LAND COVER TYPOLOGY USING GEOGRAPHIC INFORMATION SYSTEMS FOR ROMANIAN VITICULTURAL LANDSCAPE

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Abstract. Viticultural landscapes traditionally consist of a diverse mosaic of different elements of agricultural and semi-natural ecosystems, providing a variety of ecosystem services. In the context of VineDivers landscape ecology, landscape buffers of 750 m in diameter were delimited around the centroid of the studied vineyard parcels. The results of landscape mapping are parameters such as percentage of semi-natural elements, mean size of vineyard parcel, and complexity index. In Romania were studied sixteen vineyards ecosystems from Târnave Viticulture Region – Transylvania. Landscape mapping offers a better understanding of spatial information and structural inventory of agro-ecosystems. Also, it should be possible to study the effects of landscape pattern upon species composition, and biodiversity.

Keywords: landscape mapping, landscape extent, semi-natural elements

INTRODUCTION

When considering land cover it should be confined to describe vegetation and man-made features, and when considering land use it should be confined to describe the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain the observed biophysical cover on the earth's surface (Di Gregorioand Jansen, 2000). A landscape is defined as the spatial representation of an ecosystem, as an entity defined in terms of spatial characteristics (Farina, 2001).
Quantifying spatial pattern is the first step in studying the causes, processes, and consequences of spatial heterogeneity (Frost et al., 2007; Chapin et al., 2011; Wu, 2013).

If it is explored the spatial dimension of the landscape with the aim of building an indicator of landscape state that accounts for the difference in heterogeneity among rural landscapes across Member States, it is found that the country with the highest landscape heterogeneity is Belgium, with a mean value of 26.4, and Romania having over 15.0 the edge density (the edge density being sensitive to landscape fragmentation rather than heterogeneity alone) (Frost et al., 2007).

This paper presents the inventory of structures/elements in the landscape of the study region, Aiud-Târnave – Transylvania Plateau, Romania. The landscape mapping was undertaken using Geographic Information System (Burrough, 1986), and applying the methodology specific to landscape ecology (Burel and Baudry, 2003; Wu, 2006) and VineDivers landscape mapping protocol.

The definitions of landscape elements were based on the criteria for minimum size, and were stemed from EUNIS (http://eunis.eea.europa.eu/) and CORINE LAND COVER (eea.europa.eu/publications/tech40add,wiki.openstreetmap.org/wiki/ Corine_Land_Cover).

The landscape structure was defined as landscape pattern (Boller and Remund, 1997), which is determined by land use and specific characteristics, such as: size, shape, configuration and distribution of individual elements of landscape.

MATERIAL AND METHODS

In 2015, the coordinates of landscape buffer centroid were determined (Hoble et al., 2016) for all sixteen windows (Fig.1). The selection of sites was made based on the following aspects: (a) the vineyard parcels should be maintained with two different management regimes: high intensity tilling regime – bare soil, or with low intensity management – cover crops or wild plants; (b) the percentage of semi-natural elements would show low and high structural diversity; (c) the shape and size of the landscape buffer should approximate a circle of 750 m radius around the centroid of each studied vineyard parcel; (d) the boundaries of landscape buffers should not overlay.

Fig. 1. Generating the landscape buffer, resulting in 16 landscape windows representative for Aiud - Târnave - Transylvania Plateau

In the landscape mapping process were used geo-referenced aerial photographs, with the following characteristics: (a) the flight direction was from east to west; (b) the period of flight was between 2003 and 2006 years; (c) the resolution was 20-50 cm; (d) the precision was ±0.6 m; (f) the spectral band was in RGB (red, green, blue) system; (g) the projection systems was the Romanian National Projection System, Stereo 70.

The mapping of landscape buffer started with the delimitation of landscape entities as land cover - landscape buffer as a cover. The digitization of landscape elements was done by using ArcGIS 9 – ArcMAP 9.3. The landscape buffer coverage was digitized with the aid of snap command. The list of landscape elements considered to be digitized was according with CORINE Land Cover classes. The color system used during landscape mapping process is showed in Table 1 and Table 2. All the landscape elements with the width over 1 m were digitized as polygons.

Using the Arc Toolbox - Analysis Tools - Proximity - Buffer, the boundary of the buffer was generated, with the circle shape and the area given by a 750 m radius, resulting in a surface of about 1,766,250 m^2 to be analyzed on a circle. In the selection of the lots, in general, it was considered that they were specific to the regional landscape, both in terms of the intensity of soil management and in terms of the quantity of semi-natural elements.

Table 1.

The color symbology for Landscape Elements at Level 1, used in rendering space analysis using the Geographic Information System - ArcMAP – level **1**

Level 1	CODE	R	G	B
Semi-natural Elements	SNE	153	204	0
Viticulture	Viti	204	0	255
Water entities	Water	0	176	240
Other agriculture	Other Agri	255	217	102
Artificial/Constructed enties	Artificial	191	191	191

Table 2.

