Research Journal of Agricultural Science, 48 (2), 2016

CHANGES IN THE SPATIAL STRUCTURE OF LANDSCAPE WITHIN THE SITE OF COMMUNITY INTEREST ROSCI0233 SOMEȘUL RECE

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Abstract. *The paper points out the changes in the landscape structure and functionality within the territory of the Site of Community Interes ROSCI0233 Someșul Rece between 2006 and 2012 as a consequence of the transformations in land cover. In this purpose, GIS applications have been used in order to identify the shift of land parcels between various land cover categories, while changes in the spatial structure of landscape units (changes in land parcel shape, landscape fragmentation etc.) have been expressed through some landscape metrics indices. Results are discussed in relation to the socio-economic changes that have described local communities during the envisaged period (evolution of the local economic activities as forest exploitation and cattle breeding, changes in the demographic structure, land ownership, economic profile of local municipalities etc.). At the same time, the results are analyzed in relation to the protection status of the area (included in the Nature 2000 ecological network) and its conservation objectives.*

Key words: *landscape assessment, landscape metrics, forest management, economic transition*

INTRODUCTION

Landscape structure and the resulting spatial relationships between its individual elements can be described and quantified by means of landscape metrics (WALTZ, 2011). This instrument has been used for more than 20 years in Europe and North America in a variety of studies in the scientific and experimental area (WALTZ, 2011). During the last period, diverse applications have been developed for this instrument in various fields, as spatial planning (BOTEQUILHA LEITˇAO AND AHERN, 2002, SZABO ET AL., 2012), road network development (PATARASUK, R., 2013, FU ET AL., 2010, CORPADE ET AL., 2014), landscape connectivity (SAURA ET AL., 2011), ecosystems and landscape monitoring (TASSER ET AL., 2008), nature protection (BLASCHKE, 2000, UUEMAA ET AL., 2009, VOROVENCII, 2015).

Someșul Rece protected area (the study area), with a surface of 8499 ha, was declared in 2006 as Site of Community Interest (Nature 2000 Ecological Network), protecting 8 community habitats (forests, bogs, hays and pastures), 4 mammals, 1 amphibian, four fish species and 2 invertebrate species. It is located in north-western region of Romania, the mountaineous unit Gilău-Muntele Mare and overlaps the administrative territory of two communes in Cluj County: Măguri Răcătău and Valea Ierii.

By approaching landscape assessment in nature protected area, the paper will provide with scientific knowledge for using landscape assessments in the management of nature protected areas. Landscape metrics is used to point out the composition and spatial arrangement of a landscape (size, shape, edge etc.), for a single element of the landscape or for the landscape as a whole (diversity of the landscape). As related to the use of landscape metrics in protected areas analysis, it is extremely important, as protected areas features changes throughout time, driven by natural or cultural forces and landscape indicators could point out the evolution of these changes and provide with important information for management and monitoring. At the same time, biological diversity in all its dimensions and facets is always tied to habitats, which need a concrete territory for their existence (WALTZ, 2011). Biological diversity is therefore always defined for a certain reference area, and landscape structure is a key element for the understanding of species diversity (WALTZ, 2011). Spatial diversity or heterogeneity, as an indicator of landscape structure, is an essential element for the explanation of the occurrence and distribution of species from the local to the global level (ERNOULT ET AL., 2003).

MATERIALS AND METHODS

Landscapes are characterized by three main elements: *structure* (the spatial configuration of landscape elements), *ecological function* (how ecological processes operate within that structure) and *dynamics* (evolution in time) (CORPADE, 2014). Understanding and predicting landscape changes is a rather challenging attempt (CORPADE, 2014). Disturbance usually produces patches (distinct areas with environmental conditions that are different from surrounding areas) (CORPADE, 2014). Landscape fragmentation is the result of the interaction of past disturbance and the heterogeneity of the abiotic environment, while monitoring change at the patch-based level of spatial pattern is an important way to assess landscape change (GERGEL AND TURNER, 2005).

In order to express landscape cover changes, a spatial analysis method applied to landscape units was applied. The input database consisted of Corine Land Cover Database 2006 and 2012. For the statistic analysis of landscape structure in the two moments (2006 and 2012), we employed Patch Analyst (PA), an ArcGIS extension that facilitates the spatial analysis of landscape patches and the modeling of attributes associated with patches (CORPADE, 2014). The program includes capabilities to characterize patch pattern and the ability to assign patch values based on combination of patch attributes (CORPADE, 2014). Patch Analyst can calculate not less than 15 landscape indicators, but for the paper purpose we have considered that four were more relevant as they can outline the evolution of land cover changes in the analyzed protected area: Number of Patches, Mean Patch Size, Total Edge and Edge Density.

