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PREDICTING THE POTENTIAL INDEX OF MAJOR FLOODS PRODUCTION IN THE SUHA RIVER BASIN (SUHA BUCOVINEANA)

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Abstract

The Suha River basin is the right tributary of the Moldova River and occupies a mountain area and high and small depressions (such as: Gemenea, Negrileasa, Stulpicani – Frasin), which favored the increasing concentration of the population in this area. Because of the increased basin population, issues related to the formation and evolution of flow regime in the Suha River basin are particularly important. The years 1975, 1981, 1984, 1991, 2005, 2006, 2007 and 2008 have registered significant flood insurance rates (20%, 10%, 5% and 2%) being generated by rainfall with torential character and very high intensities. For a better management of the emergency situations arising from the rapid increase of the water level, in this paper we analyze a new method proposed by Smith (2003), in order to realistically assess the potential index of flood transmission.Based on data obtained from the hydroclimatic network of hydrometrical stations in the basin (Gemenea 1, Gemenea 2, Slatioara 3, Stulpicani and Valea lui Ion), we intend to estimate the potential index of flood transmission identifying areas of vulnerability to floods in the Suha River basin. The estimation of the index is based on the analysis of the following physical-geographical factors: precipitation, soil texture, slope and land use. The index values will be obtained by processing the data, which results from the analysis of spatial distribution of the factors taken into account, in GIS software. By generating the map on the estimation methods of the distribution of the index of potential flood resulted as Suha basin presents a medium risk of flood production on 75% of its surface**.** The importance of the index of potential flood production lies in the fact that such a method allows the identification of critical areas with high drainage potential and areas which favor the evolution of floods.

Keywords: the index of potential flood production, risk classes, Suha River basin.

1 INTRODUCTION

The effect of global climate felt on the surface the Suha River basin by the alternation of the intense flood phenomena and the droughts, which affect both the population and the economy of the area. The issues related to the formation and evolution of the flood regime in the Suha River basin (drained by its tributaries) are particularly important. The flood regime is determined both by natural geographical factors (climate, relief, geological composition, biopedogeografic cover) and by anthropogenic influences (Barbuc & Matreata, 2008).

There are some features in the Suha River basin, which affect both the runoff and flooding in the case of major flash floods. The main natural element that influences the water runoff is reprezented by the increasing amount of alluvial transport and the sedimentation of these deposits in the riverbeds, especially in the middle and lower sections of the main water courses: Suha, Gemenea, Slatioara and Negrileasa.

When we talk about floods, we have to take into account tha fact that the agradation of riverbeds reduces intensly the transit capacity, generating frequent flooding. So, the estimation of the index of potential flood production is an important step in identifying areas with rapid drainage potential and areas which favor the production of floods.

2 STUDY AREA AND METHODS

2.1 Study area

The Suha River (Bucovineana) is the right tributary of the Moldova River located upstream Gura Humorului town and receives the following tributaries: on the right side – Negrileasa and Branistea and on the left side – Brateasa, Botusan, Muncel, Gemenea, Slatioara, Ursoaia and Valea Seaca (I.N.M.H. 1971). The Suha River basin occupies the southern tip of Obcina Feredeului, the slope of the Rarau mountains, the eastern slope of Ostra and Suha, and NV of Obcina Voronetului, part of the Stanisoarei mountains (Figure 1).

