FLOOD SUSCEPTIBILITY ASSESSMENT IN THE NIRAJ BASIN

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ABSTRACT – Flood susceptibility assessment in the Niraj basin.
In the context of global warming and the increasing frequency of extreme weather events, it becomes evident that we have to face natural hazards, such as floods. In the area of Niraj basin this phenomenon is specific both in the spring, because of the snow melting and of the precipitations which come along with the season, and then in the summer because of the torrential precipitations but rarely in autumn and winter. The aim of this paper is to determinate the susceptibility of the zone and obtain a map which will take into consideration the possibility of a flooding. Defining vulnerability can help us understand this type of natural disasters and find the best ways to reduce it. For this purpose we use thematic layers, morphological characteristics (slope and depth fragmentation), hydrological characteristics, geology, pedology (permeability and soil texture), landuse, precipitation data, and human interventions because in this way we have the possibility to use data mining for this purpose. Data mining will allow us to extract new information based on the existing sets of data.The final result will be a thematic map that highlights the areas which are exposed to the flood. Therefore, this map can be used as a support decision for local government or business purposes.

Keywords: floods, vulnerability, data mining, G.I.S., Niraj river

1. INTRODUCTION

Floods are a normal part of a river's cycle caused by high waters and flash floodswhich are specific to Romanian climate zone; because of the damages they induce, floodsrequire a closesupervision.

Thus, for the economic and water management activities it is important to take into account the qualitative and quantitative flow characteristics, their way of occurrence, and natural and anthropogenic factors which contribute to their appearance and evolution.

As we shown in a previous article (Roşca 2011), the Niraj River, despite continuous development works continues to represent a flood risk for the settlements nearby.

The aim of this paper is to determine the vulnerability of the area and obtain a map which will take into consideration the possibility of a flooding.

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The susceptibility shows us the occurrence potential of the process analyzed based on the conditionalfactorsexistingin thebasin. We can consider the susceptibility analysis as a spatial analysis of the hazard depending on the exposition degree of the territory at risks process.

2. CASE STUDY

The research focuses on the Niraj basin area (651 km2), located in the center of Romania, in the Mures basin. (Fig 1)

The succession of the altitudinal landforms: mountain relief (Gurghiu Mountain west slope) in the superior basin, high hill relief (TransylvanianSub Carpathians) in the middle basin and low hills (Niraj and Tarnava hills) towards the shedding zone. This area is the origin of the hydrographic basin slope increase which will determine a high increase of the flash floods;

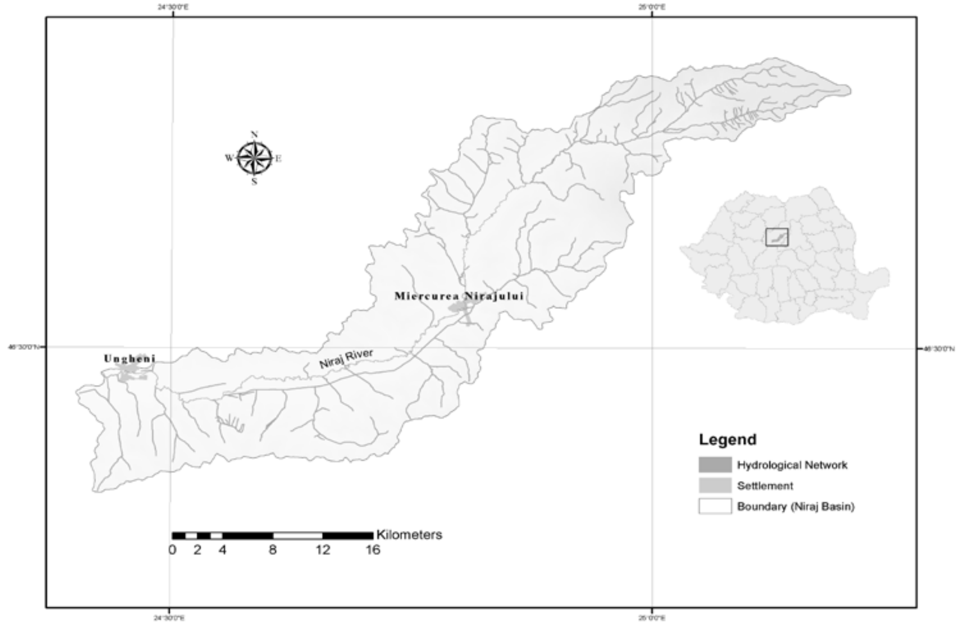

Fig. 1: Niraj Basin – Geographical position

The general slope of the relief is from NE to SW which channels the flow in the same direction.

