GIS DATABASE ON SOIL EROSION BASED ON DIGITAL PHOTOGRAMMETRY

OBȚINEREA BAZELOR DE DATE SIG PRIVIND EROZIUNEA SOLULUI PRIN MIJLOACE ALE FOTOGRAMMETRIEI DIGITALE

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Abstract. *Irresponsible use of soils in agriculture may cause the start soil damaging processes. Among the forms of soil damage, erosion has concentrated most of researchers' efforts for mapping. The erosion forms have to be located and studied, in order to apply the most adequate technologies for ecological rehabilitation. The objective of the study is to develop a mapping technique for erosion forms, within the specific conditions of Suceava Plateau. The target area of the study was identified based on the analysis of orthorectified and georeferenced digital images. These aerial images represent the material used for identifying and characterizing the erosion forms present within the target area. The instrument for the actual delineation of erosion formations is the photointerpretation key, obtained by comparing ground data to corresponding images. The final result of the study is represented by a GIS database containing necessary information for ecological rehabilitation of affected areas.*
Key words: *land degradation, Suceava Plateau, GIS Database*

Rezumat. *Utilizarea nerațională a resurselor de sol în agricultură poate cauza inițierea procesului de degradare a solului. Dintre formele de degradare, eroziunea a concentrate în cea mai mare măsură eforturile de identificare şi cartare. Pentru a propune cele mai bune soluții de reabilitare ecologică, formele erozionale trebuie să fie localizate şi analizate. Obiectivul studiului este dezvoltarea unei tehnologii de cartare a formelor de eroziune în condițiile specific din Podişul Sucevei. Zona de studiu a fost identificată în baza analizei imaginilor digitale ortorectificate şi georeferențiate. Aceste imagini aeriene reprezintă practice materialul utilizat pentru identificarea şi caracterizarea formelor de eroziune prezente în zona de studiu. Instrumentul folosit pentru delimitare este reprezentat de cheile de fotointerpretare interactivă, obținute prin compararea situațiilor din teren cu imaginile corespondente. Rezultatul final este reprezentat de o bază de date SIG care conține informații necesare reabilitării ecologice a zonelor afectate.*
Cuvinte cheie: *degradarea terenurilor, Podisul Sucevei, baza de date GIS*

INTRODUCTION

The rational use of soil is one of the important requirements of the sustainable management of the renewable resources, because of its role as a main nutrient source within the substances circuit in nature. The unreasonable usage of these resources may lead to the occurrence of the soil's degradation forms, which

influence both the productivity of those terrains and the hydrologic and gravitational equilibrium of the zones in which they produce.

From the soils degradation processes, *the erosion* has concentrated the most part of the researchers efforts to develop some specific study methods, that should lead to ecological reconstruction technologies adapted to the conditions specific to the areas in where these phenomena take place (Băloiu, 1967, Rusu et al., 1981, Boş et al., 1986, Untaru et al., 1981, Perlado, 1998, Maftei, 2007).

The objective of the study is to substantiate a method for creating a georeferenced database into the specific GIS format regarding the land degradation by sheet and gully erosion, in Suceava Plateau work conditions.

MATERIAL AND METHOD

The researches comprised the largest part of the Suceava Plateau, namely the part that lies between Romania's North border, Suceava and Moldova rivers and Obcinele Bucovinei (fig. 1).

The *used materials* are the *digital orthophotos* taken in 2004 – 2005 within the LPIS programme (Land Parcel Identification System), *topographic plans (*1:5000 scale), *geological and pedologic maps* (1:200.000 scale) (fig. 2). All the imagistic materials have been acquired in digital format, or brought to this format by scanning and georeferencing in Stereo 70. There have also been used the GPS *Garmin GPSMAP 76CSx* and *Topcon GMS 2* receivers. The software platforms used were *ArcGIS 9.3* and *ERDAS Imagine 2009*.