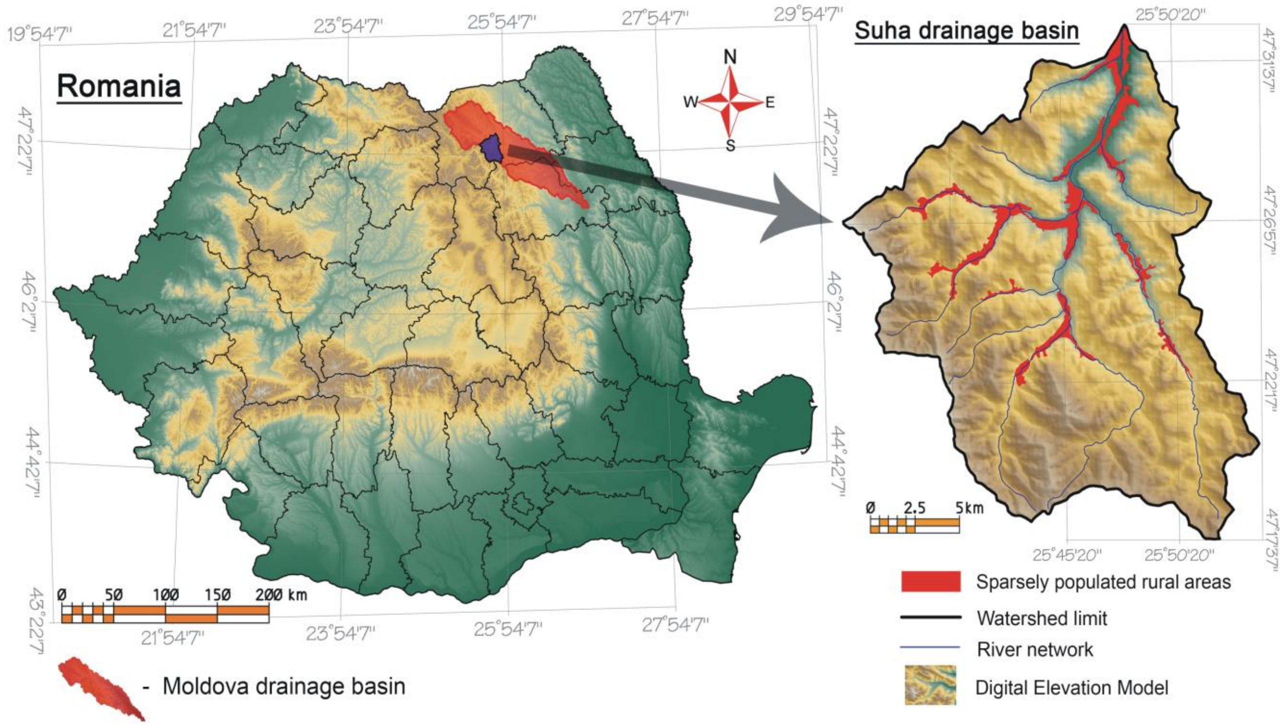

Figure 1. The geographical location of Suha basin

2.1.1 The peculiarities of the area of study, which favor the production of flood

Ichim (1979) presents the following features of the Suha River basin:

- The relief has the appearance of an amphitheatre, which decreases in height from South to North;
- The energy of relief is averaging 300-400 m, and the slope varies between 16 degrees and 30 degrees;
- The general coefficient of afforestation in the drainage basin is 78%. The situation on the tributaries is as it follows: Baisescu River - 95%, Brateasa River- 85%, Botusan River - 92%, Muncel River – 79%, Gemenea River- 76%, Slatioara River– 86%, Negrileasa River – 75%, Ursoaia River – 92%, Branistea River– 64%, Valea Seaca River– 79%;
- The nature reserve „Codrii Seculari”, with an area of 1065 acres, that conserves the natural vegetation, is part of the Slatioara River basin. This coefficient of afforestation ensures a certain regularization of the flash floods, taking into consideration the rather large slopes present here.
- However, floods are rather frequent, not because of the torrential rainfalls though, but particularly because of the significant size reduction of the river beds (because of the silting process);
- The existence of the depressions: Brateasa – Slatioara tectono-sculptural, Slatioara – Gemenea a "field-long" type of depression, and Plotonita-Suvarata;
- The presence of a selective erosion basin, Stulpicani – Doroteia basin;
- The presence of hogbackuri (the most representative in Stanisoarei mountains);
- The existence of a network of valleys with the most expanded terraces in the Stanisoarei Peak area, which do not adapt to the structure;
- Keeping the most obvious effects of the periglacial landforms: solifluxion and gully erosion;
- The modification of the main water courses at every important flood (meanders or side erosion).