The Niraj river receives an important quantity of water due to its mountain tributaries which characterize themselves by the higher precipitation quantity.

The hydrographic basin is situated in the way of atmospheric fronts, so the west mass air which determines high levels of precipitation on the west side of the Apuseni mountains, after it crosses the Transylvanian Depression, it causes the fall of huge quantities of water as the altitude grows, in the TransylvanianSub Carpathian area. (Tabel no.3)

This area has been an attractive demographic area since ancient times;

There is a high density of settlements (10 settlements/100km² higherthan7/100km^{2}which is the national average) 28 being located on the flood plain near the valley and so they are exposed to floods which demonstrates the necessity of this study. It should be way of raising awareness for the inhabitants towards the risks they face and also an evaluative way of the best protective measures against those phenomena.

3. METODOLOGY

We use a geoprocessing approaches to analyse and process the data, and for displaying and visual interpretation we chose a GIS environment, which is more suitable for our purpose. Therefore the ArcGIS software, which is provided it by the ESRI, had been used as a primary application.

Layer data used in this process(elevation, land use, geology, soil, rivers network, average amount of precipitation) were converted in raster format and reclassified according to susceptibility classes with values between 5 (for high susceptibility) and 1 (for low susceptibility) depending onspecific suitability. We converted the data into raster format in order to calculate the susceptibility value for each pixel. Using Spatial Analyst function, the data were gathered for each pixel. (Tabel 1)

The method was customize based on the input data and afferent observation. (Fig 2)

Slope (%)	20%
Soil Permeability	10%
Surface soil feature	7,5%
Depth soil texture	7,5%
Precipitations (mm/an)	20%
Geology	15%
Fragmentations Density	10%

Table 1.*The weight of the factor in the final result*

3.1 The relief

The relief influence is realizeddue to the altitude which determines the altitudinal ratios for climatic, vegetal and pedosphere factors. As the altitude gets higherit can be observed a ratio precipitation increase (300-600 mmyear) and also specific vegetation type, the superior Niraj basin having more forest than the inferior one.

The altitudinal offset which characterize the Niraj hydrographic basin is of 1219 m, from the Gurghiu mountain west slope which has an altitude of 1509 m to 290 towards confluence. These values had been extracted from a Digital Elevation Model (DEM) with 26 meters spatial resolution cell, provided by ASTER GDEM.

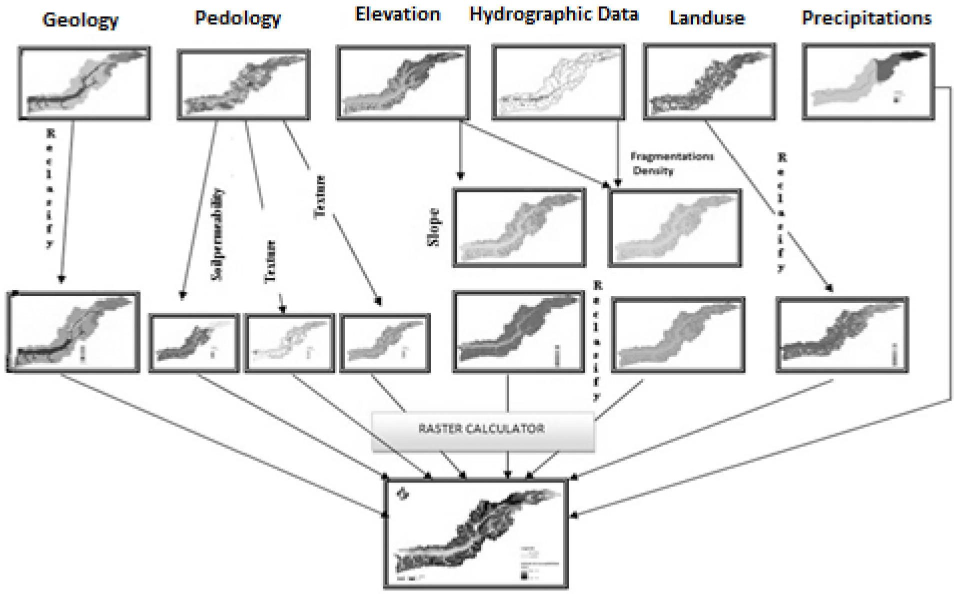

Fig. 2.*The raster modeling process*

The slope influence on the genesis and the flash-floods propagation waves is: as the relief slope gets higher, the drainage water speed is higher, the water concentration time is smaller and vice versa: as the slope is smaller, the drainage water speed is smaller, the concentration time will be higher and the maximum flow is directed by the infiltration and the evaporation processes, the risk towards flash floods being higher.

