

# LANDSCAPE TRANSFORMATION IN THE LOW KARST PLAIN OF BELA KRAJINA (SE SLOVENIA) OVER THE LAST 220 YEARS

## SPREMEMBE KRAJINE NA OBMOČJU BELOKRAJSKEGA NIZKEGA KRASA V ŽADNJIH 220 LETIH

Andrej Paušič, Andraž Čarni



ANDREJ PAUŠIČ

Steljniki of Vinomer near Metlika. As a result of land use abandonment, steljniki are mostly overgrown today. Traditional agricultural methods and knowledge are lost.

Vinomerski steljniki blizu Metlike. Zaradi opuščanja živinoreje se danes steljniki zaraščajo, s tem pa se izgublajo tudi tradicionalne metode kmetovanja.

## **Landscape transformation in the low karst plain of Bela krajina (SE Slovenia) over the last 220 years**

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**ABSTRACT:** The changes in land use, landscape structure and heterogeneity in Bela krajina were compared over a time interval of 220 years and linked to the socioeconomic factors. A significant increase of forested areas in the past 220 years is evident, which has led to forestation of open pastures. Until 1913, the landscape was agricultural. After human emigration at the beginning of the 20<sup>th</sup> century and World War I, the land was partly abandoned. During and after the World War II local inhabitants migrated from the region. The land structure changed and became of a transitional type. The third wave of emigration started in the 1960s. By around 1980, the study area had become completely forested. After 1981, the number of inhabitants again increased in settlements near traffic routes but people were employed in other economic activities. This trend had no significant impact on the landscape. The study shows that the present landscape structure is substantially different from those in past and reflects the current social and economic features.

**KEYWORDS:** geography, landscape heterogeneity, landscape structure, landscape change, afforestation, Slovenia, Bela krajina

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### **ADDRESSES:**

#### **Andrej Paušič**

Jovan Hadži institute of biology

Scientific Research Centre of the Slovenian Academy of Sciences and Arts

Novi trg 2, SI – 1000 Ljubljana, Slovenia

E-mail: andrej.pausic@zrc-sazu.si

#### **Andraž Čarni, Ph. D.**

Jovan Hadži institute of biology

Scientific Research Centre of the Slovenian Academy of Sciences and Arts

Novi trg 2, SI – 1000 Ljubljana, Slovenia

and

University of Nova Gorica,

Vipavska cesta 13, SI – 5000 Nova Gorica, Slovenia

E-mail: carni@zrc-sazu.si

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# 1 Introduction

Intensive clearing, burning and the formation of the open landscape of Bela krajina dates to time between the late prehistoric and medieval periods. Palynological research suggests that human impact was significant and contributed to increasing biodiversity (Andrič 2007b). The human impact on vegetation in Bela krajina was much stronger than in other parts of Slovenia (Andrič and Wallis 2003; Andrič 2007). This is an indication that the region was not unpopulated, as it has been in the recent period. Bela krajina became part of the Krain Region (nowadays an integral part of Slovenia) in the 15th century. In the 16th century, the so-called Vojna Krajina (War March) was formed in Croatia and Serbia, and Turkish incursions ceased to be a threat to the country. Areas of forest were already small at that time and were the property of feudal lords. After the first agrarian reform (beginning of 19th century), the local peasants were free from taxes and could possess their own land. As a consequence, the land was divided among the people (Kos 1991). The region thus experienced the gradual formation of a cultural landscape, which began to change intensively at the beginning of the 20<sup>th</sup> century. This was a result of a period of migration of the local inhabitants away from Bela krajina. There were three major migration flows, with the first at the beginning of the 20th century, when people migrated to Western Europe and North and South America. The second wave of migration took place during WWII and the third wave resulted from the delayed industrialisation in the 1960s, when the local inhabitants emigrated to larger industrial hubs (Orožen Adamič et al. 1995). During and after the emigration waves landscape was abandoned and the process of afforestation was going on. As a consequence, the structure and heterogeneity had changed.

