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Landscape dynamics at borderlands: analysing land use changes from Southern Slovenia

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Abstract: This study presents the results of an in-depth study on landscape changes over the last two centuries in the region of Bela krajina, south-eastern Slovenia. Since this region is situated along the Slovenian–Croatian border, immigration and emigration are permanent fixtures in the region. Due to historical reasons, population structure and land use changes occurred. With regard to these processes, two case studies were selected: settlements of Adlešiči and Bojanci. Adlešiči is a village mainly inhabited by farmers of catholic religion. Bojanci was colonized by Orthodox Uskoki, i.e. refugees from Ottoman Empire who become Habsburg soldiers who lived a military life and had different attitude towards land cultivation. Landscapes in these two settlements have its own distinctive patterns contrasting to each other in the land use, showing historically distinctive cultural landscapes. The study aimed to interpret the development of cultural landscapes in these settlements by analysing the land use changes and identifying the factors that influenced it. Even though these sites have different management regimes, they are both affected by difficult karst terrain and isolation. The results confirmed the land abandonment and overgrowth of agricultural land in both case studies, however, at different rates.

Keywords: land use changes, cultural landscapes, rural areas, depopulation, land abandonment, Adlešiči, Bojanci, Bela krajina

1 Introduction

Landscapes represent the place where land and people come together, addressing the spatial dimensions of culture and meanings of land [1]. Cultural landscapes are multifunctional landscapes, which simultaneously provide and support productivity, habitat, regulatory, social, and economic functions [2,3]. The extent of integration between environmental (ecological) and socio-economic functions of the landscape depends on the patterns and intensities of land use. Land use is the main object of human impact [4].

Cultural landscapes are continuously changing [5]. The extensification of land use and consequent land abandonment is considered a major trend of change affecting remote rural areas with poor accessibility and less favourable conditions both social and economic. Remote rural areas are usually affected by decreasing population and agriculture becomes less productive, or in the less favourable conditions for agriculture, marginalization of land use and land abandonment is predicted to increase [6]. Rural depopulation leads to a loss of traditional farming knowledge. The loss of traditional land management practices leads to ecosystem change, which successively is likely to lead to the loss of important biological or cultural values [7]. Most European landscape systems have been developed almost entirely by the presence of human activities, and traditional practices and management of these systems have shaped the European landscapes [8]. Slovenian cultural landscapes recognized as valuable are probably the main element of national identity [9]. The wide range of cultural landscapes in Slovenia as a result of their geographical and cultural diversity has their place in social conception of space [9,10]. Kučan [10] has showed that Slovenian national identity is defined by symbolic places and special landscape types. Specific landscapes emerge as representative of the whole, appearing as symbolic places or as conceptualized landscape types composed of various and distinct landscape features [10].

Moreover, as locals and non-locals decide what is meaningful for them and how to manage the landscape [11],

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landscape management is dependent on local inhabitants and their cultural context. Marcucci [12] claimed that “The history of each landscape is unique – it is also complicated.” The creation of the current landscape, as we see it now, is dependent on the values and activities that people had and continue to have in their environment. Today’s landscapes are in part the product of historical cultural values [12].

The aim of this research is to interpret the development of two cultural landscapes by analysing the land use changes and identifying the factors which influenced it.

As landscape can be seen as spatial variations in vegetation cover, and it is possible to determine its diversity based on land use patterns [13], we analysed the spatial processes and patterns across temporal and spatial scales to unveil the landscape changes. Structural changes in land use are diagnostic of the restructuring occurring at the economic and social levels. Spatial and temporal analyses were undertaken on two case studies (settlements of Adlešiči and Bojanci) which were selected for an in-depth study of landscape changes over the last 200 years based on historical sources.

We hypothesized that the landscape changes over time might be different in Adlešiči and Bojanci, as result of different cultural realities (such as traditions and ethnicity) and socio-economic influences (such as migration). Weber *et al.* [14] suggest that migration and ethnicity are two main components that shape the cultural orientation system, which influences decision-making concerning land use, inducing new practices. Although these case studies have different management regimes (Adlešiči is still being cultivated and Bojanci is mainly covered by forests), they are both affected by difficult karst terrain and geographical isolation. These case studies show historically distinctive cultural landscapes formed by a long-term interaction between natural conditions and human influence.

2 Materials and methods

2.1 Study region and case studies

Bela krajina (White Carniola) is located in the south-eastern part of Slovenia (Figure 1), along the Slovenian–Croatian border, covering 595 km². The region is characterized by a weak economy, unfavourable demographic structure (ageing population) and well-preserved nature.

