DEVELOPMENT OF DIGITAL ELEVATION MODEL FOR MODELLING AND SPATIAL ANALYSIS OF FLOODS IN THE PRUT HYDROGRAPHIC BASIN

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Abstracto. *La modelación y el análisis espacial de las inundaciones en el medio GIS solicitan una amplia y detallada información sobre las características morfológicas y morfometricas del alivio territorial estudiado. En este trabajo están presentadas las etapas de la creación del modelo digital de alivio de la cuenca hidrográfica Prut. En base de este modelo hemos generado una serie de indicios morfometricos y analizado la distribución espacial de estos indicios en aria de la cuenca.*

Key words*: GIS, Digital Elevation Model, Shuttle Radar Topography Mission, hydrographic basin.*

Abstract. *Modelarea şi analiza spaţială a inundaţiilor în mediul GIS solicită o informaţie amplă şi detaliată despre particularităţile morfologice şi morfometrice ale reliefului teritoriului studiat. În lucrare sunt prezentate etapele creării modelului digital al reliefului bazinului hidrografic Prut. În baza modelului au fost generaţi o serie de indici morfometrici şi analizată distribuţia spaţială a acestora în cadrul bazinului.*

Cuvinte cheie: *Sisteme Informaţionale Geografice, Modelul Numeric al Terenului, SRTM, bazin hidrografic.*

Introduction.

The Prut River originates in the Carpathian Mountains (Ukraine), Goverla peak, on the north-eastern slope of the ridge Cerna-Hora (2068 m). By form and geomorphological appearance, in the Prut basin three sectors are clearly identified: the upper flow, medium flow, and the lower flow. In the upper Prut river flow, the direction is from NW to SE and in the medium and lower direction is from N to S.

The Prut hydrographic basin expands over the territory of three countries: Ukraine, Republic of Moldova, and Romania. The total surface is of 27450 km^2: R. Moldova - 8250 km^2 (cca. 30 % from the total basin surface), Romania – 10900 km^2 (40 %), Ukraine – 8300 km^2 (30 %).

The main flow has a total length of 967 km. Respectively, in the Republic of Moldova the Prut river has a length of 695 km, and represents completely the natural border with Romania (or 72% from the total length), on the Ukrainian territory – 251 km (26%, the upper sector of the river), to which 21 km are added, which represent the natural border between Ukraine and Romania (2%).

For modeling and spatial analysis of floods in the Prut hydrographic basin, a first step would be to develop the numerical model for this area.

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DEM combines a complex of information technology, earth sciences and mathematics, known as terrain analysis or quantitative geomorphology.

Digital Elevation Model implies the approximation of a portion of the topographic surface using electronic means of calculation and an appropriate mathematical model based on the coordinates (Xi, Yi, Zi) points "known" on it so that the interpolation to obtain share Zj any point in the same area, defined by its coordinates planimetry (xj, yj), with a precision fit for the purposes envisaged and the available means (Craciunescu V. http://earth.unibuc.ro/analiza-mnat).

The implementation of DEM on a global or regional level, takes place through a series of projects, such as ETOPO5, ETOPO2, GTOPO30, GLOBVE, DTED0, SRTM. Satellites also can be used as bases for creating DEM, thus for this reason having made known our satellite images Aster.

In the present paper, DEM for the area of study were created based on the SRTM90 images.

Data sources. The SRTM90 data for creating DEM were downloaded from Global Land Cover Facility (http://www.landcover.org/index.shtml), currently available for free online. The original data have the resolution of approx. 30 m, but which are available only for the USA.

It is important to mention that SRTM was realized through usage of the "interferometry radar". Thus, a radar signal is transmitted, reflected by the Earth's surface, and captured in 2 points simultaneously. As a result, 2 radar images are captured. The differences between these two images allow the calculation of the altitude. The SRTM mission has used 2 antenas, one main and a secret antenna, fixed on a 60 m extension arm. The differences between images allow the calculation of the altitude of a dot. The SRTM mission has used 2 antennas – 1 main,

Methods and Analysis. With the goal of creating DEM, the SRTM images that fully cover the Prut hydrographic basin were downloaded from Global Land Cover Facility.