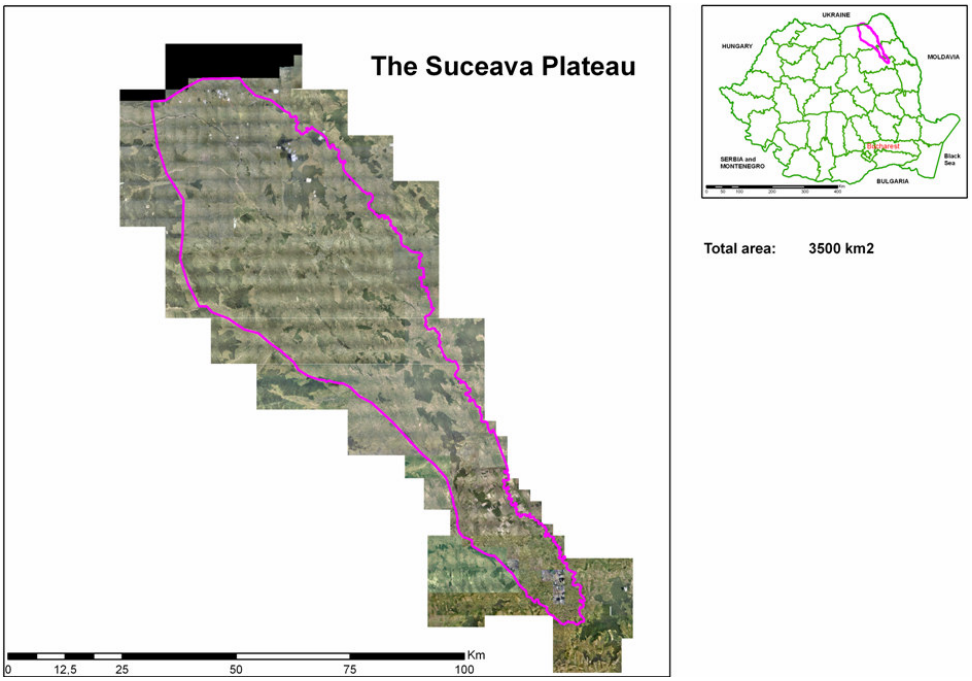

Fig. 1 – Researches location (Suceava Plateau)

Research method. The main research methods are *observation and the comparation.* Basically, the substantiation of the mapping method consisted in comparing the field observations with the corresponding image fragments. The correspondence was done by means of the GPS points taken in the field in the points in which the observations regarding the land degradation phenomena were done (fig. 2.b). The intermediary result obtained is represented by both the erosion forms (gullies, ravines, surface erosion) *interactive photointerpretation keys* and the elementary units from the complex degradation forms.

The actual *mapping* of the degradation forms and of the elementary units (the ones which are expected to take the same ecological reconstructions measures) was done within some representative target areas, which totals 10 % of the surface of the study area. The mapping was checked by analyzing the disparity, in other areas then the ones used in making the photointerpretation keys. The mapping model was extended at the level of the whole study area, and the vectorial files resulted were overlapped on the pedologic and geological maps of the study area. The way of the vectorial information integration is represented by the geodatabase format, characaterisitc to the 9.2 and 9.3 *ArcGIS* versions.

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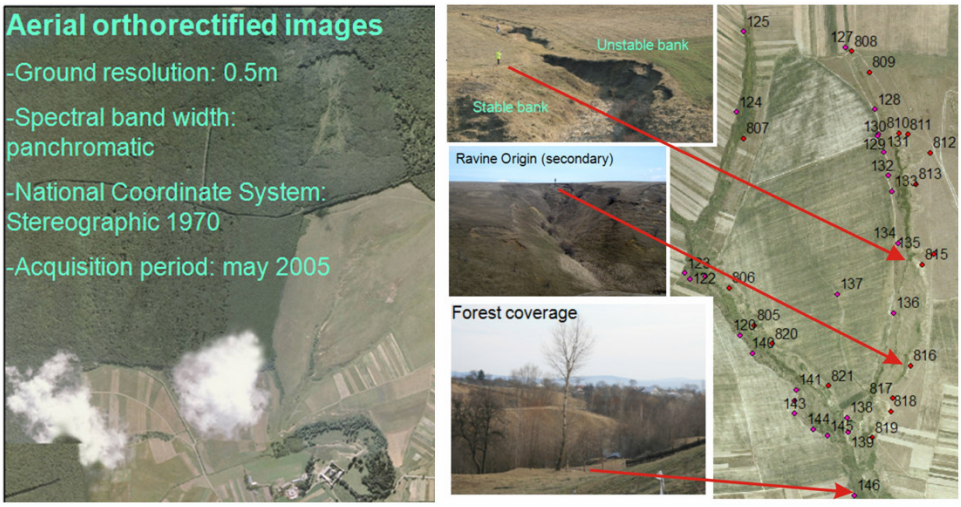

a. b.

