MONITORING OF GRASSLAND HILLS FROM EASTERN TIMIS COUNTY ON HIGH SPATIAL RESOLUTION AERIAL IMAGERY

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Abstract. *The scientific researches consulted in the specialized literature, as well as their own observations, in the field, support the hypothesis that, irrespective of their mode of use, agricultural lands can be regarded as components of the constantly changing environment, both through the action of natural factors and processes (afforestation, erosion processes, etc), as well as as a result of changing the evolutionary tendency through anthropic intervention (changes in the category of use or the way of use, deforestation, abandonment or "recovery" of some agricultural or non-agricultural land areas). In this context, this study was developed to capture the spatial-temporal changes produced in the case of grasslands, based on high spatial resolution images, using GIS (Geographic Information Systems) techniques and geospatial data (satellite or aerial images), the analysis being done between 2006 and 2018. At the same time, the aim is to test a research methodology that meets the main objectives of the study. Data collection was done in the GIS environment, by vectoring the differences occurring in time and space. The grassland surface was shaped in 2006 and in 2018, and subsequently, through multilayer spatial analysis, the two vector entities were "cut" to capture the differences between them. High spatial resolution aerial images (orthophotoplanes) were used, thus making it possible to perform a detailed analysis, with high precision and accuracy. One of the major advantages of this procedure is that "past" aerial images can be used so that the comparison with the present situation is possible. Following the spatial analyzes, it was found that the grassland considered a case study has "lost" within 12 years, an area of 17.55 ha as a result of the extension of the forest areas. This aspect indicates under-exploitation, lack of proper management, against the background of negative demographic indicators. Through the proposed research methodology, the main objective proposed was reached, this working procedure being applicable in any area and generates both statistical, non-graphical data and thematic maps useful for visualizing, understanding and interpreting the results.*

Keywords: *grasslands, change, GIS, aerial images.*

INTRODUCTION

Grasslands, viewed as dynamic, open systems, are components of the geographic environment "mobile" in time and space, under the influence of natural and / or anthropic factors, the changes being produced both in terms of their surface (the cadastral and the useful), as well as from the aspect of species participation or "location" of plant formations.

From the point of view of the multidisciplinary researches, the changes produced in the surface and the structure of the grasslands, can be analyzed from different perspectives, considering the complexity of the pastoral environment and the interdependence relations with the other components of the geographical and socio-economic space.

Numerous scientific papers investigating the impact of climate change on grasslands can be consulted in the specialized literature (YU, ET AL, 20012; GRIME, ET AL, 2000; O'MARA, 2012; KOVÁCS-LÁNG, ET AL, 2000; FANA, ET AL, 2009) or changes produced under the influence of land use (WRIGHT, WIMBERLY, 2013; ERIKSSON, ET AL, 2002; BLÜTHGEN, ET AL, 2012).

It is remarkable, however, that the use of geomatics methods and means in pratology (Geographic Information Systems and remote sensing) allows the analysis of pastoral environment changes in an "automated" way, with high accuracy and precision, a concept

supported and demonstrated through numerous scientific researches, with theoretical and practical applicability, internationally but also in Romania (TARANTINO, ET AL, 2016; SHALABY, TATEISHI, 2007; COJOCARIU, ET AL, 2018; COPĂCEAN, ET AL, 2019).

Starting from the premise that the pastoral environment is dynamic in time and space, the purpose of the research is to capture the spatial-temporal changes produced in the case of grasslands, based on high spatial resolution images, using GIS techniques and geospatial data. At the same time, the aim is to test a research methodology that meets the requirements of the study.

MATERIALS AND METHODS

The working methodology is presented, step by step, in Figure 1.

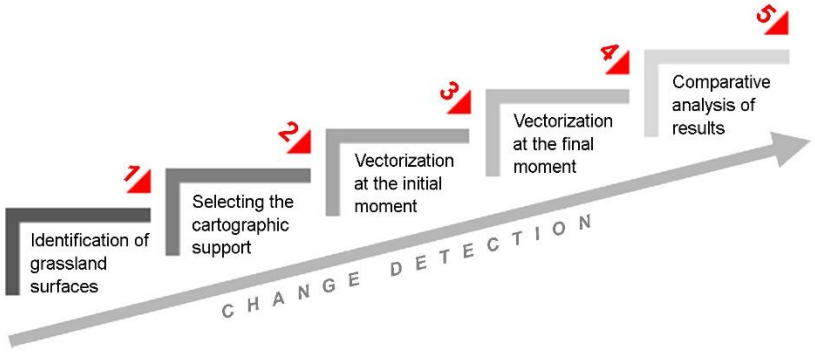


Figure 1 Working methodology

Considering that each stage of the working methodology materializes as a result, it will be described in detail in the section "Results and discussions".

The materials and software used are schematically described in Table 1.

