ANALYSIS OF LAND USE CHANGES AND THEIR INFLUENCE ON SOIL FEATURES. CASE STUDY: SECAȘ VILLAGE, TIMIȘ COUNTY (ROMANIA)

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Abstract. The soil, regarded as a natural resource, but also as a determinant element of the living standards of rural communities, mainly agricultural, may be influenced, directly and indirectly, by the modality of land organizing and use. Starting from this consideration, through this study, the spatial and temporal evolution of land use is being pursued, particularly that of forest areas and wooded grasslands. The goal is to notice the changes that have occurred over a 30-year period and the manner how these changes are reflected on the soil features. The researches presented in this paper have been taking place in the north-eastern hilly area of Timiș County, that area having entirely a rural character. For realizing this study satellite images, topographical and cadastral maps, from different time periods, national and international databases, data from specialty literature were used. To all these we should add direct observations in the field, topographic surveys and information collected from local authorities. The processing of cartographic materials and data and scientific information has been realized with Geographical Information Systems specific applications. The obtained result has been expressed in the form of thematic maps, in graphic form or as statistical analysis. At the level of the analyzed area, the obvious changes in the land use, registered over time, are caused by a number of factors, such as: the organization form, from communist to capitalist policies, leaving agricultural land as fallow ground, reduction in livestock, changing land use etc. All these changes have caused the extension of the wooded grasslands, reduction of arable land, installing inferior forest vegetation in qualitative and quantitative terms etc. As a result, the soil, one of the most important natural resources, is degraded qualitatively, underexploited, and on the other hand, its role as a direct and indirect food producer for local communities is significantly reduced.

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1. Introduction

The soil, considered as „*the heart of terrestrial ecosystems*” (Brady and Weil, 2008), regarded as a natural resource, but also as a determinant element of the living standards of rural communities, mainly agricultural, may be influenced, directly and indirectly, by the modality of land organizing and land use.

The Geographical Information Systems (GIS), by various techniques, approaches and methods, are used with ever more advanced results within mapping, representation and analysis of soils, both in international (Ramakrishnan and Guruswamy, 2009; Forkuo *et al.*, 2011; Shit *et al.*, 2016) and domestic research (Anghel and Todică, 2008; Ionuș *et al.*, 2013; Pașca and Năsui, 2016). In the same time, GIS methods and techniques are also used in pedological researches, with various topics: yield and production estimates (Li, 2001; Yu *et al.*, 2010; Siegmund *et al.*, 2016), establishing the grazing season (Dogan and Bozkurt, 2017), invasion of non-specific vegetation and trees in the meadows (Mast *et al.*, 1997), conservation of biodiversity (Isufi *et al.*, 2018; Cojocariu *et al.*, 2019).

On the other hand, under current technical conditions, monitoring the changes on land use and its organization, with global implications for the entire territorial system, may be done by remote sensing methods and techniques. This means „remote” data acquisition, data processing and obtaining results in a short time, but the most important, the possibility of comparing satellite images from different time periods.

Considering its practical applicability, the analysis of land use changes by remote sensing and GIS techniques and methods is used in pedological and pedological research, with remarkable results (Wang *et al.*, 2003; He *et al.*, 2005; Fu *et al.*, 2007; Wang *et al.*, 2011).

The way of land use and/or the human interventions may generate changes in soil's features, both in the "positive" sense, by raising the fertility rate, but also in the "negative" sense, by various degradation forms, physical, chemical or mechanical. Because the soil is a component part of ecosystems or geosystems, it is affected, in time and space, by a number of quantitative and qualitative changes. Therefore, through this study, the spatial and temporal evolution of land use is being pursued, particularly that of forest areas and wooded grasslands. The goal is to notice the changes that have occurred over a 30-year period (between 1986 and 2016) and the manner how these changes are reflected on the soil features.

2. Materials and methods

2.1. Materials. The materials used for this study are schematically presented in figure 1.

- Landsat 4 and Landsat 8 satellite images for A.T.U Secaş – at 186, row 28
(<https://earthexplorer.usgs.gov/>)

- Cadastral data

(Archives of the Office for Cadastre and Real Estate
Advertising Timiș; Secaş Hall Archives)

- Pedological data for A.T.U Secaş – year of study 2012

(Archives of the Office for Pedological and Agrochemical Studies Timișoara)

Other data sources – national databases (www.geo-spatial.org) and international databases (www.eea.europa.eu), data from specialty literature, field observation and information from local authorities.

Fig. 1. Materials used for realizing the study

2.2. Methods. The processing of cartographic materials and data and scientific information has been realized with Geographical Information Systems specific applications, the softwares ArcGIS 10 and IDRISI Saleva. The obtained result has been expressed in the form of thematic maps, in graphic form or as statistical analysis. Three stages were carried out in the applied methodology (Tab. 1).

Table 1. The stages carried out in the study methodology

1. Data collection	1.1 <i>office stage</i> 1.2 <i>on the field</i>
2. Data processing	2.1 <i>satellite image processing</i> 2.2 <i>cadastral data processing</i> 2.3 <i>pedological data processing</i>
3. Obtaining and interpreting the results	3.1 <i>Normalized Difference Vegetation Index (NDVI) calculating</i> 3.2 <i>soils types identification</i> 3.3 <i>changes analysis</i> 3.4 <i>determining the affected areas</i>

2.3. Study area

The study area, namely the administrative-territorial unit (ATU) Secaș, is located in the north-eastern hilly area of Timiș County (Fig. 2), that area having entirely a rural character.