Fig. 2 – a. Digital orthophotos used in mapping the soil erosion; b. the correspondence between the field descriptions and the characteristic image fragments

RESULTS

The results from the mapping and spatial data integration implementation are represented by national coordinate system georeferenced database, which contain many important information for the ecological reconstruction process of the areas affected by sever forms of surface and depth erosion.

A mapping example of the elementary units is the one of Salcea–Plopeni area ravines, which are extended on many kilometres and show tendencies of lateral and at the origins area evolution (fig. 3).

The proportions between the elementary units which are found within the study area have been determined depending on the aria of each polygon resulted by vectorization:

- confluence – 11
- forest vegetation areas – 9
- origins – 16
- relatively stable shores – 22
- unstable shores – 32
- thalweg – 4
- surface erosion (e_3-e_4) - 6

The mapping precision analysis reveals insignificant differences between the outline points terrestrial determined (by GPS) and by photointerpretation on aerial images based on the photointerpretation keys. The maximum of these errors is ±1.2 m, due to the orthophotos georeferencing and orthorectifying errors and to the evolution of the phenomena after the image taking. The erosional phenomena evolution errors appear in the areas which are vulnerable to these phenomena, mainly in the origin and unstable shores areas.

The integration of the spatial data which came from the other cartographic resources has been done with a high precision, after the projection systems harmonization, projections which are attached to each raster file used, by ArcGIS transcalcultation. The organizatory structure of the SIG database allows the complex spatial information extraction by intersecting the thematic layers and processing that data.