Figure 1: Geographical location of the study region (Bela krajina), its three municipalities (Črnomelj, Metlika and Semič), and the selected case studies (settlements of Adlešiči and Bojanci).

According to Plut [15,16], the uneven regional development of Bela krajina is a reflection of the relatively scarce natural resources, karst terrain, remoteness regarding major roads, underdeveloped infrastructure, belated industrialization, dispersed settlements, and low education levels.

Bela krajina was selected as the study region because it represents a geographically marginal Slovenian karst landscape and of its cultural diversity. Karst landscapes in Slovenia cover over 44% of the country’s area and are characterized by stony surfaces with dolines, collapse dolines, solution valleys, poljes, corrosion plains, and dry and blind valleys [17]. Karst landscapes are recognizable important features at a national level, cultural and symbolic landscape identity, and natural characteristics with distinctive features limiting and directing human activities. As Bela krajina is located along part of the national border and mainly due to the border itself, immigration and emigration have been the permanent fixtures in the region [18; Figure 2]. The region has been settled by various ethnic groups that have contributed to its ethnic and cultural diversity.

The arrival of the Ottoman Empire in Europe at the end of fourteenth century demographically influenced the settlements in Bela krajina [19]. Consequently, the Habsburg Monarchy began to organize defences, establish a military frontier, and settle a war-capable population. Uskoks, refugees from the Ottomans that fled from the conquered or even unconquered areas of the present-day Croatia and Bosnia and Herzegovina, began settling in Bela krajina to protect the Habsburg Monarchy from Ottomans invasions [19].

In the second half of the nineteenth century, the Ottoman threat ceased and the military frontier became obsolete.

Figure 2: Demographic fluctuation in Adlešiči and Bojanci settlements.

Inhabitants of Bela krajina were, besides political changes, also affected by the agrarian reforms.

It is difficult to determine only one main factor for mass emigration from the region. But the most decisive factor was the poor economic situation in the last years of the nineteenth century. People from Bela krajina emigrated to the United States of America and to a lesser extent to Canada and Argentina. The first economic migrations across the Atlantic (ocean) were documented in 1847, and it was reported [18] that the major peak of emigration in Bela krajina was reached between 1912 and 1927. Paradoxically, the population emigrated vastly right after the construction of the railway, which enabled faster outmigration [20]. Until the Second World War, Bela krajina was partly abandoned. After 1945, the connection of Bela krajina with modern infrastructure and industrialization began. However, emigration continued, even after this time [21].

Spatial and temporal analyses were undertaken on two case studies. The two case studies were selected to represent the settlements of Adlešiči and Bojanci (Figure 1). The choice for these case studies was guided by the

distinctive patterns of its landscapes (land use and appearance), as a result of their historically distinctive character.

Adlešiči is a settlement of Slovenian ethnicity and catholic religion. Before the First World War and during the interwar years, the inhabitants of Adlešiči were predominantly a peasant population who lived from agriculture, animal husbandry, and partly from viticulture. After 1955, many inhabitants of Adlešiči started working in Črnomelj (in food and concrete industries), and in Semič (in electrical industry) after 1970 [22].

Bojanci was selected as its inhabitants are different from other nearby Slovenian settlements, in the sense of mother language, national identity, and religion. The area around Bojanci was colonized by Uskok population in 1548 [23]. As a result, Bojanci presents a different ethnic composition of its inhabitants (Serbs, Slovenes, Croats, and Yugoslavs; Table 1). With colonization by the Uskok population, deforestation took place in Bojanci. In return for military service, land was given to Uskoks as inherited property. They were also involved in animal husbandry, especially of sheep, and trade [24].

Table 1: Ethnic declaration of the Uskok population in the settlements of Bojanci [25]

Settlement	Ethnically defined											
	Number of inhabitants										Ethnically undefined or unknown	
			Serbs		Slovenes		Croatsians		Yugoslavs			
	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991
Bojanci	97	99	74	47	21	18	-	1	1	14	1	19

Uskoks brought with them a special breed of sheep (“*pramenka*”) and pig (“*mangulica*”), which grazes outdoors [26]. Compared with the inhabitants of Adlešiči, Uskoks had special rights and were not directly integrated into the feudal system [24]. Cooperativism was until the Second World War, still preserved in the settlement. Marriages happened only between community members. Regarding religion, most of the inhabitants preserved the Orthodox faith and they also preserved the heritage of their homeland as well as the costumes, despite centuries of outmigration and disconnection from their mother country [27].

Figure 2 shows the fluctuation of the population in the Adlešiči and Bojanci case studies from 1830 to 2015.

