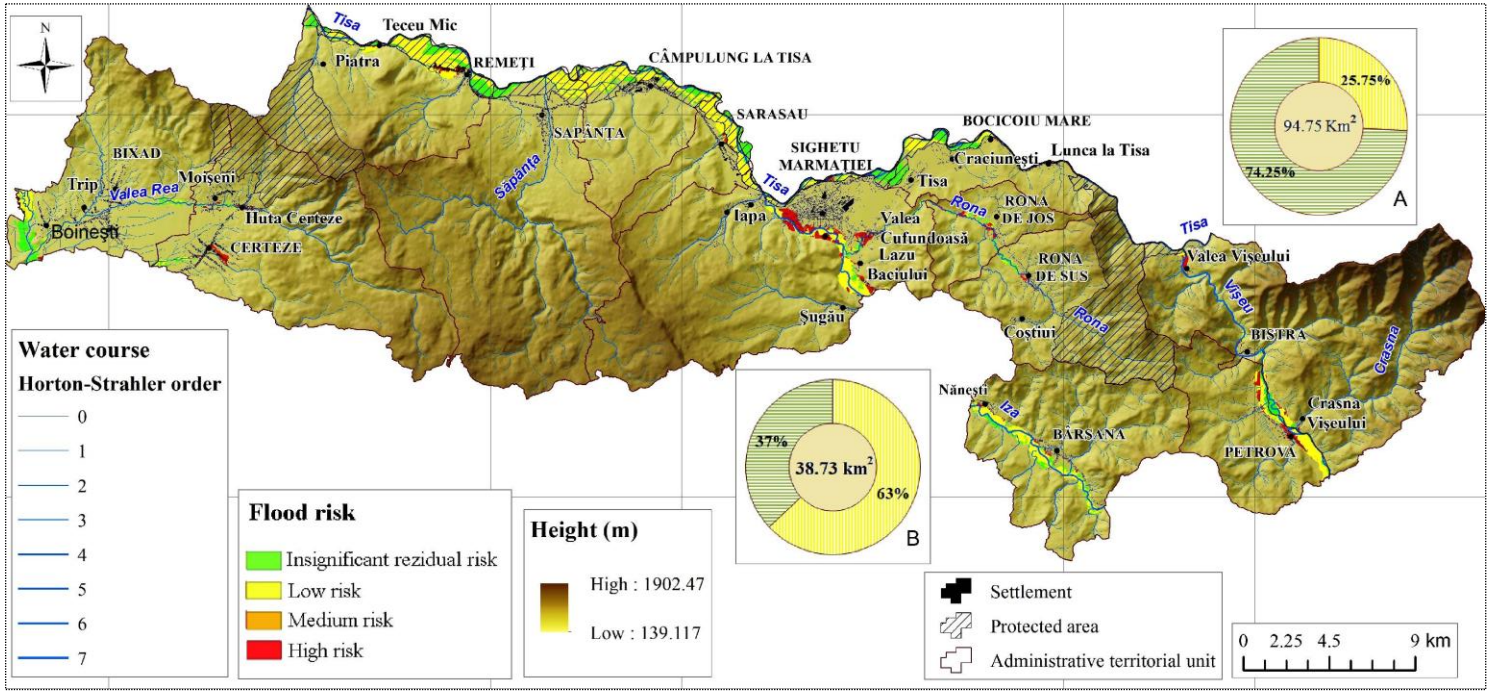

Fig. 3. The flood risk with 1% probability overlapping administrative-territorial units and Pricop - Huta-Certeze and Upper Tisa Natura 2000 protected areas (composite processed starting from the Floods Directive – "Romanian Waters" National Administration)

protected area, 65% are exposed to flooding, while only 35% of the area remains unaffected by water flow rates with 1% probability (Fig. 2).

4. FLOODS RISK OVERLAPPING PROTECTED AREAS

In the study area, flood risk is more accentuated in sensitive areas, which are located at the confluece or in larger sections of the valleys (Fig. 3).

In the **Upper Tisa protected area**, flooding *high risk* occurs in the north of the Lunca la Tisa village, north-east of the Bocicoiu Mare village, in the northern Sighetu Marmaţiei municipality, in the northern part of the Valea Hotarului village, in the eastern part of the Sarasău village and in the northern part of the Câmpulung la Tisa and Remeți villages. *Medium risk* is identified in the northern part of the Lunca la Tisa and Valea Hotarului villages, in the north of Sighetu Marmaţiei municipality, north-eastern part of Sarasău village, north-eastern and northern part of the Câmpulung la Tisa village, northern part of Remeți and Piatra villages.

The ***Upper Tisa protected area*** is also affected largely by *low risk* in the Bocicoiu Mare village area, between Craciunești and Tisa, Valea Hotarului and Săpânța, Remeți and Piatra village areas. The other protected areas (**Pricop-Huta-Certeze and Ronișoara Forest**) are not affected by flood risk.