Table 1

Materials and software used

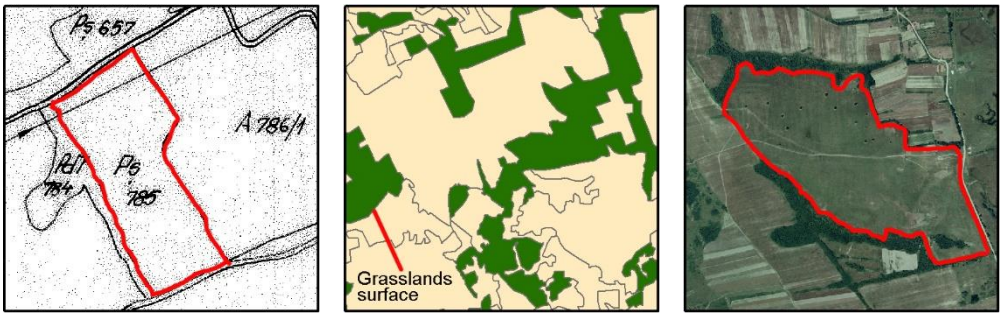
Materials	Cadastral maps (scale 1: 10,000)	Software	ArcGIS	ArcGIS Desktop 10.6.1 – geospatial data processing
	Corine Land Cover database, 2018 edition		Ps	Adobe Photoshop – image processing
	Orotrophotoplanes or		X	Microsoft Excel – graphic data processing
	Aerial images taken with UAV equipment		W	Microsoft Word – for writing the paper

RESULTS AND DISCUSSIONS

Identification of grassland surfaces

The identification and location of meadow surfaces can be done by several methods, depending on the need, the requirements regarding the accuracy of the data, the analyzed period, etc. (DIXON, ET AL, 2014; GOLDEWIJK, ET AL, 2007; IFTIKHAR, ET AL, 2016; JADHA, ET AL, 2007; SCHUSTER, ET AL, 2015).

Figure 2 shows some of the most commonly used procedures for spatial identification and location of grassland surfaces.



Identification and location of grasslands on:

a. The cadastral map b. Corine Land Cover database c. Aerial images

Figure 2 Spatial representation of grassland surfaces
(processing after: European Environment Agency (EEA) (2018): Corine Land Cover Database (CLC); Archive of the Office of Cadastre and Real Estate Advertising Timiş)

Cadastral maps (in most cases on a scale of 1: 10,000), initially in analogue format, by scanning and georeferencing, are used to locate grassland surfaces (Figure 2.a). In the case of these cartographic materials, due to their age (about 40 years), there may be inconsistencies with the reality in the field due to the change of the category of use, the modification of the cadastral boundaries, the changes of "physical" order (afforestation or natural destructive processes).

From the Corine Land Cover database (Figure 2.b), available free of charge through the Copernicus Program, the land used as grasslands (or other categories) can be extracted. This database was formed by the interpretation of satellite images, so small surfaces are excluded or partially represented. For high precision studies, it is recommended to complete and validate the data with other sources of topo-cadastral data (high spatial resolution images, topographic detail measurements, etc.).

The use of orthophotoplanes, taken from the profile institutions or generated by the UAV technology (SIMON, ET AL, 2018), allows the identification and location of the grasslands, with superior precision and visual quality. After obtaining the geometry of the plots used as grasslands (by means of topographic measurements, cadastral documents, etc.) it is possible to overlap with orthophotoplan and thus to extract the information of interest.

Change detection

Change detection through geomatics techniques, used in previous research at the level of Romania (COPĂCEAN, ET AL, 2019; KUEMMERLE, ET AL, 2009, COJOCARIU, ET AL, 2018; BOGDAN, ET AL, 2007; PETRIȘOR, ET AL, 2014) highlights both the natural phenomena "responsible" for their production, as well as the influence of the socio-economic and political environment.

Starting from the previous researches (COJOCARIU, ET AL, 2018) that attests the changes in the surface of the pastoral environment, this study aims to develop a working methodology that will surprise the nature and the way of their production, on a large scale, with precision but also high accuracy.

To capture the evolution of grassland surfaces in time and space, two aerial images (orthophotoplanes) from different time periods were used, namely the years 2006 and 2018, taken from the Archive of the Cadastral Office and Real Estate Advertising Timiş.

In the GIS environment, the grassland surface was vectored at the level of 2006 and then the comparison with the image from 2018 was made (Figure 3), according to ArcGIS technical specifications.