2.2 Data collection and processing

As stated by Cousins [28], land use maps corresponding to different time periods make it possible to observe the changes between land use categories and to analyse the land use history of a specific site. The analyses of landscape change are thus based on a variety of sources, including historical maps, cadastral maps, archival data, and data acquired in the field.

The basis of these analyses was the delineation of land use units, from four data sources: Franziscean Land Cadastre (1824), Revised Land Cadastre (1877), Agricultural Map (1987), and field mapping (2012). Historical maps utilized in this study were produced using different cartographical and land surveying techniques.

The Franziscean and the Revised Land Cadastres were acquired from the Archives of the Republic of Slovenia. The Agricultural Map was acquired from the Administrative Unit of Črnomelj. These historical maps were first scanned (except Franziscean Cadastral map sheets that were previously acquired in digital format), georeferenced, and converted to vector format to be further analysed. For estimating the accuracy of the historical maps, several control points were chosen from these maps, corresponding to the locations identified in digital orthophotos from 2009 acquired at the Surveying and Mapping Authority of the Republic of Slovenia (GURS), using ArcGIS 10. Data for the contemporary land use (2012) were acquired through field mapping; and at the end, field maps were digitized in ArcGIS. Each data set was handled in a separate layer in geographic information system (GIS).

Data on cultural reality (ethnicity and demographic data) were acquired from the literature and archives.

2.3 Assessment of land use dynamics

The land use analyses were carried out in two steps. The first step was to create land use maps that are thematically comparable [28]. In general, the various maps used in this study are comparable, but they are not identical because they have been created for different purposes and the mapping methodology used was also different; therefore, the land use categories vary among them. In the analysis, we included data from each of the available years (1824, 1877, 1987, and 2012). As the data from 1987 (agricultural map) did not have information for meadows and pastures individually, but only a class of grasslands (including meadows and pastures), we considered meadows and pastures as only one land use category (grasslands), and this also applies to the other three data sets (1824, 1877 and 2012). And so, we have used eight land use categories: cultivated field, garden, vineyard, grassland, shrubland, forest, inland water, and built-up. As raw data from 1877 do not provide information about shrublands, we assumed that there were no shrublands in this period.

The second step was to analyse the landscape changes (through land use changes) through time for both case studies. Land use maps pertaining to the four time periods were created in ArcGIS 10.1. In such a way it is possible to visualize changes between layers. The calculation of land use changes among land use categories was also done in ArcGIS 10.1.

3 Results

3.1 Land use changes

Major changes over time can be noted in Adlešiči for the land use categories: cultivated fields, grasslands, and forests (Figure 3). Major changes over time can be noted in Bojanci for the land use categories: cultivated fields, grasslands, shrublands, and forests (Figure 4).

Cultivated fields in Adlešiči showed a slight increase from 1824 to 1877 but a significant retraction from 1877 to 2012 (Figure 5; row 2 in Table 2). The areas occupied by gardens in Adlešiči experienced fluctuations for the time span studied (Figure 5; row 3 in Table 2). Vineyards in Adlešiči show an increase until 1877 and from then a retraction (Figure 5; row 4 in Table 2). Grasslands in Adlešiči show a slight increase in area until 1987, and after this period the area was reduced due to an increase

Figure 3: Land use categories over time for the Adlešiči case study.

in forests (Figure 5; row 5 in Table 2). Shrublands in Adlešiči do not occur in 1877, after this period they increased (Figure 5; row 6 in Table 1). The forest areas in Adlešiči slightly decreased from 1824 to 1877 but significantly expanded from 1877 to 2012 (Figure 5; row 7 in Table 2). Over all of the map series, inland waters in Adlešiči appear constant with only minor variations (Figure 5; row 8 in Table 2). Built-up areas in Adlešiči doubled in size from 1824 to 2012 (Figure 5; row 9 in Table 2).

Cultivated fields in Bojanci showed a dramatic decrease from 1824 to 2012, although this change is more evident from 1877 to 1987 (Figure 6; row 2 in Table 3). The areas occupied by gardens experienced fluctuations for the time span studied (Figure 6; row 3 in Table 3), the same as in Adlešiči. In Bojanci, the area of vineyards is almost negligible; and as with gardens, this land use category also experienced slight fluctuations from 1824 to 2012 (Figure 6; row 4 in Table 3). In 1824, grasslands dominated in Bojanci, and this area significantly increased until 1877. After this period, the area was reduced due to the increase in forests (Figure 6; row 5 in Table 3). Shrublands in Bojanci occupied an extensive area in 1824; in 1877, this land use category

did not occur; but from 1877 to 2012, it increased, although to a smaller proportion than the initial area (Figure 6; row 6 in Table 3). Even though forest area was already quite extensive in 1824, the afforested land significantly expanded over time (Figure 6; row 7 in Table 3). In Bojanci, inland waters were represented by a negligible area in 1824 and 1877, corresponding to water ponds; and after this period, these areas do not occur (Figure 6; row 8 in Table 3). Urban expansion occurred in Bojanci from 1824 to 1987, after this period the built-up areas show a small reduction (Figure 6; row 9 in Table 3).