NumP (Number of Patches) measures the total number of patches of a specified land use or land cover class. When NumP is too high, it indicates that the patch class is highly fragmented. The total number of patches in a landscape results from first defining connected areas of each cover type *i* (GERGEL AND TURNER, 2005, CORPADE, 2014).

Patch density and size metrics (Mean Patch Size). Mean Patch Size (MPS) is an indicator representing the average size of patches of a particular class level or of the whole landscape. According to MCGARIGAL AND MARKS (1995), patch area is one of the most important and useful information that can be obtained in a landscape analysis.

Mean patch size is often used when assessing landscape undergoing transformation induced by urban or transportation sprawl. MPS at the class level equals sum of the area of the patches across all patches of the corresponding type divided by the total number of patches of the same type, being calculated through the following formula (LEITAO ET AL., 2006, CORPADE, 2014):

$$\text{MPS} = \frac{\sum_{j=1}^{n} a_{ij}}{n_i} \quad (1)$$

a_{ij} = area of the patch (m^2) and n_i = number of patches in the landscape of patch type.

Edge Metrics (Total edge, Edge Density). Edge calculations provide a useful measure of how dissected a spatial pattern is and can be calculated in a variety of ways. An edge is shared by two grid cells of different cover types when a side of one cell is adjacent to a side of the other cell. The total number of edges in a landscape can be calculated by counting the edges between different cover types for the entire landscape, every edge being counted only once (GERGEL ET AL., 2002, CORPADE, 2014).

Edge density (in m/ha) equals the length (in m) of all borders between different patch types (classes) in a reference area divided by the total area of the reference unit. The index is calculated as:

$$ED = \frac{E}{A} \qquad (3)$$

E = total edge (m)

A = total landscape area (ha)

After calculating the landscape metrics indicators for both envisaged years, the transition of land cover types between 2006 and 2012 was calculated, in order to identify ecosystems evolution trends and provide with useful instruments in the management of the area and act as basis for the setting of appropriate conservation measures.

RESULTS AND DISCUSSIONS

The analysis of the land cover categories distribution (Fig. 1) in 2006 and 2012 outlines some significant changes in the landscape composition, as well as in the natural habitats distribution. The coniferous forest decreased in surface from 5872 ha in 2006 to 5203 ha in 2012, shrubs and transition areas increased from 1360 ha to 2313 ha, while hays and pastures decreased from 1130 ha in 2006 to 834 ha in 2012. These results point out some cultural changes in the local community pattern, such as: the abandoning of hays and pastures due to the decrease of animal breeding occupation and lack of young labour force, which is migrating towards urban areas; deforestation, wood exploitation being a traditional occupation in the area and one of the most profitable and which, in spite of the protection status, is still present, degrading the natural habitats, the biotopes of the protected species and the landscape as a whole. The area covered with deciduous trees forests, located in the northern part of the nature protected site, preserved to a great extent its area between 2006 and 2012. Thus, an increase in the areas covered with shrubs and transitional formations occurred, as they advanced on deforested and abandoned pastures and hays areas.