For the Niraj superior coursecharacterized by a higher slope(>45°), the drainage water speed is higher than in the inferior course.

For the river's inferior and middle course the drainage water speed decreases as the slope becomes smaller (2-5°). The flash floods duration will increase, but factors like minor river bed morphology and the geological structure represented by friable rocks might result in a certain degree of flash floods wave attenuation. For the Niraj inferior basin this can be seen in the major riverbed greater width, its morphology through higher negative concentration relief forms which leads to water retention.

3.2. Soil characteristics.

Soil is an important geographical factor which has a direct influence on the drainage process because of its characteristics like: texture, permeability degree and structure.

This is why we converted the initially obtained soil types from the soil map 1:20000 in raster format out of the need to obtain a new database derived with the help of ArcMap functions.

Looking at the Florea&colab (1987) studies, soil types according to permeability were classified in medium infiltration speed, profile texture and surface soil texture as shown in Table 2. If the soil texture has a large width the permeability degree is bigger which means that water infiltrates quicker than in the smooth texture soils.

In the great permeability areas it can be observed a delay in the appearance of the maximum flow as a result of great water volume loss; on the contrary, on the rocks which have a lower permeability degree, the maximum flow appears faster, situation encountered with the water saturated rocks too.

Table 2.*The susceptibility classes for relief slope and soil permeability (Florea, 1987)*

Susceptibility class	**Relief slope (degree)**	**Soil permeability according to:**		
		Medium infiltration speed	Surface soil texture	Profile texture
5 The highest susceptibility rate	0,1-2 °	<7	Clay-Loam	Clay-Loam
4 High susceptibility	2,1-5°	8-20	Loam-Clay	Loam-Clay
3 Medium susceptibility	5,1-15°	21-65	Loam	Loam
2 Low susceptibility	15,1-35°	66-120	Loam-Sandy	Loam-Sandy
1 Very small susceptibility	>35°	121-160 >160	Sandy-Clay	Sandy-Clay

3.3 Landuse

The antropic influence over the river basin is due to the landuse. To obtain layers with this parameter we used data from CorineLandcover 2000 project. Those layers were converted into raster format and divided into five susceptibilityranks.(Table no. 3)

The forest and rich vegetation coverage determines a delay in the maximum flow and in the rain-originated water consumption. It also has a major effect on soil erosion because of the drainage.

So, the smallest protection is represented by crops planted on a high susceptibility erosion field, their roots being small. The fields cultivated with herbaceous vegetation present a higher resistivity due to higher vegetation density. Some species have roots of over 1 m depth. (Dana Gotiu, 2008)

The forests offer the greatest degree of resistance to erosion by its deep roots (up to 8 m), by its canopy which absorbs water, but also by reducing flow at ground level. There are difficulties in determining the vegetation impact on the specific riverbed processes due to its annual changes in some agricultural land.

Susceptibility class	Land use	Rock hardness (Geology)	The average amount of precipitation (mm/year)
5 **The highest susceptibility rate**	Agricultural lands Deforested land	Gard rocks (Andezites, pyroxenes)	600
4 **High susceptibility**	Areas with complex crops	Compact Rocks (Vulcanogen sedimentations rocks)	500
3 **Medium susceptibility**	Pastures Urban and rural space Vineyard	Weak Compact Rocks (Coluvium, Sands, Clay)	300
2 **Low susceptibility**	Orchards	Deluvium, Proluvium, Clay, Loam, Tuff	
1 **Very lowsusceptibility**	Forests	Inconsolidate Rocks (fluvial deposits, sands, Pietrişurişinisipuri,leosoid deposits, debris)	

Table 3.*The susceptibility classes for landuse, geology and soil permeability (Florea, 1987)*

3.4 Geology

The geological (Romanian Geological Map, 1960) data have been reclassified according to the hardness class to which they belong: hard rocks have received a high susceptibility value; where as the hardness levels of the rocks decreases, the index get a lower value.