Many studies have been conducted in Europe that have attempted to understand and evaluate changes in landscape (Skanes and Bunce 1997; Aničič and Perica 2003; Eetvelde and Antrop 2004; Urbanc et al. 2004; Kaligarič et al. 2006; Schneeberg et al. 2006; Sirami et al. 2010; Persson et al. 2010; Tempesta 2010; Ignacio-Diaz et al. 2011, Paušič and Čarni 2012). These studies have also dealt with the landscape indicators that drive changes in land use and landscape structure and even determine the appearance of the landscape as a whole, therefore the spatial heterogeneity that indicates the variability of the system's properties in spatial terms (the landscape structure) (Calvo-Iglesias et al. 2006; Sirami et al. 2010).

In our study we investigated the landscape structure change and its indicators. We observed the following landscape characteristics (Farina 2001, 2007): a) the proportion of major land use (forest, meadows, pastures, fields, vineyards and urban areas); b) heterogeneity (homogenous space, heterogeneous fine-grained, heterogeneous coarse-grained, heterogeneous mixed); c) landscape type (agricultural, transitional or wooded and forested) (Anko 1982).

The main aims of this study were: (A) to determine (and evaluate) changes in the landscape in the area of SE Slovenia in the past 220 years, (B) to relate landscape changes to demographic changes and (C) to identify the rate of modification of the landscape during the process of population migration and abandonment of agricultural land use.

Additionally we were keen to answer the following sub-questions: (1) how important is sheep grazing (main grazers in study area) for the landscape structure and heterogeneity, what happens to the landscape structure if such disturbance is eliminated from the area?

The changing of the human population was also studied in detail. Our second (2) objective was to establish whether the changes of human population could be associated with increased land afforestation.

## 2 Methodology

### 2.1 Study area

The research took place in the south eastern part of Bela krajina, near Črnomelj. To the south and east Bela krajina is bordered by the Kolpa River, to the north by the slopes of the Gorjanci mountain range, and to the west by the Poljanska Gora and Kočevski Rog mountain ranges. From the Bela krajina plain (190–220 m), the surface rises to Slovenia's high Dinaric karst in the northwest of Bela krajina between the Kočevski Rog and Gorjanci mountain ranges (Gams et al. 2011). Northeastern part of Bela krajina consist of the peaks (576 and 626 meters above sea level), the upper edge of the vineyard belt is around