3.2 Factors which influenced the landscape changes

In both case studies, the major landscape changes took place between 1877 and 1987. Since in Bela krajina the major peak in emigration was between 1912 and 1927, it was expected that the amount of land abandoned would increase as a result of outmigration. In this period, the amount of cultivated fields declined in both case studies

Figure 4: Land use categories over time for the Bojanci case study.

(Figure 7). Gardens also decreased in both case studies between 1877 and 1987. The assessment of the relationship between abandonment of agricultural land (through changes in the surfaces occupied by cultivated fields) and population dynamics for the time span between 1824 and 2012 is shown in the Figure 7.

The changes in cultivated fields are closely related to the demographic changes in Bojanci (shown in brown, Figure 7). The slight increase in these areas between 1824 and 1877 was accompanied by an increase in the number of inhabitants in Bojanci for the same period. The pronounced decline in cultivated fields between 1877 and

Figure 5: Changes in proportion of land use categories over time for Adlešiči.

Table 2: Coverage of land use categories (ha) in the Adlešiči case study

Land use category	1824	1877	1987	2012
Cultivated field	44.23	44.89	7.67	3.48
Garden	0.32	6.32	1.01	10.02
Vineyard	4.49	8.4	3.8	2.83
Grassland	68.55	73.25	74.16	46.93
Shrubland	16.06	0	0.93	14.35
Forest	13.67	13.59	52.04	65.37
Inland water	4.99	4.99	4.95	4.21
Built-up	5.32	6.19	13.07	10.44

1987 is parallel to a pronounced decline in population due to emigration, continuing to 2012. This connection between changes in cultivated fields and population dynamics is not seen in Adlešiči (shown in green, Figure 7). A slight expansion of cultivated fields from 1824 to 1877 is not followed by an increase in the number of inhabitants in Adlešiči. Actually, demographic fluctuation is not so obvious in this case study. Nevertheless, the surface here covered by cultivated fields also immensely diminished in the analysed time period. As the inhabitants of Adlešiči were predominantly a peasant population before the First World War; and after the year 1955, they started to work in industry, which led to a change in the professional structure of the population that could be the main cause of agriculture abandonment in the settlement, and not the outmigration as seen in the Bojanci case study.

In both case studies, from 1987 and 2012, forests and shrublands continued to increase, while grasslands and cultivated fields continued to decrease. In 2012, a slight

Table 3: Coverage of land use categories (ha) in the Bojanci case study

Land use category	1824	1877	1987	2012
Cultivated field	71.05	70.76	15.15	2.89
Garden	0.25	4.24	1.2	8.08
Vineyard	0.25	1	0.56	0.94
Grassland	283.51	405.5	128.31	54.01
Shrubland	186.33	0	19.53	49.24
Forest	202.95	262.65	573.84	631.35
Inland water	0.12	0.12	0	0
Built-up	11.66	11.85	17.53	9.61

expansion of gardens was observed, suggesting a recourse towards homestead food self-sufficiency.

4 Discussion

We analysed the spatial processes and patterns across temporal and spatial scales to unveil landscape changes in Bela krajina. The analyses were undertaken on two case studies which were selected for an in-depth study on landscape changes over the last 200 years based on historical sources. The results from land use changes show that the spread of forests is a general phenomenon, mainly due to the abandonment of cultivated fields and grasslands. However, differences between the case studies are obvious. This trend is much more pronounced in Bojanci (Figures 4 and 6) than in Adlešiči (Figures 3 and 5). The total area of fields decreased by 25.9% in Adlešiči and 9.0% in Bojanci, while the total area of forests increased by 32.8% in Adlešiči and 56.7% in Bojanci.

Figure 6: Changes in proportion of land use categories over time for Bojanci.

Figure 7: Changes in the surfaces of cultivated fields and demographic fluctuation between 1824 and 2012 for both case studies.

Figure 8: Schematic representation of the major land use changes occurred in Bela krajina, during the past 200 years.