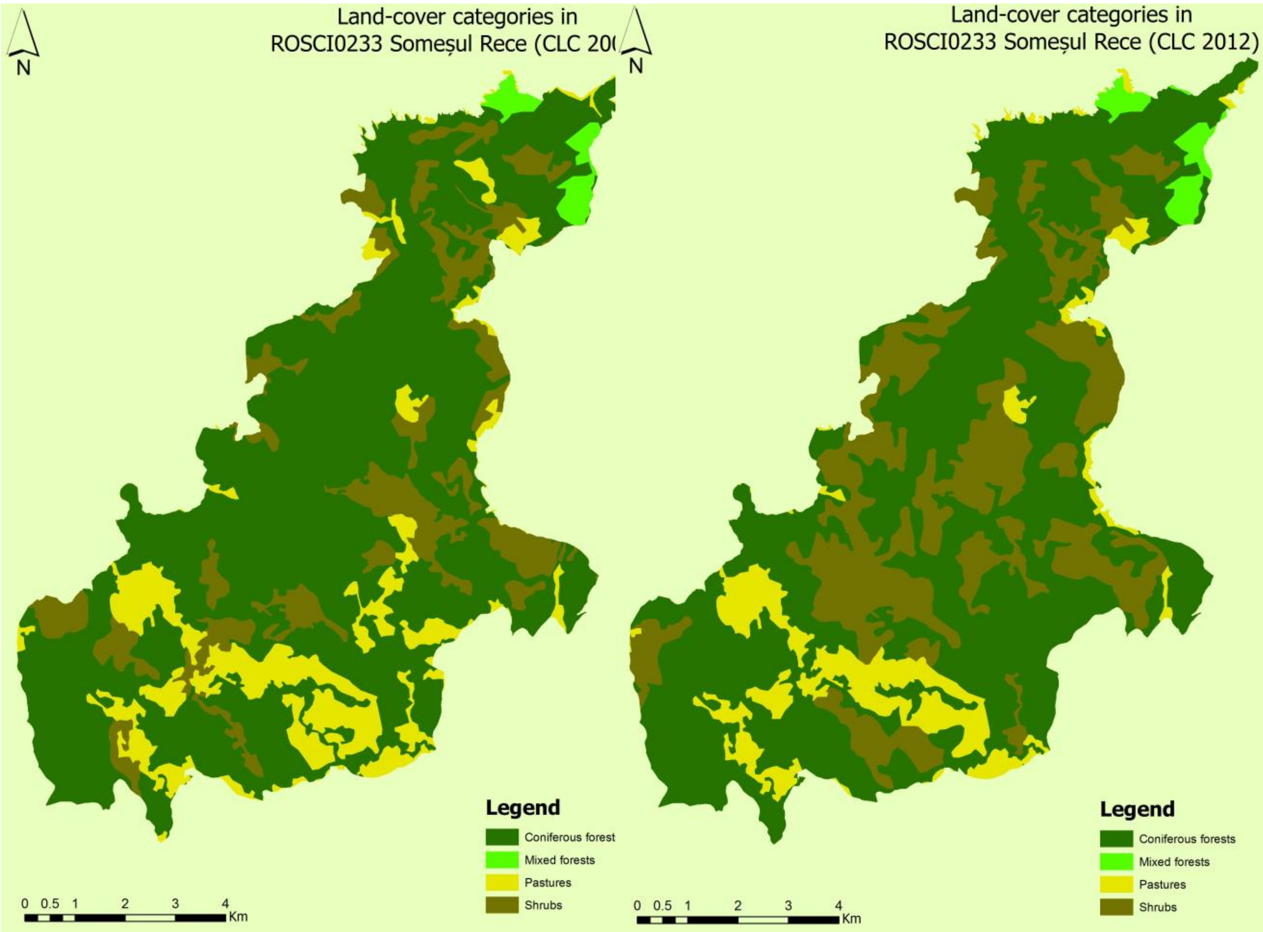

Figure 1. Land-cover categories in ROSCI0233 Someșul Rece in 2006 and 2012

As related to landscape metrics indicator, the following conclusions could be mentioned (Table 1, Figure 2):

– Total edge decreased significantly for the areas covered with hays and pastures and increased mixed forests, coniferous forests and shrubs and transition areas. In the case of the coniferous forest, which decreased in area, as shown in figure 1, the increase of total edge can be explained by the increase of fragmentation;

– No significant changes were identified in the case of Edge density indicator, the values being in accordance with those obtained in the case of the total edge calculations;

– Mean patch size analysis indicated considerable changes in the case of coniferous forests that decreased from 5872 ha in 2006 to 1300,81 in 2012 and the shrubs area that increases from 56,66 ha in 2006 to 165,19 ha in 2012;

– The Number of patches indicator reveals the decrease of patches in the case of hays and pastures, from 30 to 21, and shrubs, from 24 to 21 and the increase in coniferous forests, from 1 in 2006 to 4 in 2012.

Table 1.

Numeric results of the landscape metrics analysis for ROSCI0233 Someșul Rece in 2006 and 2012

Class	Total edge 2006 (m)	Total edge 2012 (m)	Edge density 2006 (m/ha)	Edge density 2012 (m/ha)	Mean patch size 2006 (ha)	Mean patch size 2012 (ha)	Number of patches 2006	Number of patches 2012
Hays and pastures	144309.11	93806.84	16.98	11.03	37.69	39.74	30.00	21.00
Mixed forests	10825.69	12929.18	1.27	1.52	68.44	75.29	2.00	2.00
Coniferous forests	249848.78	253202.89	29.40	29.79	5872.00	1300.81	1.00	4.00
Shrubs and transition areas	140013.14	152440.37	16.47	17.93	56.66	165.19	24.00	14.00