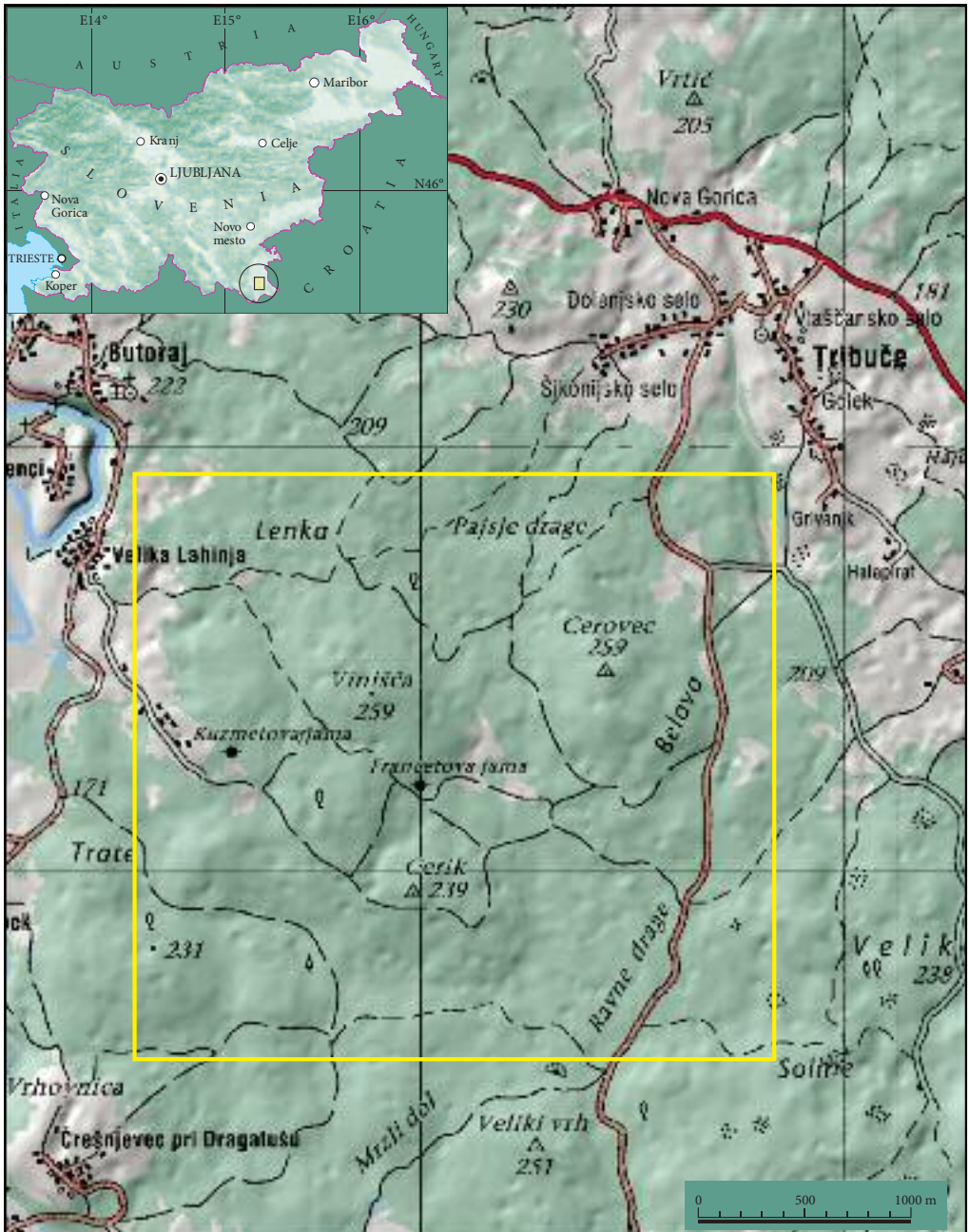


Figure 1: Study area in SE Slovenia.

400 meters, and the transition to the Črnomelj plain at the lower edge of the slope lies at an altitude of around 220 meters.

The study area is located on karst solution plain, formed mainly by calcareous rocks, limestone and dolomites. On the surface, these rocks weather into chromic cambisols and luvisols, which sporadically even completely cover them. Annual precipitation in this part of Slovenia ranges between 900 and 1200 mm

and mean annual air temperature is 10.2°C (Internet). The potential natural vegetation of the area is *Quercus-Carpinus* forest (Čarni et al. 2007).

An area of 1000 ha was selected for the research (45.514535°–45.539406°N and 15.209397°–15.246939°E) (Figure 1), with an altitude between 160 and 420 metres and fairly homogeneous in terms of geomorphology and climate.

## 2.2 Data sources – historical land-cover data

The first information about land use that can be geo-referenced is from Josephine military maps (1 : 28.000), which were prepared for military purposes at the end of the 18<sup>th</sup> century (1784–1790) (Rajšp and Ficko 1996; Rajšp et al. 1997) and were used as the information layer for 1790.

Another reliable source of information is the Franciscan land cadastre (1 : 1440 and 1 : 2880), which provides exact information about land use in 1823 (Petek and Urbanc 2004).

A military map (1 : 75.000; Militärgeographisches Institut 1913) was used for 1913, from which we obtained information about detailed land use in the study area.

In year 1918, a new state, the Kingdom of Yugoslavia, was established, which invested considerable resources in the southern parts of the country. For the territory of Slovenia only a special military map (1 : 25.000) from 1937 (V.G.I. 1937) exists.

From 1954 on, cyclic aerial photos of the land exist and were used as information layers (1954, 1975, 1986, 1999 and 2009). They were provided by the Surveying and mapping authority of the Republic of Slovenia (GURS 2009).

Since not all data were available for each time sequence for the same area, we decided to include an L-shaped study area, which covers the data of all layers.