Thus, 5 images were downloaded. To join these pictures, we used the ERDAS 9.1 program, and mosaication is necessary to reach this goal.

The newly created mosaic (fig. 1) is the work base in the future. The only inconvenience is that some black dots or "no data" dots are observed. It could be that these appeared during the process of obtaining the data itself.

To remove the "no data" points, the ENVI 4.5 software was used, where the 'Replace Bad Values' function allows this to be done. Finally we obtained a DEM without "no data" values. But, due to the fact that the area of study does not fully occupy the obtained area, it is necessary to mark only the surface of the area of interest, or of the Prut hydrographic basin.

The strictly geographic delimitation is obvious, by following the water. Using the GIS technology, this is possible to realize with the ArcGIS 9.3 software. For this, the following steps were taken (Jigmond M., 2007): "waving" the surface, determining the direction of the water flow, possible accumulations, transformation of the layer from vector format in raster format, and finally setting the closing point. The point chosen is positioned at the confluence of the Prut river with the Danube river, which represents the closing point of the basin.

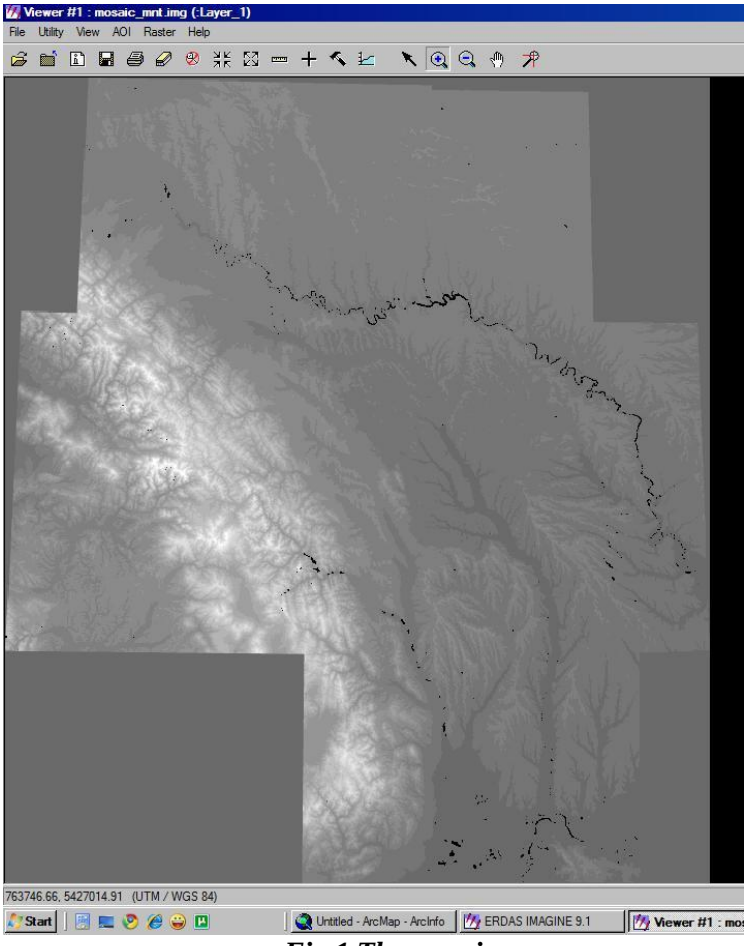

Fig.1 The mosaic.

In fact, DEM is a very useful base in the spatial analysis of hydrological processes. This enables the automatic extraction and classification of the river system, automatic delineation of hydrographic basins and calculation of associated

indices (ex: the sediment transport capacity, potential water infiltration, etc.). But in the process of flood modeling and spatial analysis is important first to analyze the morphometric indices which may explain some subsequent hydrological processes. Morphometric indices developed are: hypsometric, slope, slopes exposure.

By creating a buffer zone of 3 000 m, we obtained the limits of the Prut hydrographic basin, created based on the DEM.

