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# CHANGES IN LANDSCAPE METRICS INDUCED BY DEFORESTATION IN ROSCI0358 PRICOP-HUTA-CERTEZE NATURE 2000 SITE

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**ABSTRACT. – Changes in Landscape Metrics Induced by Deforestation in RoOSCI0358 Pricop-Huta-Certeze Nature 2000 Site.** The paper analyzes the changes in the landscape structure within the territory of the Site of Community Interest ROSCI0358 Pricop-Huta-Certeze as a consequence of deforestation. Deforestations between 1972 and 2010 were analyzed and mapped. GIS instruments have been used in order to identify the changes in the spatial structure of landscape units induced by deforestation (changes in land parcels shape, number, edge etc.) by the help of some relevant landscape metrics indices. Results are discussed in relation to the protection status of the area (included in the Nature 2000 ecological network) and its conservation objectives.

***Keywords:*** *landscape assessment, landscape metrics, deforestation, Nature 2000*

## 1. INTRODUCTION

Landscape structure and the resulting spatial patterns can be described and quantified by means of landscape metrics (Waltz, 2011). Such instruments have been used for more than 20 years in Europe and North America in cavrious scientific and experimental areas (Waltz, 2011). During the last period, diverse applications have been developed in various fields, such as spatial planning (Botequilha Leitão 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).

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ROSCI0358 Pricop-Huta-Certeze, with a surface of 3168 ha, was declared in 2011 as Site of Community Interest (Nature 2000 Ecological Network), in order to preserve or enhance the conservation state of 3 deciduous forest habitats, 5 mammals and 3 amphibians. It is located in north-western of Romania, in the volcanic mountainous and pre-mountainous area of Oaş Mountains and overlaps the administrative territory of four communes in Maramureş and Satu-Mare Counties (Remeţi, Săpânţa, Bixad and Certeze). The site is mainly covered by forests (2118 ha), being managed by two forest ranges: Negreşti-Oaş (Satu-Mare County) and Sighetu-Marmaţiei (Maramureş County).

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 analzye the composition and spatial arrangement of landscapes (size, shape, edge etc.). Using landscape metrics in protected areas management 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 (Corpade et al., 2016). 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). At the same time, deforestation is also an important issue to be analzyed, taking into account the major ecological services that forests provide with. Despite their ecological importance and sometimes despite the protection status, in Romania, forested areas continue to decrease in surface at alarming rates due to deforestation, storm damages, improper logging practices or fires. Ecosystem services they provide (such as genetic resources, protection from natural hazards and riparian functionality) are thereby diminished (Keeton et al., 2007; Wirth et al., 2009, apud Knorn et al., 2012) and biodiversity they harbour is threatened (Knorn et al., 2012).

## 2. MATERIALS AND METHODS

Deforestations were analyzed and mapped between 1972 and 2010 by digitizatizing them from topographical maps (1972 edition), ortophotoplans (2006 and 2010 editions) and satellite images (2014 edition).

Two datasets of land cover types distribution in the envisaged Nature 2000 site were generated, one taking into account the deforested areas and another one in which the deforested areas were assimilated to the primary land cover type or habitat, point thus out how these practices influenced landscape structure.

In order to express landscape cover changes induced by deforestation, a spatial analysis method applied to landscape units was applied. The input database consisted of Corine Land Cover Database 2006 and 2012. For the statistical analysis of landscape structure for the two databases (with deforestation and without deforestations), 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 et al., 2014). The program includes capabilities to characterize patch pattern and the ability to assign patch values based on combinations of patch attributes (Corpade et al., 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 induced by deforestation 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 et al., 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 et al., 2014):

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

*$a_{ij}$ = 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 et al., 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:

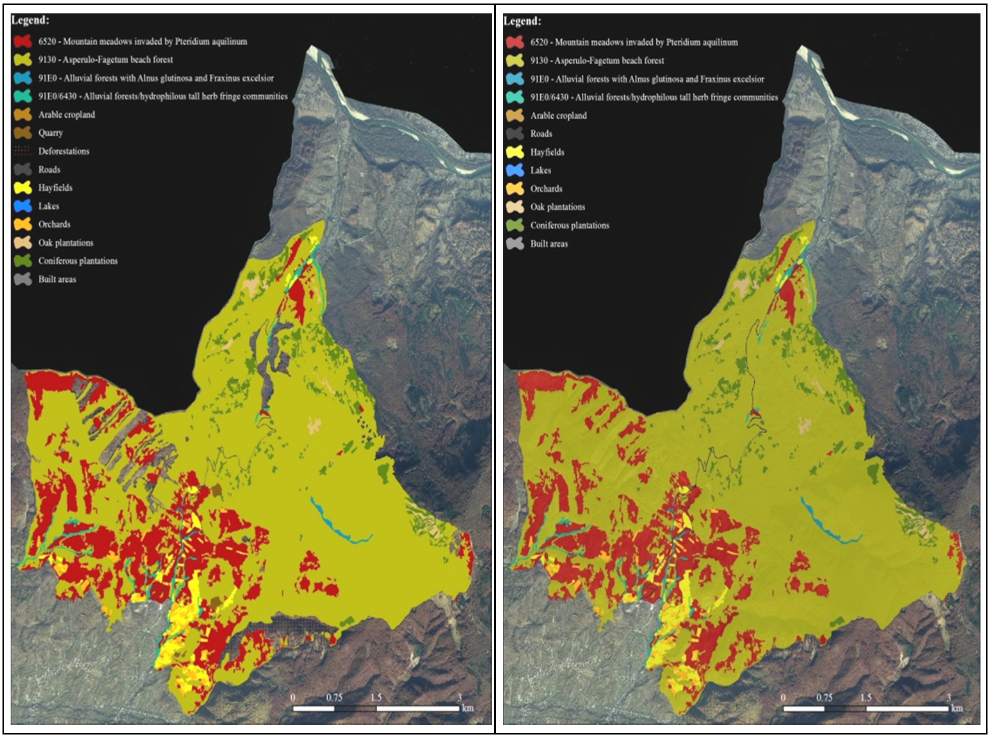
$$ED = \frac{E}{A} \qquad (3)$$

*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.

## 3. RESULTS AND DISCUSSIONS

The analysis of the land cover types distribution (Fig. 1) outlines some important changes in the landscape composition, as well as in the natural habitats distribution. Between 1972 and 2010, around 110 ha of forests were cleared. Deforestation mainly took place in Sighetu-Marmaţiei Forest Range, along Sugătagu Mare Valley, near the national road no 19, but also in Negreşti-Oaş Forest Range, within Şesu Forest. Deforestation occurred for industrial purposes, some volcanic rock quarries being open here, but also for domestic purposes, wood exploitation being a traditional occupation in the area and one of the most profitable and in spite of the protection status of the Nature 2000 site, it is still present, degrading the natural habitats, the biotopes of the protected species and the landscape as a whole. Two land cover types appeared in the landscape as a result of deforestation: quarries (4 patches) and deforested areas (48 patches).




a. With deforestations b. Without deforestations

**Fig. 1.** Land-cover types

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

- All the changes in landscape structure occurred within the territory occupied by the habitat 9130 *Asperulo-Fagetum* beech forests, whose total edge, mean patch size and edge density decreased slightly, while the number of patches increased;
- Deforestation did not affect any other land cover type in the focused Nature 2000 site, it did not even trigger the extension of forest roads, meaning that deforestation took place near existing roads;
- Fragmentation of landscape increased slightly, as the total number of patches increased with 52 new patches.

**Table 1.** Numeric results of the landscape metrics analysis for ROSCI0358 Pricop-Huta-Certeze without deforestation

| No | Land cover type | Total edge (m) | Edge density (m/ha) | Mean Patch Size (ha) | Number of patches |
|---|---|---|---|---|---|
| 1 | Habitat 6520 | 188595.79 | 59.50 | 3.40 | 153 |
| 2 | Habitat 9130 | 307779.52 | 97.10 | 15.63 | 151 |
| 3 | Habitat 91E0 | 4952.42 | 1.56 | 1.90 | 4 |
| 4 | Mixed habitats 91E0_6430 | 32479.39 | 10.25 | 1.27 | 29 |
| 5 | Arable cropland | 580.44 | 0.18 | 0.07 | 5 |
| 6 | Roads | 21821.41 | 6.88 | 3.15 | 3 |
| 7 | Hay fields | 36437.86 | 11.50 | 1.13 | 57 |
| 8 | Built area | 4103.20 | 1.29 | 0.02 | 66 |
| 9 | Coniferous forests | 81713.77 | 25.78 | 0.65 | 176 |
| 10 | Oak plantations | 15946.57 | 5.03 | 0.72 | 30 |
| 11 | Orchards | 24847.74 | 7.84 | 0.35 | 91 |
| 12 | Lakes | 169.56 | 0.05 | 0.02 | 3 |