## 2.3 Analysis of land-cover data

Land cover data were digitalized and geo referenced using ArcInfo 9.2 programme (ESRI 2008). Digitalised military map and cadastral maps (1790 and 1823), digitalised topographic maps (1913 and 1937) and aerial photos (1954, 1975, 1986, 1990, 2009) provided a relatively good insight into the dynamics of changes that have taken place in the study region. The Josephine military map (1 : 28.000) provides just an approximation of the real land use of that time since the map is rather imprecise. Another problem these map has is the determination of land use types (eg. pasture – meadow, meadow – field) since those categories were not clearly marked.

Franciscan land cadastre (1 : 1440 and 1 : 2880) on the other hand is reliable and accurate material to use. The land use types are well described and marked with the parcel number in the descriptive part of the cadastre.

The material from younger age (after 1823), used for the study, is accurate enough to distinguish the basic land use categories and to fulfil the precise study.

Data on the rate of spontaneous afforestation are of considerable importance in terms of the dynamics of landscape transformation and also provide an insight into the fundamental rules of interrelation and transition between individual land use categories (forest, field, meadow, pasture). It can be therefore determined which of these categories have been subject to change, which of them have expanded the most and how the landscape structure used to appear (and also enable a presentation of the results).

We analysed the appearance of forest areas, pastures, meadows, fields, vineyards and urban areas in the above-mentioned time interval and transformations of one land use into another. We selected for that purpose 200 equidistant plots, at the distance of 150 meters within the study area. The plots were located in different land use types. Information about the land use dynamics and afforestation was extracted by overlaying old cadastral maps, military maps and digital orthophotos.

In the next stage a diagram of landscape structure transformation was prepared along with a matrix for transformations of individual land use during selected time periods. The matrix facilitates understanding of the processes taking place during the observed periods and provides information on the conservation status of an individual land use (Reger et al. 2007).

Based on the information obtained through all the analyses performed, a diagram of landscape structure transformation was prepared.

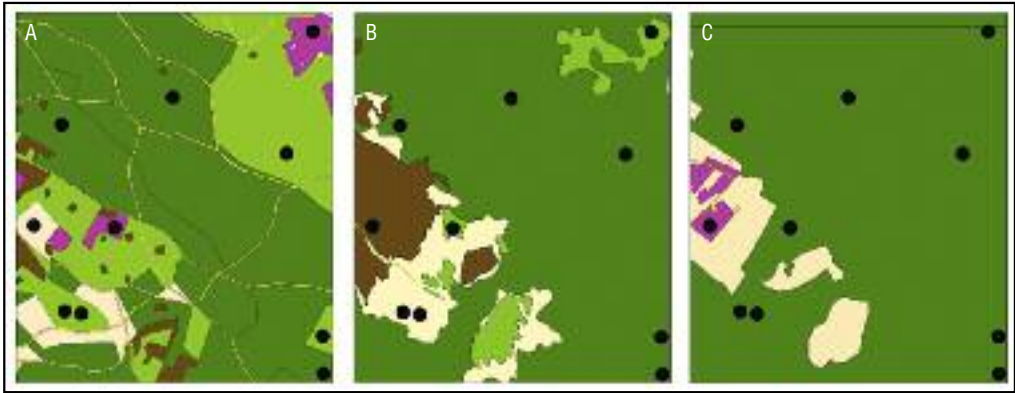


Figure 2: Landscape fragmentation of the studied area. In situation A (1823), there are 9 polygon groups (the randomised point fell in nine different plots). In situation B (1954) 5 groups appear. In situation C (2009) there are just two groups (attrition process).

## 2.4 Human population data; data on sheep number

Changes in the number of inhabitants and the number of sheep in the study area are indicators that facilitate better understanding of landscape transformations. Spontaneous afforestation is often described as a delayed phenomenon that follows population migration (Scozzafava et al. 2004). The total sheep number provides good information about land use. This, in turn, has an influence on the landscape mosaic pattern (Lang and Blaschke 2007).

Data on the number of inhabitants was collected from available sources provided by SURS (2012) (Internet) and Šifer (1969). We obtained data on the number of sheep for 1823 (Franciscan land cadastre for Kranjska 1823–1869), 1913 and 1931 (Local Lexicon of the Drava Banovina 1937), 1971, 1981, 1991, 2002 (SURS 2012).