Results and Discussion.

DEM obtained under SRTM90 was used successfully as the basis for representation morphometric indices, such as hypsometric, slope, slopes exposure.

Hypsometric map (fig. 2) of the area studied was classified in altitude steps of 50 m to 50 m, which allows us to see clearly that the subject of the study has the following features: the upper course of the Prut River prevailing altitudes above 1000 m, which gradually descends, along the river valley reaching up to 100 m

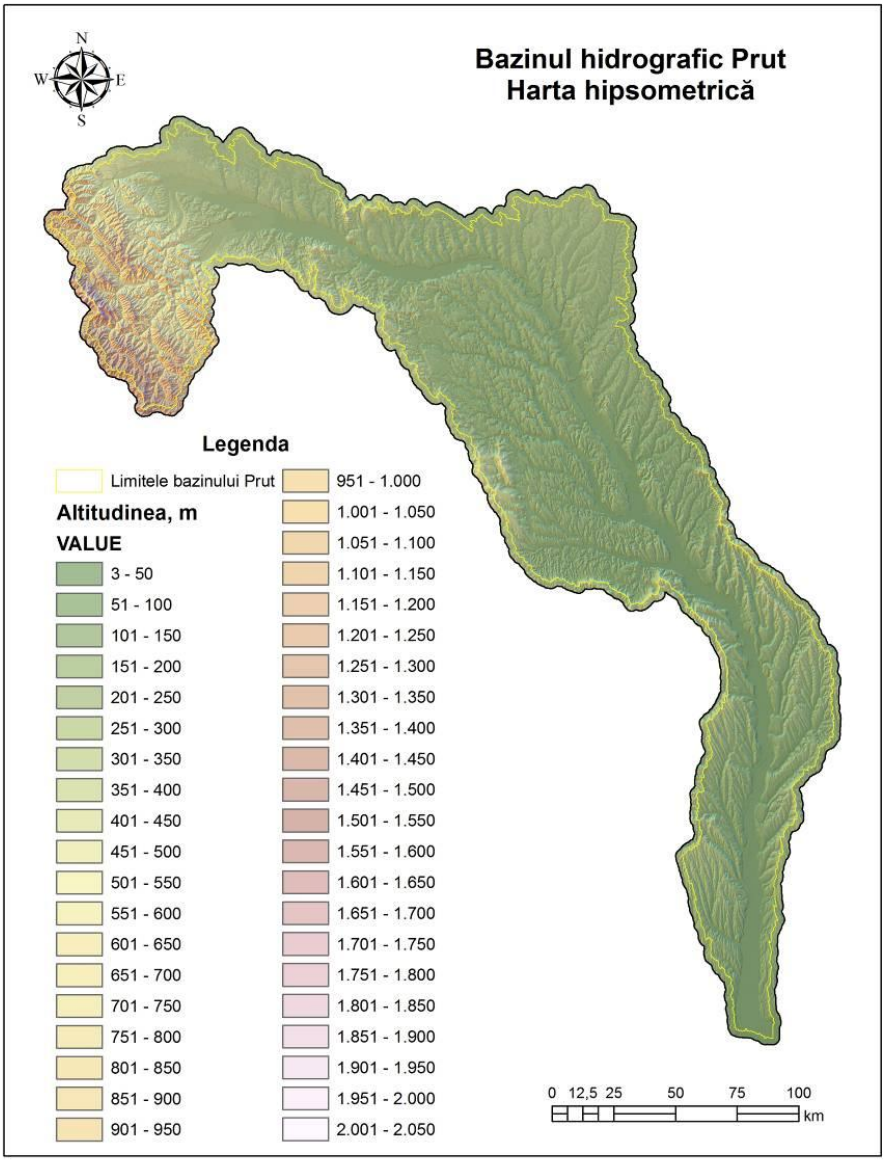

Fig. 2. Hypsometric map

Slope is one of the most important morphometric parameters of an area, which through the allocation and the way of combination on the terrain, highlights

the major steps of relief. Also of particular interest for hydrological processes in determining the direction and intensity of water leakage, accumulation or deposit of eroded material