**Table 2.** Numeric results of the landscape metrics analysis for ROSCI0358 Pricop-Huta-Certeze with deforestation

| No | Land cover type | Total edge (m) | Edge density (m/ha) | Mean Patch Size (ha) | Number of patches |
|---|---|---|---|---|---|
| 1 | Habitat 6520 | 188595.8 | 59.50 | 3.40 | 153 |
| 2 | Habitat 9130 | 333250.2 | 105.14 | 13.7 | 158 |
| 3 | Habitat 91E0 | 4952.42 | 1.56 | 1.90 | 4 |
| 4 | Mixed habitats 91E0_6430 | 32479.39 | 10.25 | 1.27 | 29 |
| 5 | Arable cropland | 580.44 | 0.18 | 0.07 | 5 |
| 6 | Querry | 2168.84 | 0.68 | 1.80 | 4 |
| 7 | Deforestations | 52624.22 | 16.60 | 3.95 | 48 |
| 8 | Roads | 21821.41 | 6.88 | 3.15 | 3 |
| 9 | Hay fields | 36437.86 | 11.50 | 1.13 | 57 |
| 10 | Built area | 4103.20 | 1.29 | 0.02 | 66 |
| 11 | Coniferous forests | 81713.77 | 25.78 | 0.65 | 176 |
| 12 | Oak plantations | 15946.57 | 5.03 | 0.72 | 30 |
| 13 | Orchards | 24847.74 | 7.84 | 0.35 | 91 |
| 14 | Lakes | 169.56 | 0.05 | 0.02 | 3 |

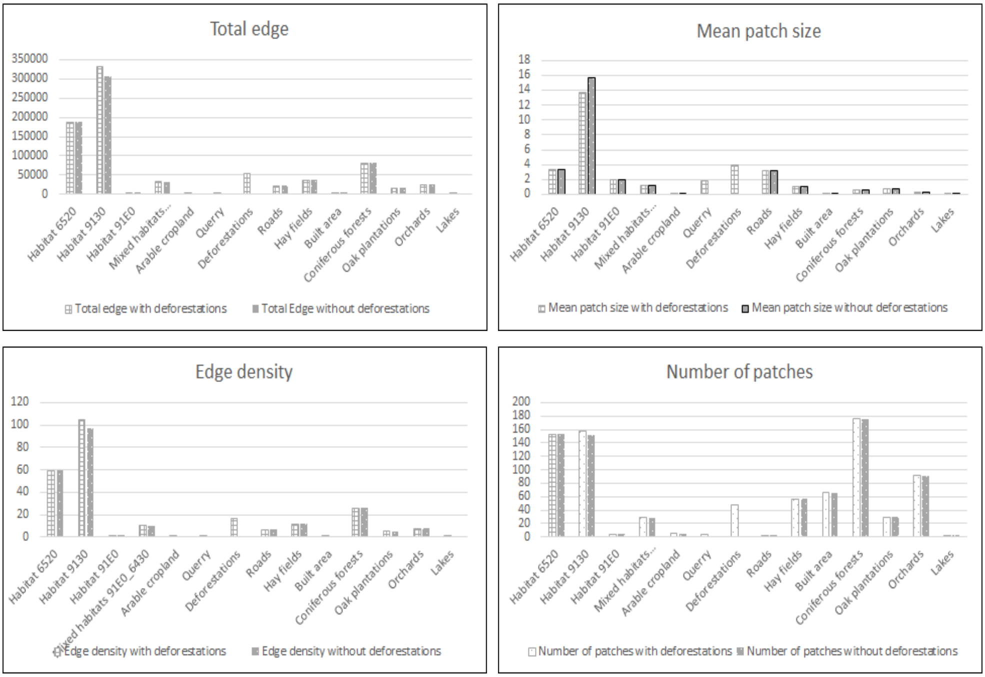



**Figure 2.** Graphic results of the landscape metrics analysis for ROSCI0358 Pricop-Huta-Certeze

## 4. 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 tool 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 the case of the analyzed area, deforestations and the induced change of the landscape pattern may endanger the favourable conservation status of the protected forest habitats, thus forestry management in the area should be reconsidered and, besides the economic value of the forest, the ecological one should receive more attention.

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