Data on the number of inhabitants and the number of sheep were collected for four villages in the close vicinity of the study area (Tribuče, Butoraj, Dragatuš and Bojanci) and the result obtained was presented as the sum of these values.

## 2.5 Analysis of the landscape fragmentation process

We set 300 randomized points in our study area and extracted the land use type for them for selected years (1790, 1823, 1913, 1954, 1986 and 2009). A table (Table 1) was prepared from the results, that shows (1) the mean surface (ha) of the land use category within which the points lie and (2) the number of (all) points, that lie in the same land use surface (same patch!). Two points that lie in the same land use area (polygon) but were separated in a previous time set therefore indicate the rate and manner of the landscape defragmentation process (Figure 2).

According to Anko (1982) and Pirnat (2000), a forested landscape is a landscape in which the proportion of forest exceeds 85% of the total surface area (interior area of the forest matrix) and a transitional landscape means a landscape in which the proportion of forest ranges between 40 and 85%. Forest cover in an agricultural landscape is 20–39% in the impact area (interior area of agricultural and urban areas).

Heterogeneity of a landscape structure implies that landscape elements are distributed unevenly and non-randomly (Farina 2007). It is described by the size (and combination) of individual landscape elements in a mosaic. The optimum is a coarse-grained landscape structure (Lang and Blaschke 2007; Ahlqvist and Shortridge 2010) that includes some fine-grained areas. Such a structure should provide a habitat for the existence of species associated with interior as well as edge areas (Farina 2007). We distinguish between a) an entirely homogeneous environment, b) a homogeneous environment with a small proportion of other land use types (between 1 and 5%), c) larger grains, d) finer grains and e) shape combinations (Lang and Blaschke 2007).

## 3 Results and Discussion

By overlaying various cadastral maps and recent aerial orthophotos, we obtained information on how the landscape changed between 1790 and 2009 (Figure 3), as proportions of different land-use categories. The changes in human population and in the number of sheep between 1823 and 2002 in study area in Bela krajina are represented in Figure 4.

The diagram describing the changes in proportions (%) of land use types in Bela krajina between 1790 and 2009 (Figure 5). It gives an insight into the dynamics of land structure change, since it clearly demonstrates the fast transformation of the landscape structure (by the changing proportion of observed land categories). On the basis of transformation of an individual land use type to another during the elaborated period, the process of landscape change can be divided into three segments:

- A characteristic of the period between 1790 and 1913 is that land use remained the same. More than 80 % of land was thus used in the same way during the period (with the exception of arable land, which became subject to spontaneous afforestation in 1913).
- The period between 1913 and 1954 was characterised by transformation of most categories into forest area.
- After 1954 there was an intensive trend toward afforestation of all observed land categories (the land-use conversion rate to forest was 60% or more of all observed areas).

### 3.1 Landscape structure between 1790 and 1913

In 1790, the study region had the characteristics of an agricultural landscape. The prevalent land-use type was pasture, indicating that sheep grazing was an important economic activity at that time. Forested areas were scarce and did not exceed a third of the study area. At that time, the area of forest had been reduced to its minimum extent.

The next periods for which information is available are 1823 and 1913. The total area of pastures was already declining in 1823 (and even more in 1913), while the total arable area was increasing. The total area of vineyards was below 2% of the whole area. It is evident that the landscape structure in this period remained more or less stable.

In this period, the landscape was an agricultural one, with extremely few urban areas (Figure 3). There were more urban settlements (grouped villages and villages along roads) in the westernmost part. The structure of the landscape mosaic was characterised by a combination of finer grains in the west and a homogeneous, coarse-grained structure in the east (Figure 3). Generally, small forest patches prevailed. There were no hedgerows or non-forest patches in the forested areas. The common straight forest edge was either un-fragmented or little fragmented. Based on the landscape matrix analysis, it can be said that it was a typical agricultural landscape type.