5. EFFECTS OF FLOODS ON SEVERAL HABITAT COMPONENTS FROM *PHCTS* PROTECTED AREAS

Protected areas habitats present different flooding reactions, due to their specificity. Periodic floods are critical to maintaining the ecological integrity and biological productivity of the river floodplains (Rasmussen 1996, Poff et al. 1997, Juradja and Reichard 2006). In the river system, massive floods are the main cause of variability and environmental disruption (Michener and Haeuber 1998).

An important differentiation occurs between floods with lateral invasion and those of erosive type that have different effects on **fish populations**. Erosive floods are characterized by a fast-moving and turbulent water with power of training and movement of the components related to the river bed, often with dramatically destructive impact on the river bed`s natural habitats and riparian areas (Mathews 1998, Juradja and Reichard 2006).

Nonerozive lowland areas floods determine specific invasion of some broad terrestrial habitats areas, allowing fish populations to move into the affected areas searching for food (Ross and Baker 1983, Mathews 1998, Juradja and Reichard 2006).

An important flood effect is the significant reduction in the abundance of fish species, and in some cases up to extinction, between pre-flood (before flood) and post-flood (after flood) moments (Jurajda et al. 1998).

In the Upper Tisa protected area, from East to West, we can identify the following types of fish species and their habitats (Figure 4 – underlined species are representative and are found on the standard forms of the studied sites):

- in section 1, the A Habitat, Vișeu Valley, based on electrophishing, were found

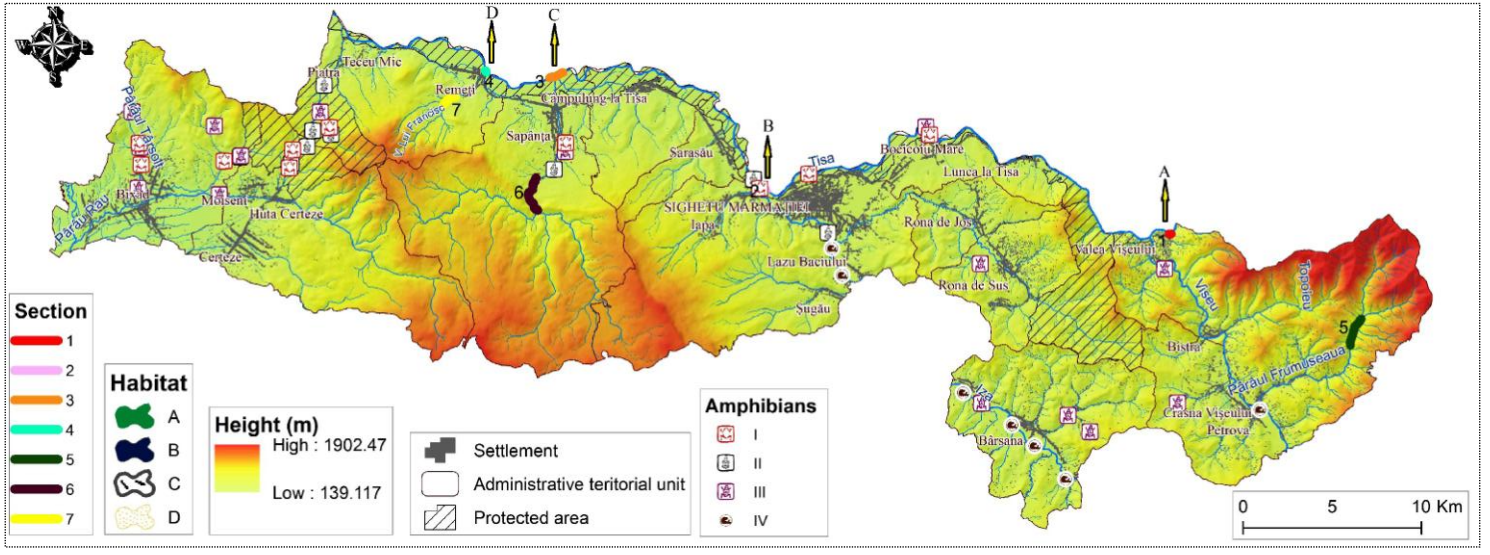

Fig. 4. Species and habitats identified in the administrative-territorial units and Pricop - Huta-Certeze and Upper Tisa Natura 2000 protected areas (by different sources and own research) I, , Triturus cristatus (Northern crested Newt) ; II, Triturus mentadoni (Carpathian Newt) ; III, Bombina variegata (Yellow-bellied toad) ; IV, Lutra lutra (Eurasian Otter)

Alburnoides bipunctatus (spirlin), *Barbus Barbus* (barbel), *Barbatula barbatula* (stone loach); habitat is one of *Hucho hucho* (huchen), with submerged rocks in the river bed and depth as well, with river sides with *Rubus vitis idaea* (cranberry), *Salix fragilis* (crack willow), *Alnus incana* (white alder), *Alnus glutinosa* (black Alder) were discovered; also, it has been observed *white-throated dipper* (cinclus cinclus) (Oprea and Irimia 2015);