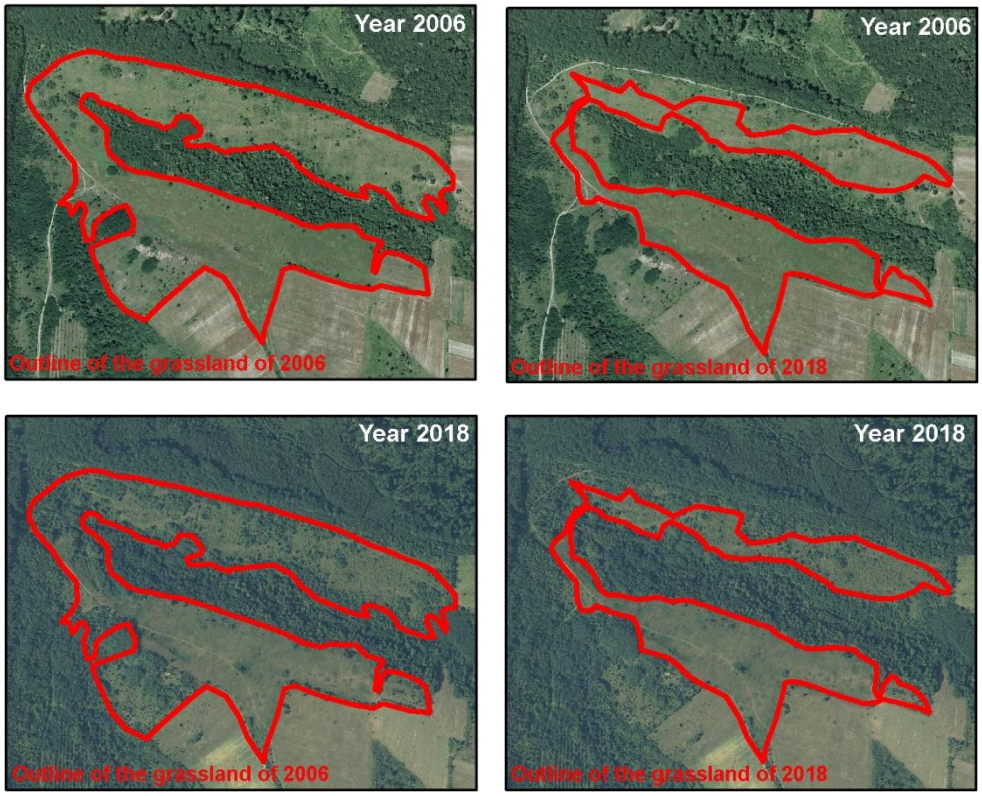


Figure 3 Representation of the grassland surface at different time periods
(processing after Archive of the Office of Cadastre and Real Estate Advertising Timiş)

The visual analysis of the images from the two years shows the changes that have occurred in the surface of the analyzed grassland.

ArcGIS 10.6.1 software was used to quantify spatial differences. Using the *Erase* function in the *Analyst Tools* mode, the two geometries were compared and thus the surface difference was calculated (Figure 4).

During the analyzed period, respectively 2006 - 2018, the area of grassland taken as a case study, was reduced by 17.55 ha as a result of the modification of the surrounding forest boundary (Figure 4).

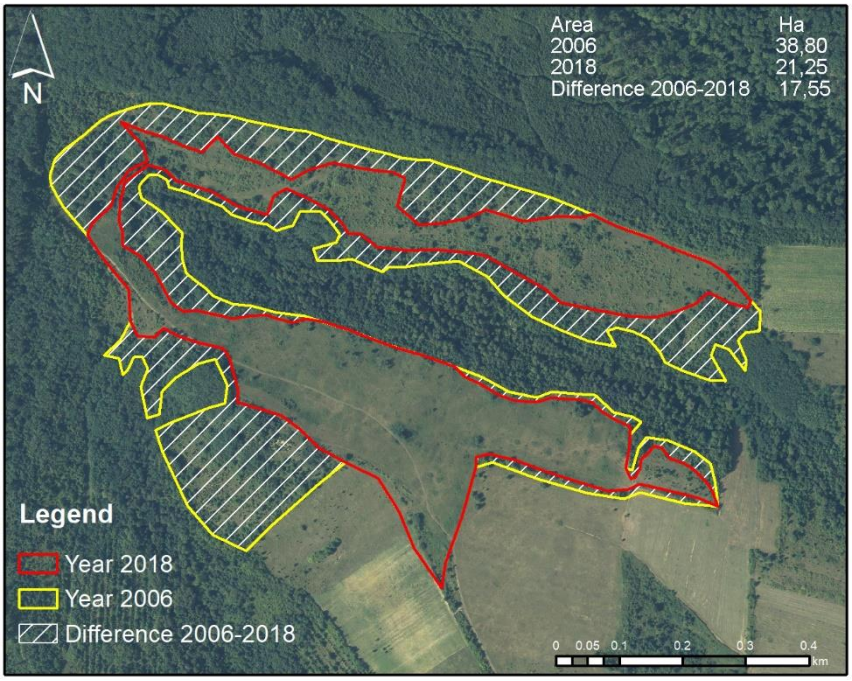


Figure 4 Change detection
(processing after Archive of the Office of Cadastre and Real Estate Advertising Timiş)

The use of GIS techniques allows the "localization" of the changes, which means that both the surface difference in the analyzed range and the affected areas are known (Figure 4).

CONCLUSIONS

Through geomatics techniques applied to high spatial resolution aerial images, in pratological studies it is possible to determine and quantify changes produced in the pastoral environment, in time and space, without the need for field measurements.

One of the major advantages is that aerial images "from the past" can be used so that the comparison with the present situation is possible.

The meadow, considered a case study, "crumbled" within 12 years, an area of 17.55 ha as a result of the extension of the forest areas. This aspect indicates under-exploitation, lack of proper management, against the background of negative demographic indicators.

Through the proposed research methodology, the main objective proposed has been achieved, it is applicable in any area and generates both statistical, non-graphical data and thematic maps useful for visualizing and understanding the results.

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