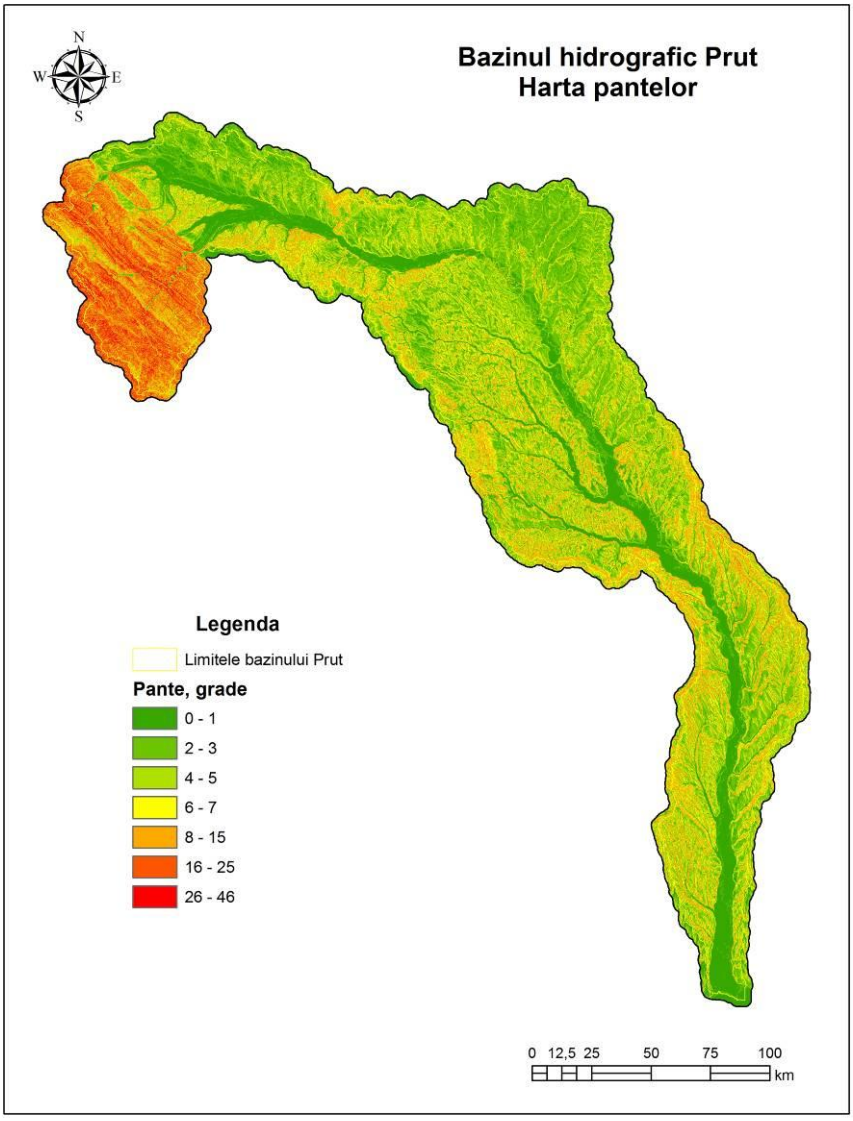

Fig. 3. Slope gradient map

To calculate the slope by classical methods (based on topographic maps and plans), it takes time and often the final results have a low accuracy. DEM use as a basis for calculating slope leads to superior results in a relatively short time.