The increase in forests and decrease in cultivated fields were also noted in other cadastral municipalities in Bela krajina [29]. In general, the study region is characterized by the abandonment and overgrowth of agricultural land, this could be seen as a result of its remoteness, less favourable conditions for agriculture (karst terrain), and less favourable socio-economic structure, similar trends have been discussed by [6].

Interestingly, the natural conditions for agriculture were identified [30] as being more favourable in Bojanci

than in Adlešiči; however, land abandonment in the studied period was more pronounced in Bojanci. This suggests that even though the natural characteristics of karst landscape hamper agricultural production in the study region, as it was previously showed by [18], they do not explain the differences between the case studies but might be one of the reasons for outmigration from the region (Figure 8).

The differences among case studies could be attributed to different cultural realities and socio-economic

influences as hypothesized. However, the relation between land use changes and the cultural conditions, especially ethnicity, is not obvious as the cause of a profound change in the landscape. Before the colonization of Uskok population, Bojanci was a forested landscape. Uskoks also brought their shepherd tradition with them and introduced special breeds of sheep and pig. In this way, they introduced their cultural and agricultural practices, but these practices are not noticeable in the landscape. As the share of inhabitants from Bojanci who defined themselves as Serbs decreased from 1981 to 1991 (Table 1), and the share of ethnically undefined or unknown inhabitants increased from 1981 to 1991, this might be an indicator for the loss of ethnic identity of the inhabitants from Bojanci. By analysing Table 1 and the land use changes in Bojanci, we cannot prove that the strong ethnic attachment still maintained by the descendants of Uskoks, as [27] claimed, has influences on land use change. So with our results we were not able to prove that different cultures have varying perceptions of the landscape functioning as it was proved by [14]. In any case, we lack data for a wider range of time as well as data from Adlešiči, to allow a comparison between both case studies. After 1991, the systematical collection of data on ethnicity and data covering religion was not done anymore. In 2002 census, the data on national/ethnic affinity and religion were not obligatory and personal data protection was guaranteed. Even though we were not able to prove the direct influence of cultural realities in land use changes, we defend that the landscape history is essential in order to understand the patterns of change in landscapes.

The relationship between demographic data and landscape changes shows that demographic changes are the main driver of land use changes in Bojanci, more specifically depopulation which is mainly connected to economic reasons. The decrease in agricultural land use and depopulation was also verified by [31].

Adlešiči also suffered from depopulation, however, not at the same extent as Bojanci. In this case study, it is likely that major changes emerged from transformation of the socio-economic structure to non-agrarian jobs and depopulation as the result of industrialization and de-agrarianization.

5 Methodological constraints

Although the use of historical maps allows analysis of long-term changes to a landscape, it is important to

mention that the analysis is dependent on the quality of the maps. As the historical maps utilized were produced for different purposes and using different cartographical and land surveying techniques, their quality is related to their original purpose and therefore uncertainties in the maps might affect the quality of the analysis [32].

For example, we noted that in both case studies, areas mapped in 1824 as shrublands were grasslands in 1877. This suggests that the category “shrubland” was not mapped at all in 1877. Since most of these areas were mapped as forests in 1987, it suggests a cartographic error of the 1877 data set (Revised Land Cadastre), as it is less likely that shrublands were converted to grasslands (1824–1877) and from grasslands to forests (1877–1987).

In 1987, an increase in built-up surface was noted in both case studies (Figures 5 and 6), suggesting that these areas were roughly mapped in agricultural map, since the surface covered with urban areas decreased again in 2012.

Nonetheless the time span between 1877 and 1987 is quite long (more than 100 years) compared to the time span between the other adjacent time series, and other changes could have taken place in this period that were not assessed in this study due to the lack of available data.

Even though the share of gardens has increased from 1824 to 2012 in both case studies, suggesting a recourse towards homestead food self-sufficiency, this could also mean that gardens have been mapped according to different criteria (e.g. according to its size or according to its proximity to houses) in each of the data sets and therefore the changes in gardens might be misleading.

6 Conclusions

Depopulation, in connection with socio-economic influences, are the main landscape drivers of the landscape changes over the years in Bela krajina. Land abandonment is a major trend taking place in Europe, usually the areas that are being abandoned are affected by physical terrain (not suitable for mechanization), isolation, and lack of alternative sources of income across the region, leading to gradual abandonment of agricultural practices [12] as it was also noted in this study.

From an environmental point of view, land abandonment and afforestation can be seen as positive land use changes; however, afforestation in the study region contributes to the loss of landscape diversity, loss of

biodiversity, and loss of the cultural landscape as [7] claimed. Conversion of farmland to forest reduces the amount of land available for food, which is an important aspect regarding the sustainable development for Bela krajina.

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