All the features mentioned above contribute to surface runoff, but the main causes of flood formation consist of important quantities of rainfall in a very short period of time.

Rainfall is the main factor of the formation of surface water runoff. The database relating to the quantities of precipitation recorded in the Suha River basin offers a comprehensive enough analysis, considering that the data we have is for a period of 20-30 years, however the hydrometrical stations location is focused on the Western half of the basin. Consequently, for a more eloquent analysis we used the data of precipitation from the pluviometric stations outside the Suha River basin. The pluviometric stations from which we gathered the data are: Valea lui Ion hydrometrical station (Valea lui Ion River), Gemenea 1 hydrometrical station (Gemenea River), Gemenea 2 hydrometrical station (Gemenea River), Slatioara 3 hydrometrical station (Slatioara River), and Stulpicani hydrometrical station (Suha River), Sabasa hydrometrical station (Sabasa River), Pluton hydrometrical station (Pluton River), Dorna Arini hydrometrical station (Bistrita River), Campulung Moldovenesc hydrometrical station (Moldova River) and Gura Humorului hydrometrical station (Moldova River) (Figure 2).

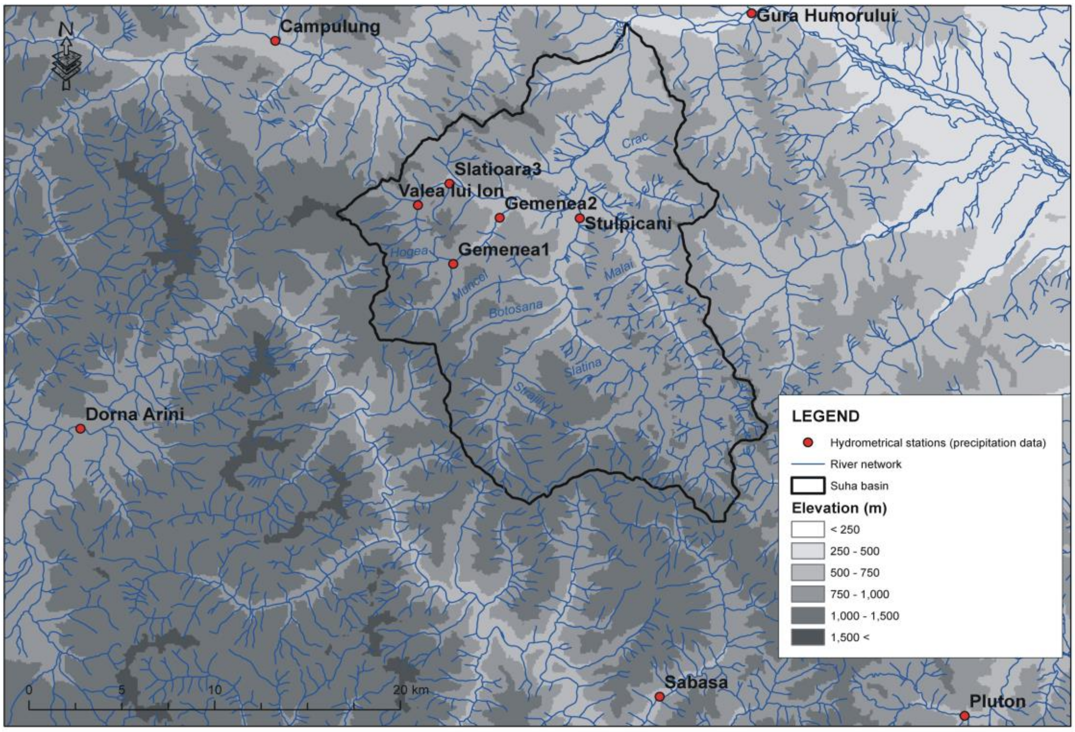

Figure 2. Hydrometrical stations Map

2.2 Methods

The high intensity of rainfall manifested in time in the water catchment area, the characteristics of the terrain and the Suha geographical position have determined the rapid concentration of the runoff and the generation of floods with destructive effects. For a more accurate management of the emergency situations arising as a result of these floods we intend to identify the areas vulnerable to floods from Suha River basin, using the method proposed by Smith (2003) in the project framework „Western Region Flash Flood Project".

Until now, this method has been used in Romania by Matreata & Matreata (2011), Achim & Borcan (2011). Applying this method for the Suha River basin we try to estimate an index, which expresses the potential occurrence of floods in this area and to determine the areas with high vulnerability to floods. In order to achieve this objective, we will analyse the main physical-geographical factors underlying the flood production: land use, soil types, slopes and as a novelty we introduced in our analysis a 1% insurance precipitation map.