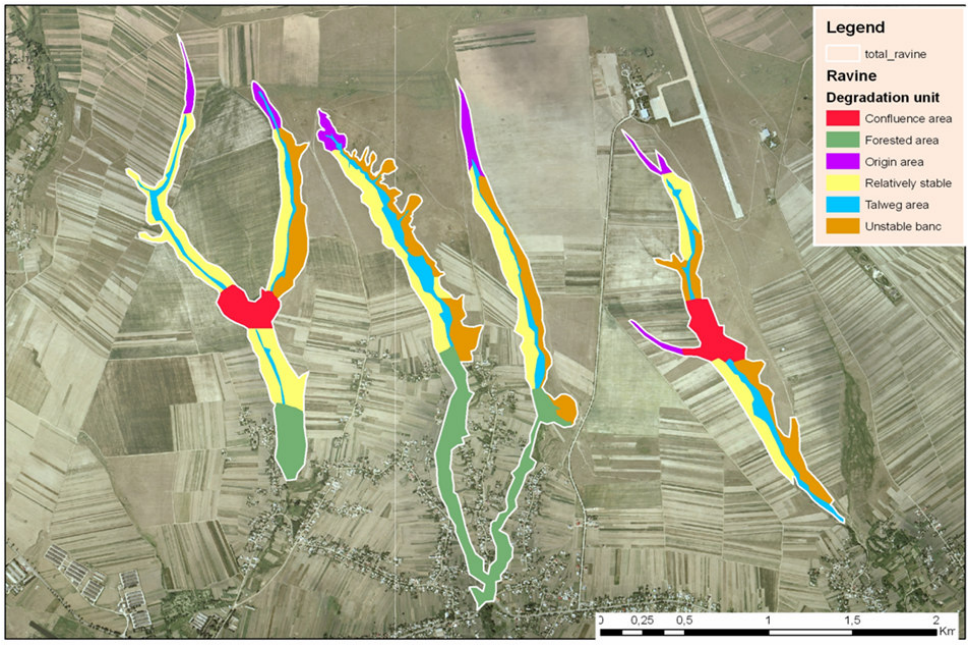

Fig. 3 – Plopeni – Salcea ravine mapping example

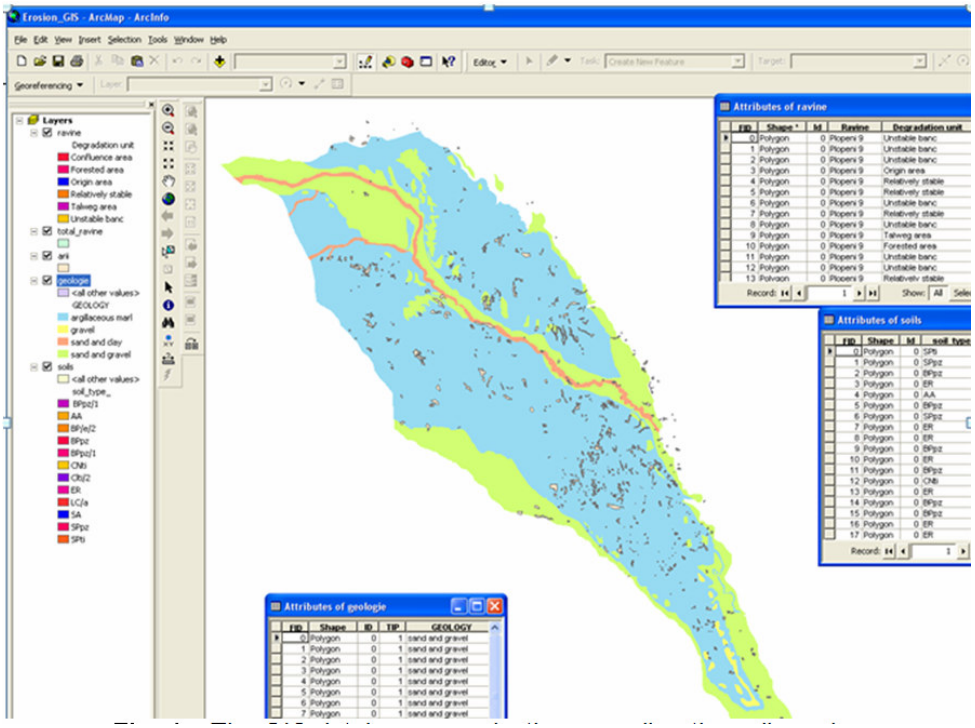

Fig. 4 – The GIS database organization regarding the soil erosion

DISCUSSIONS

The analysis of the mapping and inventory model highlights the positive aspects of this approach: the used materials (high resolution aerial images, efficient soil control equipments) assures a high identification and mapping precision of the land degradation forms, the acquiring period of the aerial images (2004-2005) assuring an up to date inventory of the soil erosion.

The aerial orthophotos usage in (LPIS programme) parcel identification assures a national coverage with such images, which can have additional usages. In this respect, the presented researches may stand for a possible beginning of a national inventory of the land degradation forms.

A possible shortcoming of the method is the forest covered terrains exclusion from the mapping activity because of the lack of visualisation under the tree canopy coverage. On the other hand, it is known that the vegetation has a protective role for the soil against erosion, fact which causes a low probability of high, dangerous intensity erosion in a forest fund.

Regarding the surface erosion in early stages, the lack of sensitivity of the aerial images from the visible channel might be compensated by acquiring multispectral satellite images, which can be used in the automatic classification depending the soil erosion degrees, according to the prior researches (Iacobescu et al. 2006).

CONCLUSIONS

1. The use of the digital aerial images photointerpretation in mapping the soil erosion presents a satisfactory precision and efficiency in widely analysing the phenomena scale.

2. The method allows the separation of elementary soil erosion units, which claim different ecological reconstruction measures.

3. The results should be analyzed cautiously because of the low sensitivity of the images in early stages surface erosion.

4. A SIG database of the soil erosion in which geology, topographic, pedologic and cadastral information are integrated too, can give the most of the needed information in projecting the ecological reconstruction of the lands degraded by this phenomena.

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