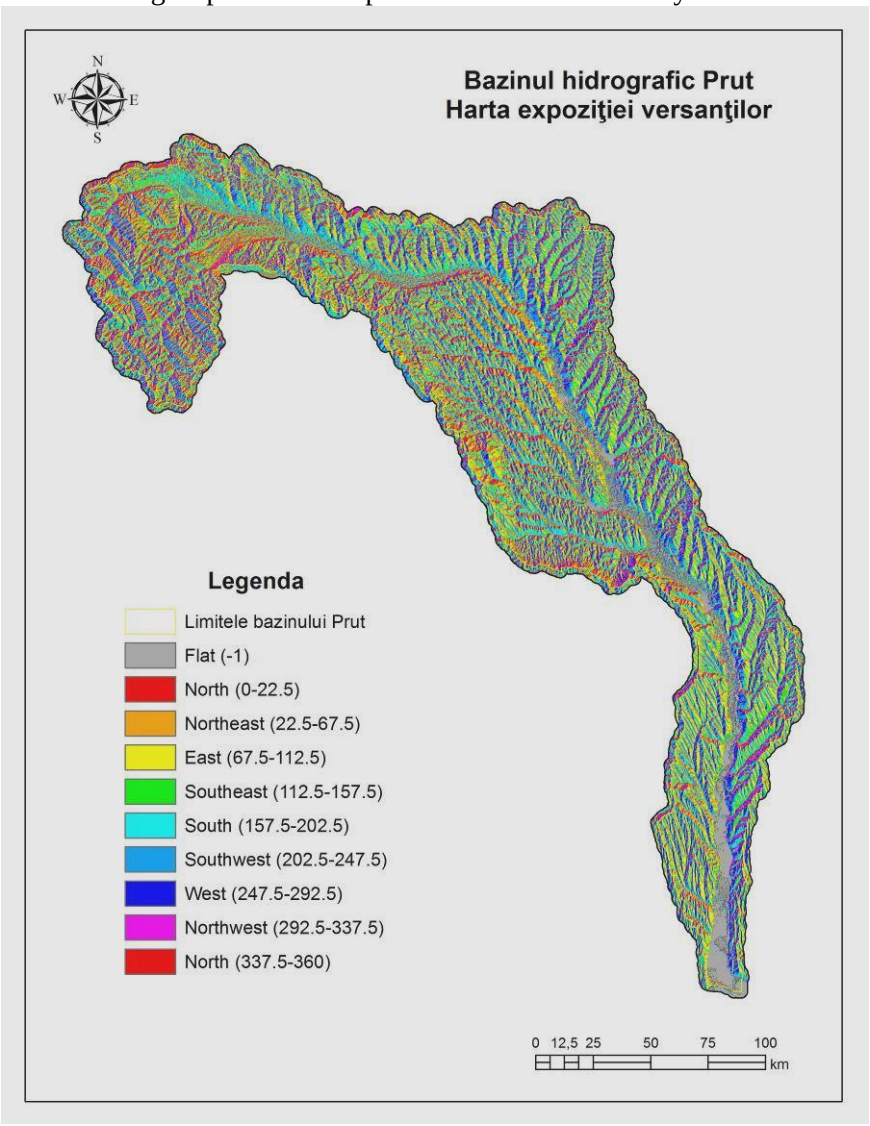

Fig. 4. Aspect-slope map

Geometrically speaking, the slope is the angle described by the tangential horizontal plane and the surface at the same point. The slope measured in degrees (0^0-90^0) or percentages. In the process of calculating the slope on the digital map is taken into account altitude values of the cells neighboring that point.

Analyzing the slopes map (fig. 3), we can see that in the Prut river basin the maximum value of the slope is of 46^0, in the upper basin due to the presence of a mountain landscape. However, slopes with values up to 3^0 occupy large areas, mainly along the valleys of the main course and its tributaries.

In general, however, it is observed that the left side of the Prut River is slower than the right, which is clearly expressed in the middle. While on the right side the prevailing values range between 8^0 and 15^0, on the left side values up to 3^0. Toward south, basin surface narrows and the slope reach maximum values of 15^0, but decreases gradually towards the river meadow. The main factor that determines the specific area is the hilly topography (Middle Cogilnic Plateau forest steppe, the middle hills of the steppe Tigheci).

Exhibit slopes, as morphometric index, was achieved in the DEM (fig. 4), which allows easy and accurate calculation of the index.

Conclusion

In this paper the initial goal of creating the DEM on the basis of SRTM90 was achieved and was also used as a basis for obtaining indices. For modeling and spatial analysis of flood risk, development of DEM is a first step in this direction.

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