- in section 2, the B Habitat, downstream of Sighetu Marmaţiei, electrophishing based, *Leuciscus cephalus* (european chub), *Alburnoides bipunctatus* (spirlin), *Barbus Barbus* (barbel), *Cottus poecilopus* (alpine bullhead) were discovered; habitat is one of floodplain forest, with *Populus alba* (white poplar), *Fraxinus augustifolia* (narrow-leaved ash), *Clematis vitalba* (old man`s beard), *Humulus lupulus* (hops), *Salix fragilis* (crack willow), *Salix alba* (white willow), *Acer negundo* (maple), with heavily herbaceous river sides (Oprea and Irimia, 2015);

- in section 3, the C Habitat, located in Săpânța village, based on electrophishing, *Leuciscus cephalus* (european chub), *Phoxinus phoxinus* (common minnow), *Alburnus alburnus* (bleak), *Barbus peloponnesius petenyi* (mediteranean barble), *Orthrias barbatulus* (stone loach), *Cottus gobio* (european bullhead) were discovered (Harka et al. 1999); habitat is one of floodplain forest, with *Populus* (poplar), *Fraxinus augustifolia* (narrow-leaved ash), *Clematis vitalba* (old man`s beard), *Humulus lupulus* (hops), *Salix fragilis* (crack willow), *Salix alba* (white willow), *Acer negundo* (maple), with heavily herbaceous river banks;

- in section 4, the D habitat, in the Remeți village, based on electrophishing, *Barbus Barbus* (barbel), *Leuciscus cephalus* (european chub), *Leuciscus souffia* (western vairone) *Alburnus alburnus* (bleak), *Barbatula barbatula* (stone loach), *Phoxinus phoxinus* (common minnow), *Pseudorasbora parva* (stone moroko) were discovered; habitat is the confluence one, dammed area with floodplain forest, *Salix fragilis* (crack willow), Salix alba (white willow), *Populus alba* (poplar), *Robinia pseudoaccacia* (black locust), *Fraxinus augustifolia* (narrow-leaved ash) (Oprea and Irimia, 2015);

- in sections 5, 6 and 7, on the Frumușeaua, Valea lui Francisc and Săpânța valleys, upstream from Crasna Vișeului, Săpânța and Remeţi villages, based on electrophishing, *Eudontomyzon danfordi* (carpathian brook lamprey) was observed, particularly sensitive to the impact of anthropogenic activities (Telcean şi Cupşa 2011).

Regarding the **amphibian populations**, their behaviour during flood is less known, although it is obvious that the phenomenon plays a vital role in the abundance and spread of such species (Tockner et al. 2006, Kupferberg et al. 2012, Ocock et al. 2014). ***Amphibians*** are very sensitive to environmental and habitat changes, primarily to changes in rainfall and flow regime, but also temperature, turbidity, water pollution with pesticides or other chemicals, or pollution with plant and animal residues (including sawdust) (Frogs in wetlands 2015). Distribution of frogs and some other amphibians related to the study area can be seen in Figure 4.

The existence of the ***eurasian otter*** (*Lutra lutra*) in a habitat depends largely on the permanence of water and the availability of adequate food resources (Melquist şi Hornocker 1983, Kruuk 1995, Prenda et al. 2001). Also, the existence of the

eurasian otter is influenced by the surrounding areas characteristics, water pollution and human-induced disturbance factor (Bas et al. 1984, Delibes et al. 1991, Prenda et al. 2001). Ardelean and Bereş (2000) showed: "Our research has proven Eurasian otter presence starting from Tisa`s riverside coppice to mountain streams with a lot trout (Iza, Vişeu, Mara, Săpânţa, Rica etc.)".

The distribution of the eurasian otter in Pricop - Huta-Certeze and Upper Tisa protected areas can be seen in Figure 4.

CONCLUSIONS

The territory related to Pricop-Huta-Certeze and Upper Tisa Natura 2000 protected areas and corresponding administrative-territorial units is characterized by a high maximum flow frequency in the spring season, especially in the month of March and the end of the season. Differentiations between Vişeu and Iza catchment areas, the rivers that drain in majority proportion the above-mentioned area, are minor, although presenting slightly different expositions to the western air masses general direction.

Achieved composite map reveal important areas covered by water at flow rates with 1% probability. In general, these are located in the floodplain areas of the basins individualized at the confluence, or in large areas of the valleys. From a total of 94.75 km^2, representing the spatial extension of protected areas (including Huta-Certeze and Ronisoara Forest areas), only 26.60% are vulnerable to flooding. If we limit the reference area only to the Upper Tisa, situation changes radically. In this sense, from 38.73 km^2 related to protected area 65% are flooding exposed, while only 35% of the area remains unaffected by water flow rates with 1% probability.

Only in the Upper Tisa protected area there is flooding *high risk*, as well as *medium-risk* or *low risk*, other protected areas (Pricop-Huta-Certeze and Ronişoara Forest) being outside the flood risk.

Both fish and batrachia populations, as well as the amphibious mammal identified in the study area, are vulnerable to floods (high turbidity effect, reduction of dissolved oxygen quantity, habitats destruction etc.). Their habitats are affected, in large measure, by the phenomenon, except some of the categories (batrachia), for which water surfaces remaining after floods at the end of spring season are favorable for their hatching and breeding.

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