The hardness rocks degree was adopted according to the classification established by Bancila, in 1980. In the category of rock swith low susceptibility degree are neogene - originated colluvium and proluvium’s gravelandsand with a high spatio-temporal mobility degree found in the major riverbed and with a high permeability.

3.5 The average amount of precipitation

In the Niraj basin, the average amount of precipitation is between 400 mm/year for the inferior and medium basin, increasing to the north up to 500 mm/year in the Sub Carpathian area to reach 600 mm/year in the upper basin.

Of course that all those factors have an influence on the formation and propagation of flashflood waves, but their combination and percentage in the final result is crucial. In a certain way will evolve the flow when we have an intense rain on a low humidity soil and other will be the flow evolution when we have a downpour on a saturated soil because of earlier conditions.

4. THE RESULT

The resulting map identifies depending on the factors involved, the areas with the highest susceptibility: 3,4% (22km²), medium susceptibility: 21.1% (134 km^2) from the total area of the basin. Those areas are determined by the high precipitation quantity from the mountain area, by the river neighborhoodand by the increasing flow due to its tributaries.

The lowest susceptibility areas, of up to 18.4% (177 km^2) from the total area of 651 km^2 can be found in high altitude areas with a low permeability degree which favors the flow.

The most important thing is the identification of the settlements exposed to flashfloods among which we mention Vargata, Valea, Dumitresti, Ilieni and Gheorghe Doja which are entirely in the major riverbed.

Unfortunately people cannot change some of the factors that influence the flood vulnerability (slope, geology and soil permeability) but rates of deforestation and landuse or distance from the settlements and river can be made.

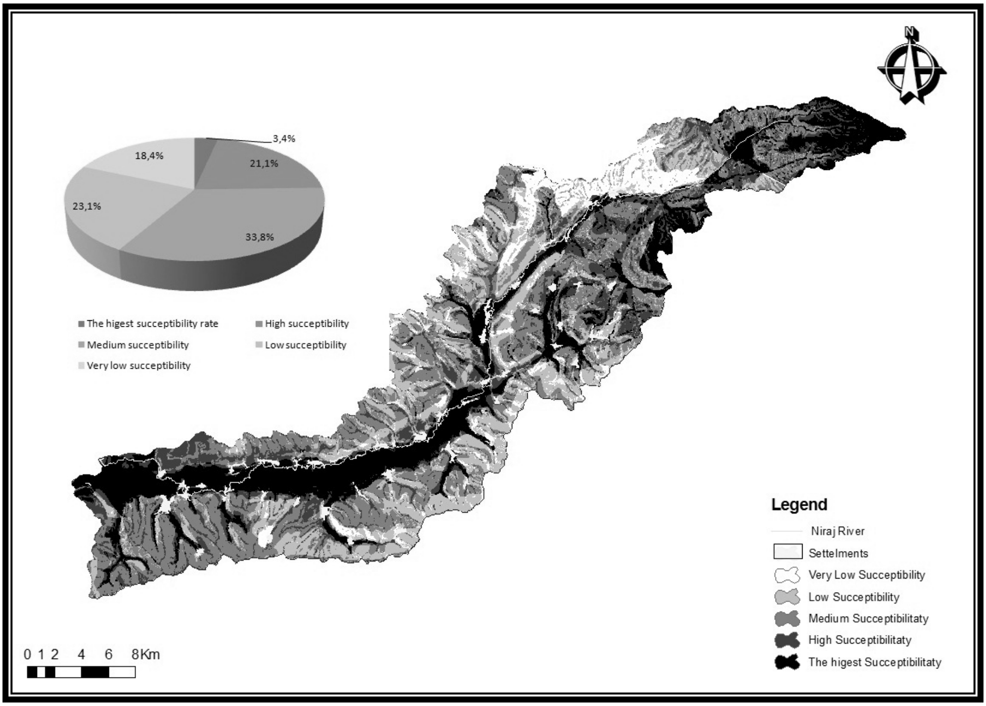

Fig. 3. ***The Susceptibility for floods in Niraj Basin***

Data mining with a spatial approach allow us to analyses and extract new information form the input data (layers) and moreover the results offer a good understanding of the phenomena.

The study approaches a systematic method for Niraj basin, which take into consideration the flood susceptibility. Based on integrated analysis of conditional factors and casual links/conditional of the factors involved this method it will need to be improved to obtain accurate results.

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