The color symbology for Landscape Elements at Level 2, used in rendering space analysis using the Geographic Information System - ArcMAP – level 1

Landscape element	**Hierarchy**	**RGB code**		
		R	G	B
Hedge andTree row	**1**	153	255	51
Grass stripe	**2**	51	204	51
Natural grassland	**3**	51	102	0
Pasture	**4**	0	153	0
Fallow	**5**	204	204	0
Sparsely wooded grasslands	**6**	153	204	0
Wetland	**7**	0	204	153
Woodlot	**8**	204	153	0
Orchard	**9**	255	102	255
Vineyard	**11**	204	0	255
Olives orchard and Olives with ground cover	**9**	255	102	255
Crops (flowering crops & non-flowering crops)	**12**	255	218	101
Artificial/constructed entities	**13**	191	191	191
Roads and gravel roads	**14**	90	90	90
Soft-surfaced paths and roads and Wall	**10**	102	102	51
Ponds & Rivers	**15**	0	176	240

Each landscape window was coded according to established rules and sampling in the field: VD - abbreviation of the VineDivers acronym; RO - abbreviation from Romania; 1, 2, 3, ..., 16 - the number of the study plot; HI - high or LO - low - abbreviated to the type of soil management. The Open Street Map, the licensed data under Open Database 1.0 License (www.openstreetmap.org) was also used to geometry the land use. For landscape analyses was used Patch Analyst tool, which is an extension to the ArcView GIS system that facilitates the spatial analysis of landscape patches, and modeling of attributes associated with patches.

For each landscape window was generated the landscape buffer as cover or both levels (Fig. 2).

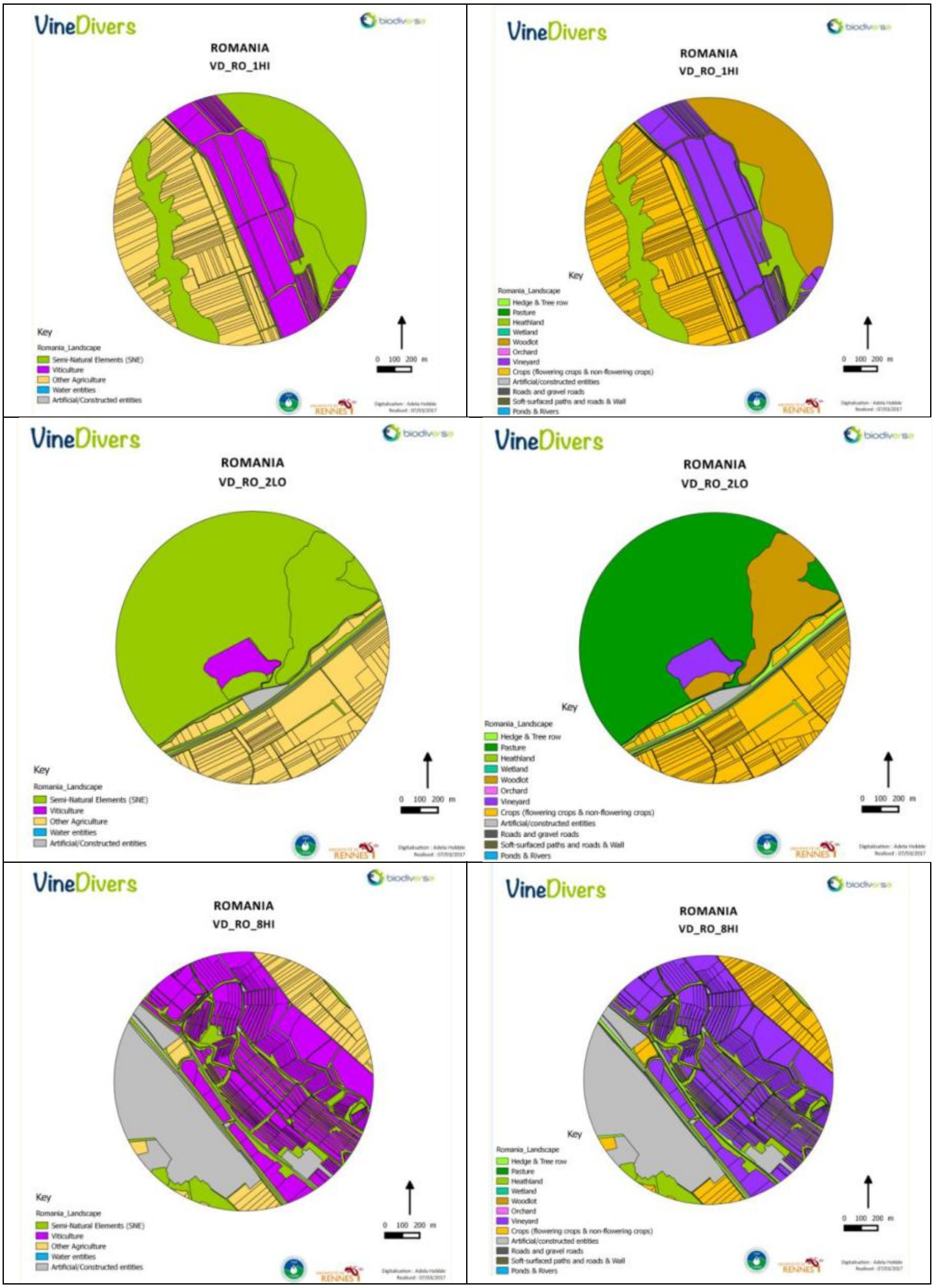

Fig. 2. Delimitation of Landscape buffer around the centroid for level 1 (first column) and level 2 (second column)

RESULTS AND DISCUSSIONS

The highest number of polygons was 504, in the area of Blaj City. This vineyard is located on a hill on which land improvement works have been carried out, such as terraces. The lowest number of polygons were 10 and 12, in two areas characterized by land use reconversion. Also, there were calculated the mean parcel area, and mean vineyard parcel area for each landscape window (Table 3).