To identify the index of potential flood prevention we have been completing the following steps in GIS:

The theme of the cover slopes was generated from the Digital Terrain Model with a spatial resolution of 80 metres (CGIAR, 2008);

- Thematic layer of soil structure was converted into a raster layer with a resolution of 80 m;
- The thematic layer with the degree of afforestation has been following extracted from the data set Corine Land Cover, 2006 (EEA, 2010);
- The theme of the rainfall layer was achieved by interpolating the values of maximum daily rainfall on a 20-30 years multiannual period, using Kriging method.

According to the method proposed by Smith (2003), to each value corresponding to a theme layer, was assigned an integer value ranging between 1 and 5, where 1 is the minimum value and 5 is the maximum value of the flood risk. In the end, the intersection and the mediation of the four layers generates the final layer with the index of flood potential prevention to highlight the areas of the river basin, which have the predisposition to flooding.

3. RESULTS

The quantities and distribution of rainfall in time and space give the characteristics of a moderate humid continental climate, mountain type to this area. The most important feature of the maximum daily multiannual quantity of precipitation is reprezented by the high recorded values, which affect the entire surface of the basin, considering its reduced size.

To underline the importance of this parameter in the estimation of the index of flood potential prevention, the 1% rainfall probability was calculated, and by interpolating these results we generated a map, which shows large amounts of rainfall concentrated in the southwest of the basin and significantly lower amounts in the northern half (Figure 3 left). We used the Kriging method in order to obtain the interpolation.

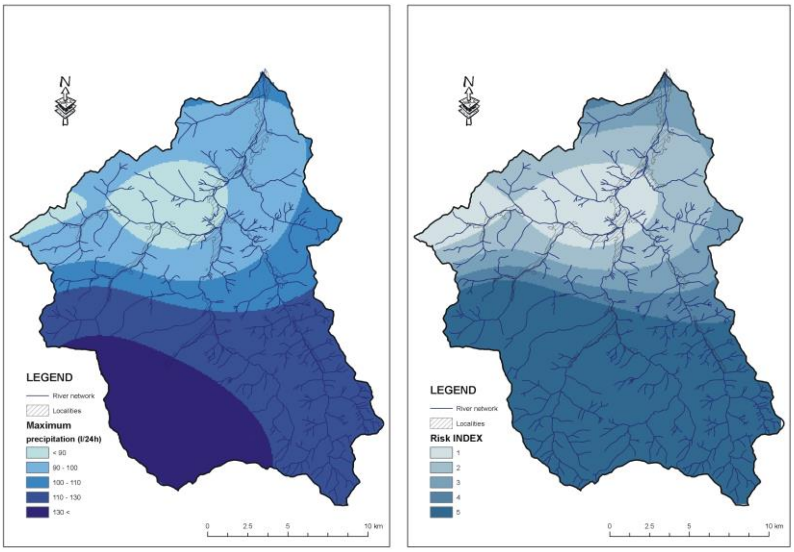

Figure 3. The maximum daily multiannual precipitation interpolation map (left). The quantity of precipitation spatialization map (resolution 80 m)