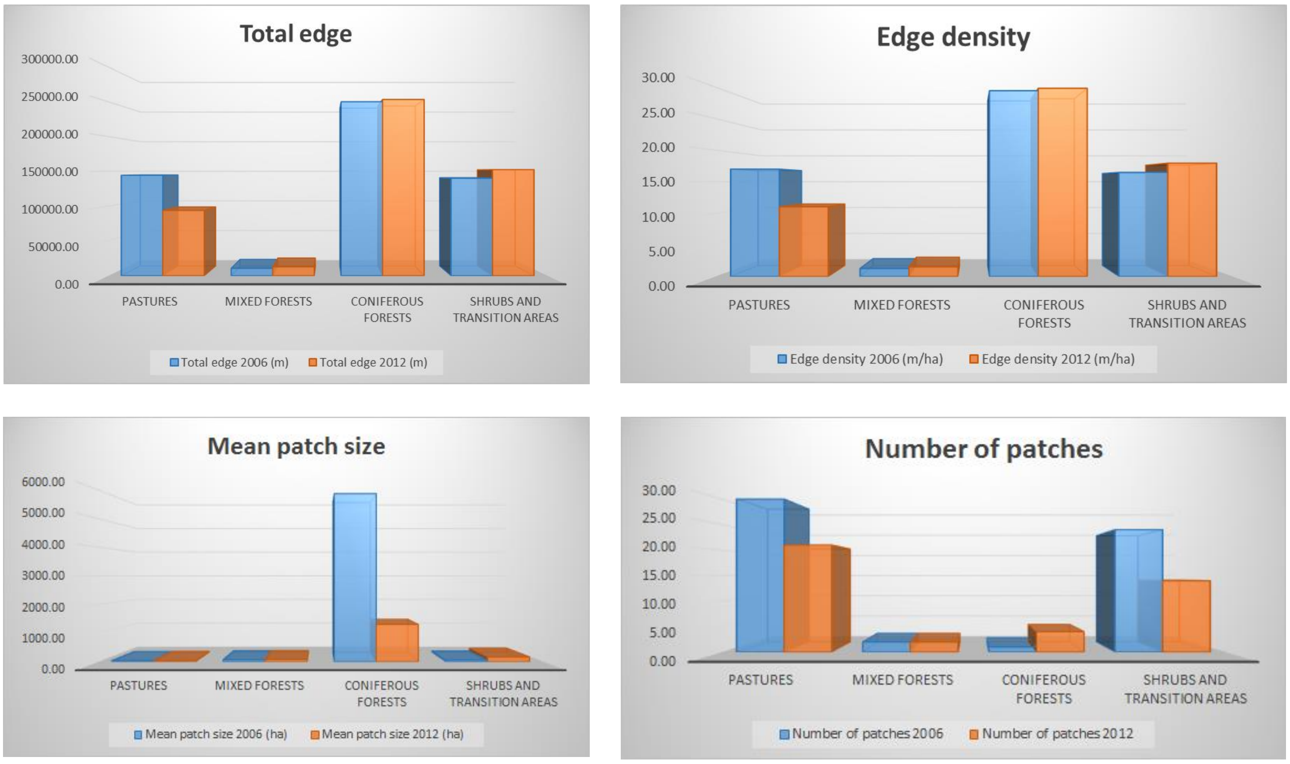

Figure 2. Graphic results of the landscape metrics analysis for ROSCI0233 Someșul Rece in 2006 and 2012

As related to land-cover transition, results are shown in Table 2 and Figure 3.

Table 2.

Numeric results of land-cover transition in ROSCI0233 Someșul Rece between 2006 and 2012

Land-cover transition	**Ha**
Mixed forests	110
Mixed forests > Hays and pastures	3
Mixed forests > Coniferous forests	15
Hays and pastures	512
Hays and pastures > Coniferous forests	306
Hays and pastures > Shrubs and transition areas	92
Coniferous forests	4114
Coniferous forests > Mixed forests	35
Coniferous forests > Hays and pastures	206
Coniferous forests > Shrubs and transition areas	1486
Shrubs and transition areas	658
Shrubs and transition areas > Mixed forests	1
Shrubs and transition areas > Hays and pastures	57
Shrubs and transition areas > Coniferous forests	621