### 3.2 Period between 1913 and 1954

In 1913, forests already formed around one third of the total study area. The area of pasture had declined and was subject to afforestation (total scrubland had already doubled in extent). In 1954, however, the proportion of forest had risen to more than half of the total area. The proportion of arable land was almost the same as in 1937.

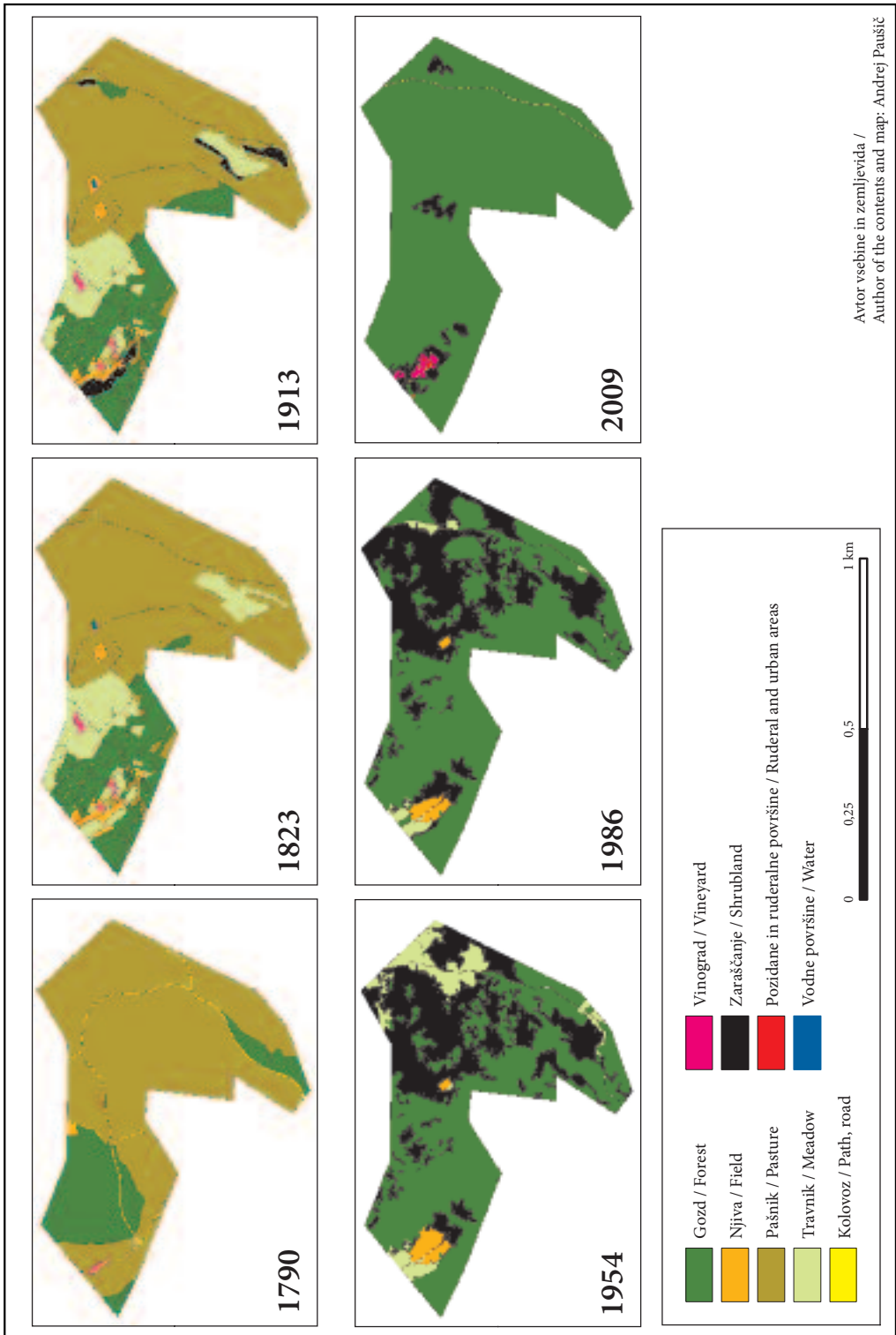
In that period, landscape heterogeneity in Bela krajina was at its peak. In year 1954 it is evident that the surface of forest patches increases already.