After processing in GIS the data obtained by calculating the probability of rainfall production of 1% we could group the quantities of precipitation into five classes of risk. The classes obtained are: 1, 2, 3, 4, and 5, where the 1st class expresses the minimum potential, and the 5th class expresses the full potential (Figure 3, right). The particularities and the dynamics of the relief intervene directly in the formation of the soil. In the mountain units the alteration crust normally shows much skeletal material which means that the soil has a slow evolution. Soils have a reduced thickness, excluding the intramontane depressions and the areas along the valleys, where the profile thickness is higher due to the thick and permeable deposits. The soil texture is the main factor in the process of draining. This is the reason why Chendes (2007) has made an adaptation of the hydrological soil groups to the Romanian texture classification, adding a new group „E", corresponding to argillaceous type soils with impermeable texture surfaces (Table 1).

Table 1. The hydrological soil groups adapted to the Romanian texture classification (Chendes, 2007)

Group	Texture	The index of potential production
A	Sandy	1
	Sandy – Sandy-Clayey	1
	Sandy – Clayey-Sandy	1
	Sandy-Clayey	1
	Sandy-Clayey – Clayey-Sandy	1
	Clayey-Sandy	1
B	Sandy – Clayey	2
	Sandy-Clayey – Clayey	2
	Clayey-Sandy – Clayey	2
	Clayey	2
	Various texture	2
C	Sandy-Clayey – Clayey-Argillaceous	3
	Clayey-Sandy – Clayey-Argillaceous	3

	Clayey-Sandy – Argillaceous	3
	Clayey – Clayey-Argillaceous	3
D	Clayey – Argillaceous	4
	Clayey-Argillaceous	4
	Clayey-Argillaceous – Argillaceous	4
E	Argillaceous	5
	Impermeable areas	5

To such classes of precipitation and soil risk index with values from 1 (minimum risk) to 5 (maximum risk) have been assigned. The GIS soil map with a resolution of 80 m was done according to this classification (Figure 4, left).

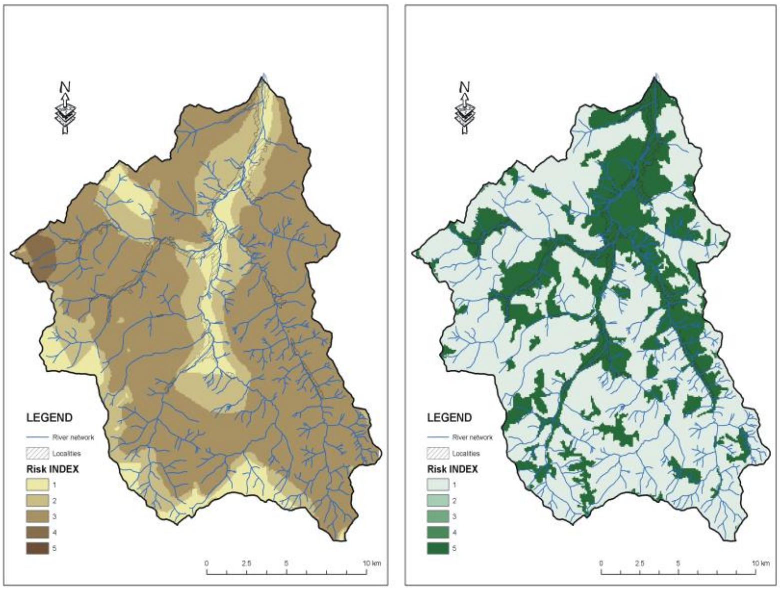

Figure 4. Soil classification map according to the texture resolution 80 m (left). Spatialization of the degree of afforestation map, resolution 80 m (right)

Analysing the map executed according to the soil texture (Figure 4, left) we can see that the types of soil with high risk are found on small areas, the largest surface of the Suha River basin being occupied by soils with medium risk. By processing in GIS the values corresponding to the degree of afforestation according to the vulnerability index (Matreata& Matreata, 2011), we concluded that we can find the medium risk index on the largest area of the basin and high values along riverbeds, where massive deforestations occured (Figure 4). The slope values present also a medium risk in the Suha River basin (Figure 5).