Table 3.

Number of polygons and mean parcel area (m^2) for each landscape window

Code of Landscape Window	Number of polygons	Number of vineyard polygons	Mean Parcel Area (m^2)	Mean Vineyard Parcel Area (m^2)
VD_RO_1HI	230	34	7684.5	12132.7
VD_RO_2LO	137	1	12897.7	54683.3
VD_RO_3HI	182	54	9705.2	8260.8
VD_RO_4HI	133	15	13290.0	55893.0
VD_RO_5HI	252	58	7010.1	5773.9
VD_RO_6HI	170	10	10400.2	1031.5
VD_RO_7HI	136	22	12992.2	8100.9
VD_RO_8HI	504	327	3506.7	2220.5
VD_RO_9LO	12	3	147171.6	284459.9
VD_RO_10LO	10	2	176652.2	322839.2
VD_RO_11LO	149	18	11864.9	33785.4
VD_RO_12LO	31	8	56991.3	114059.9
VD_RO_13LO	88	32	20082.8	23026.3
VD_RO_14LO	366	242	4827.9	3567.9
VD_RO_15LO	249	176	7096.1	6198.8
VD_RO_16HI	154	82	11475.2	12764.4

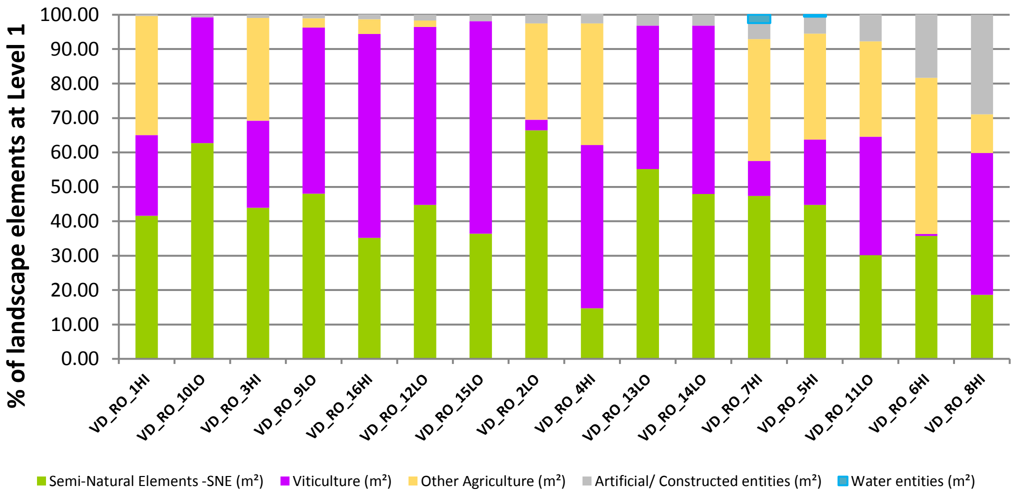

Fig. 3. The percentage of landscape elements for each digitized landscape window

The highest percent of semi-natural elements is 66.42%, completed in the same landscape window – VD_RO_2LO, with 27.97% of other agricultural land cover. The highest percent of viticultural elements is 61.75%, completed in the same landscape window – VD_RO_15LO with 36.35% of semi-natural elements. The highest percent of other agricultural elements is 45.%, completed in the same landscape window – VD_RO_6HI with 35.76% of semi-natural elements. The highest percent of artificial elements is 28.93%, completed in the same landscape window – VD_RO_8HI with 18.68% of semi-natural elements, 41.10% viticultural elements, and 11.33% other agricultural elements.

CONCLUSIONS

1. Mapping of the landscape was difficult due to the lack of orthophotomaps or updated satellite imagery. There have been major land cover changes, especially in the area of Jidvei's farms. Possible cause for this phenomenon would be: (a) the land conversion program; (b) investments made by farmers to increase the area of production (the purchase price of the land being very low compared to the purchase price in the member state countries);
2. Landscape mapping is used in database building regarding landscape analyses and determination of: total length of boundary -TE (m) or (km); Edge Density - ED, Landscape Shape Index – LSI; Patch Area Mean - AREA_MN; Landscape Richness –PR; Landscape Diversity Index –SHDI; and Landscape Heterogeneity Index –BBHI.
3. Landscape analyses could be integrated into the modeling process, knowing that biodiversity can be related to the viticulture intensity, land use and landscape context.

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