Figure 3 and figure 5 show the land transformation dynamics. It is evident that forest areas (unlike other land use categories) increased on account of pastures, that were rapidly becoming overgrown, which is why the proportion of forest had increased to such an extent (similar to other regions in Europe) (Poldini 1989; Antrop 2004; Morgan and Gergel 2010).

An important factor affecting the appearance and structure of the landscape in this period was World War II. During this period, there was a considerable increase in population emigration from the region

Figure 3: Sequence of digitalised cadastral maps and aerial photos (for 1790, 1823, 1913, 1954, 1986 and 2009). ►





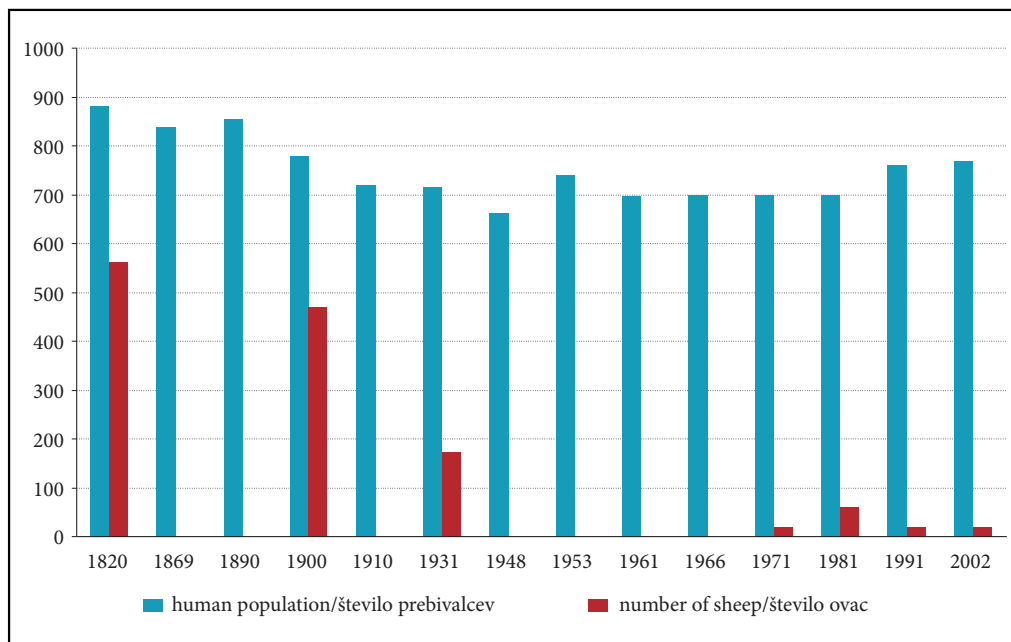


Figure 4: Changes in human population and in the number of sheep (data available for 1820, 1900, 1931, 1971, 1981, 1991 and 2002) between 1823 and 2002 in study area in Bela krajina.

of Bela krajina (the number of inhabitants was lowest in 1948), with some 60% of the area being afforested (Figure 4).

With a proportion of forest of 27,5% in 1937, it can be described as a transitional landscape type. A heterogeneous landscape structure prevailed, sporadically larger grains and a homogeneous combination of larger and finer grains in the SE part of the region. Forest patches were common and mostly medium in size. There were frequent non-forest patches (meadows or pastures within the forest). A rounded and fragmented forest edge prevailed. The landscape structure in 1954 was transitional. In the central part, a transitional landscape can be seen, while in the east, a mosaic of grazing areas and meadows under spontaneous afforestation formed a characteristic transitional landscape (Figure 3).