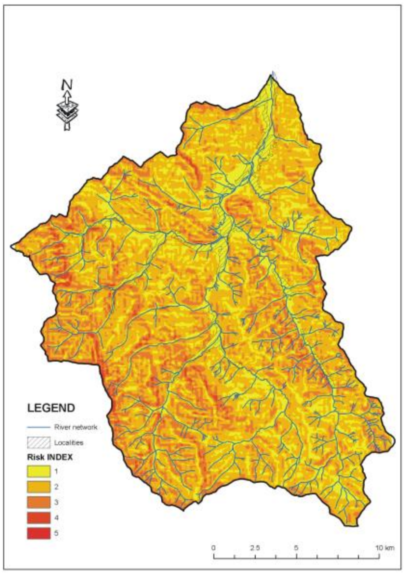

Figure 5. Classification of slopes at a resolution of 80 m

Finally, by calculating the weighted average of these four grids, with a resolution of 80 m resulted a final grid that expresses the degree of vulnerability to flood for the Suha River basin (Figure 6).

In the Suha River basin the maximum risk areas are localized in the medium course of the Gemenea River and the Muncel River, on very small surfaces, but the medium risk areas occupy a third of the surface of the river basin, especially the southern half of the basin and along the minor riverbeds of the main tributaries of the Suha River, as well as the minor and major riverbed of the Suha River (from downstream the confluence with Negrileasa River to the mouth).

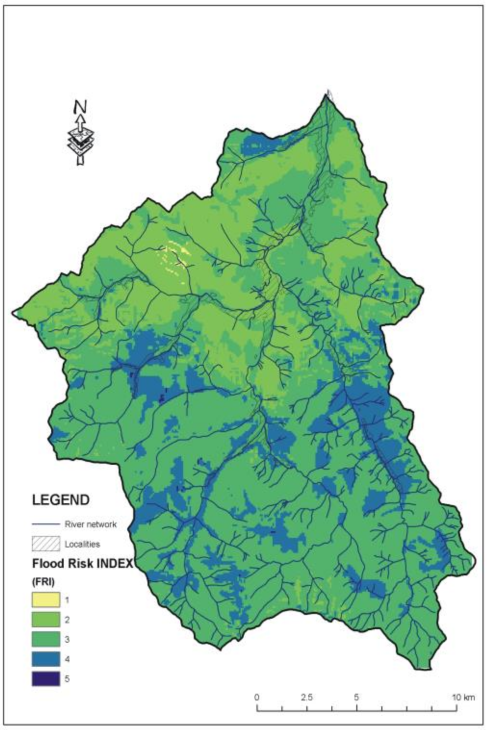

Figure 6. The estimation of the method of spatialization of the index flood producing potential

CONCLUSIONS

The method proposed by Smith (2003) allows the calculation of the index of flood potential production for the Suha River basin, using a spatial resolution of 80 m. After analyzing the spatialization of the index of flood potential production, we can observe that the maximum risk areas are extremely small and that the Suha River basin has a medium risk of floods production on 75% of its surface, respectively the entire southern half of the river basin and the tributary rivers along the Suha River up to the mouth. The main cause is the high degree of afforestation of Suha River basin, which to some extent reduces the impact/effect of the other factors (precipitation, high drain slope, impermeability of the soil texture) on the production of the flash floods.

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