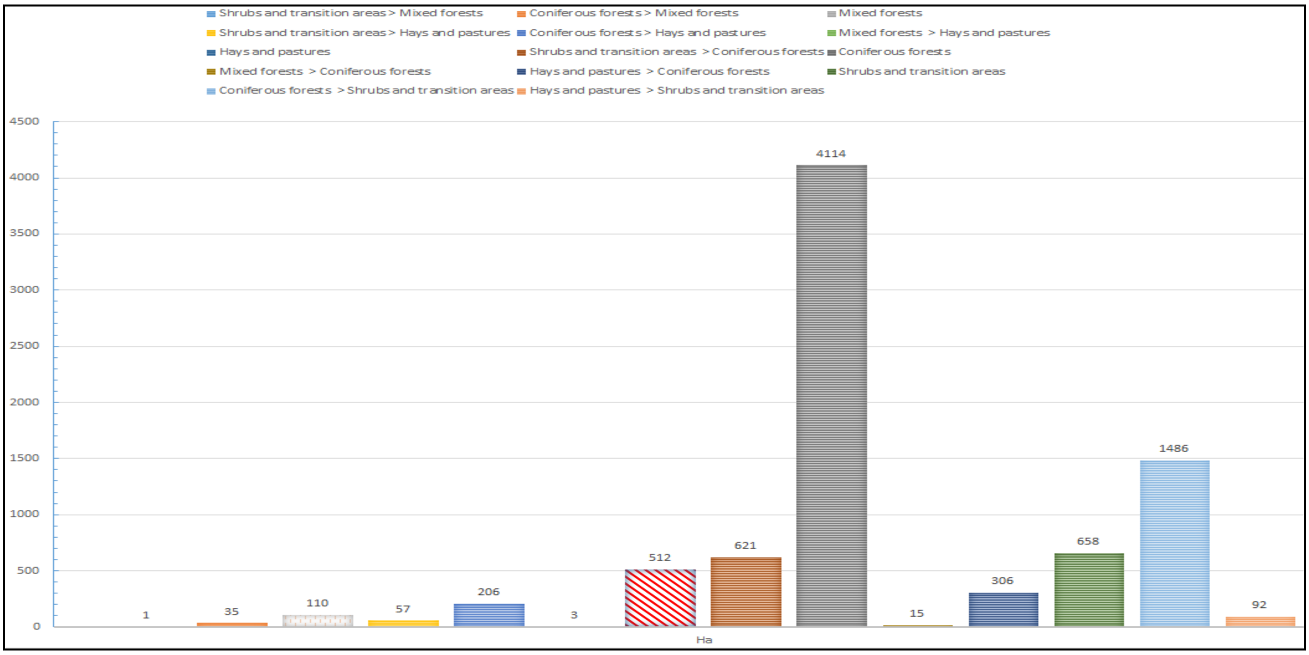

Figure 3. Graphic results of land-cover transition in ROSCI0233 Someșul Rece between 2006 and 2012

The following conclusions could be mentioned in accordance with the results' interpretation:

– The area covered by mixed forests was preserved to a great extent, a slight transition to coniferous forests being only identified;

– Around a third of the area covered with hays and pastures got a different land-cover between 2006 and 2012, such as coniferous forests or shrubs;

– 1727 ha that in 2006 were covered with coniferous trees, in 2012 were covered with shrubs, hays and pastures and mixed forests, thus a significant decrease in surface was identified for this land-cover type;

– Shrubs and transition areas significantly increase in the analysed protected area, invading the areas covered in 2006 by coniferous forests (as a result of deforestation) or grasslands (as a result of traditional farming and animal breeding abandoning).

CONCLUSIONS

As a conclusion, it can be stated that because biological diversity is rather complex, most researchers choose to analyze it at the habitats and species level. Through this paper, we intended to prove that landscape analysis can be a good indicator in biodiversity monitoring as significant changes in landscape metrics values can serve as early warnings, pointing out the demand for further detailed investigations and thus protected areas management and monitoring become more efficient and less costly, as investigations in the field requires far more time and money. In case of the analyzed area, the change of the landscape pattern endangeres the favourable conservation status of some of the protected habitats, as 9410 Acidophilous *Picea* forests of the montane to alpine levels (*Vaccinio-Piceetea*), strongly affected by deforestation during the last two decades, 6150 Siliceous alpine and boreal grasslands and 6520 Mountain hay meadows. In the case of 9410 habitat, conservative measures for habitat reconstruction should be adopted, while in the case of the grassland habitats, ways to stimulate traditional local farming, including non-reimbursable financial incentives for locals should be identified.

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