Fig. 2. ATU Secaș – location and elevation features
(processed after data from

<https://earthexplorer.usgs.gov/> and www.eea.europa.eu/data-and-maps/data/eu-dem)

3. Results and discussions

The total surface of the researched area is 5,767 ha, of which 86.79% comes from agricultural land (30.34% arable land, 43.22% grasslands and 10.28% hayfields), and the forest covers 10.53% from the entire space (Tab. 2). The researched area is overlapped over low hills, the altitude being comprised between 122.97 and 284.32 m, according to the digital elevation model (DEM) at 25 meters spatial resolution (Fig. 2).

Soil data, obtained from the Office for Pedological and Agrochemical Studies Timișoara, synthesized in table 2, have been processed in previous studies with specialized software (Cojocariu *et al.*, 2016), thus the spatial representation of the soil units being possible. According to the pedological data from the Office for Pedological and Agrochemical Studies Timișoara, the soils identified on the administrative-territorial unit Secaș have been adapted according to the newest Romanian Soil Taxonomy System-SRTS 2012 (Florea and Munteanu, 2012). Thus, the soils from the study area belong to seven classes and nine types, the largest share being covered by luvisols (approximately 56%), in line with environmental characteristics.

Table 2. Territorial distribution and share of soils in ATU Secaș
(processed after data from the Archives of the Office for Pedological and Agrochemical Studies Timișoara; Rogobete and Țărău, 1997; Cojocariu *et al.*, 2016).

Soil class	Soil type	Surface	
		ha	%
Protisols	Aluviosol	11.63	0.23
Cernisols	Phaeozem	26.07	0.52
Cambisols	Eutricambosol	337.10	6.74
Luvisols	Preluvosol	1596.34	31.88
	Luvosol	1197.52	23.92
Vertisols	Vertosol	412.32	8.24
Hydrisols	Gleysol	389.02	7.77
	Stagnosol	19.94	0.40
Anthrisols	Anthrosol	1016.05	20.30
Forest areas		607	10.52

Landsat satellite images used in this study (<https://earthexplorer.usgs.gov/>), processed with specialized software (Idrisi, ArcGIS, Erdas), have provided a number of very important information.

Two images purchased at different times were selected (1986 and 2016) to observe the changes that have taken place over this 30-year period. Based on these images, the Normalized Difference Vegetation Index (NDVI) has been calculated

(<http://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and-images/ndvi-function.htm>), with the formula: $NDI = NIR - R / NIR + R$, where: NIR = near infrared; R = red (Gandhi *et al.*, 2015). This index provides differences in the structure of the vegetal cover during the analyzed period (Fig. 3).

The distribution of the NDVI values in the two analyzed moments it is different. This means that there have been changes in the environmental factors reflected also on the soil cover. Based on this consideration, the study was continued with the computerized statistical analysis of the changes (Eastman, 2012 a; Eastman, 2012 b; Popescu *et al.*, 2015) in order to quantify them and to identify the affected areas.

The decrease of the two images (Fig. 4) highlights and validates the changes occurred in the way of the land use over the course of 30 years.

Fig. 3. NDVI values for ATU Secaș and the analysis of the changes
(processed after <https://earthexplorer.usgs.gov/> and
<http://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and-images/ndvi-function.htm>)

The scientific data and information presented above certify that some changes occurred in the structure of the vegetal layer, with direct and indirect effects on soils, but the modifications in the land use are analyzed based on topo-cadastral data. In this way, the maps and the cadastral plans of the 1980s have been compared with recent cadastral data (maps, plans, topographic elevations etc.). So, the spatial analysis shows that:

Fig. 4. Transpose of the changes into areas or soil types

- „positive” changes have as cause the abandonment of the arable land and the reduction of the worked surfaces from the localities; therefore, in this way, the grassy areas and those with bush vegetation, considered „wooded grassland” were

being extended. To these changes contributed also the fact that the rural population of the area is aged and in a continuous process of emigration;

- „negative” changes, manifested especially in the case of forest areas, have as cause the deforestation, on the one hand, and the changing of species composition, on the other hand, which led to a lower vegetation index at the end of the analyzed period.

4. Conclusions

At the level of the studied area, the obvious changes in land use, registered over time, are caused by a number of factors, such as: land organization form, from communist to capitalist politics, leaving agricultural land as fallow ground, reduction in livestock, changing land use etc. The most pronounced changes, indicated by vegetation indices, are noted for arable land, independent of cadastral changes. The „negative” changes, meaning the diminution of the vegetation consistency, have been mainly identified in the case of forests.

The „positive” changes, meaning the higher NDVI values, can be noticed especially for luvosols and preluvosols, the arable land becoming secondary grassland as a result of not working them or because the changing the land use mode. In this situation, the soils from these areas are agricultural underexploited and, in some cases, still subjected to improper processes and phenomena such as soil erosion and landslides.

The „negative” changes, the case when the NDVI values are lower at the end of the analyzed range than at the beginning of the interval, can be observed in the forest areas, especially at their skirt, a large part of the agricultural land being afforested (shrub vegetation), but also due to extensive deforestation.

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