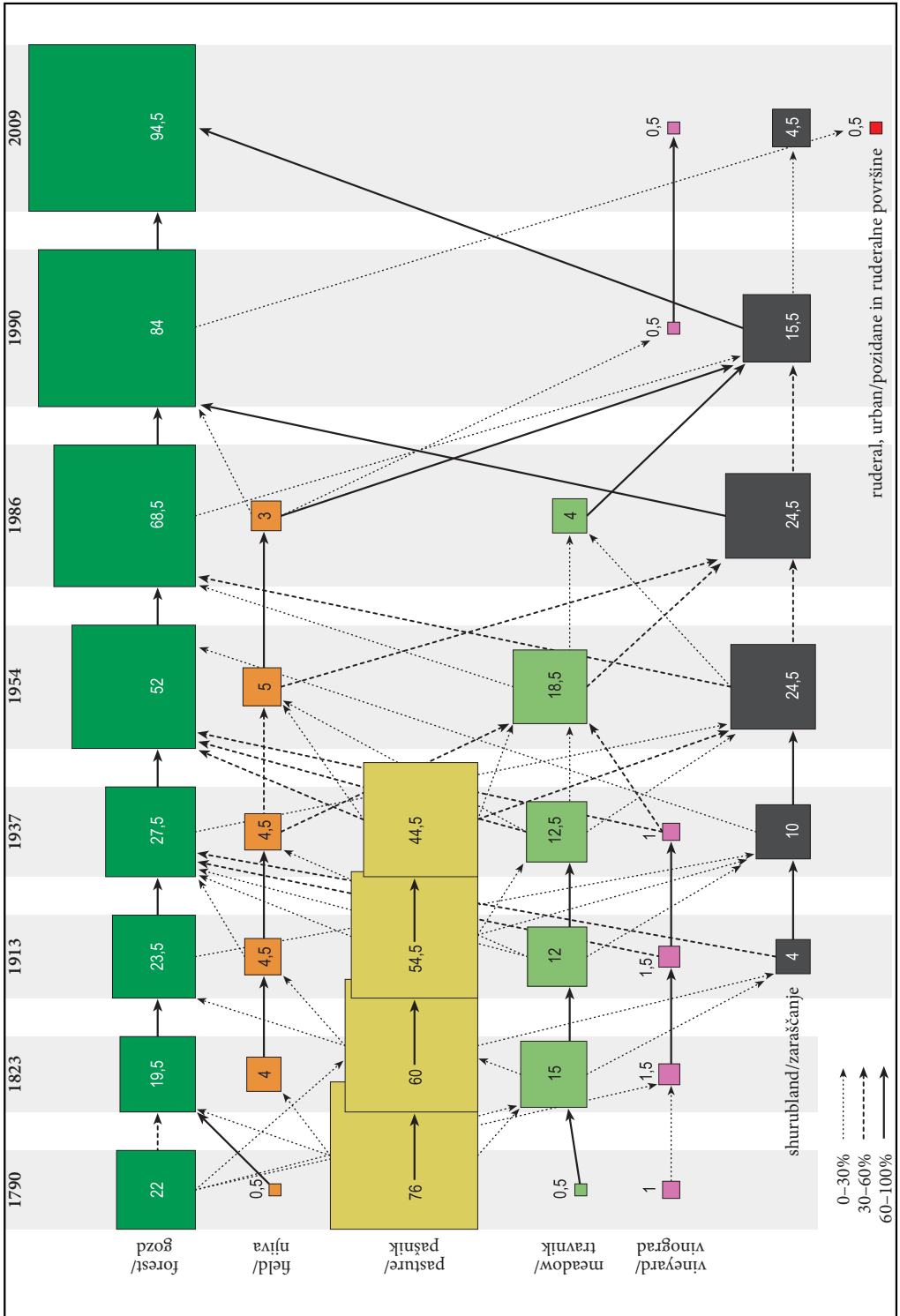
### 3.3 Landscape structure from 1954 to the present (2009)

In the most recent period, one third of the entire area being scrubland (in 1986). Fields, pastures and meadows have a very limited extent and have not existed in the study area since 1986 (since the landscape have even more abandoned). In comparison with the two previously described periods, this is a time in which the landscape lost its diversity (Topole et al. 2006).

By 1990, forest already covered 84% of the area and 15.5% was subject to spontaneous afforestation. Consequently, after 1990, the region features only 3 land use categories (out of 6 in 1937), which once again indicates the downward trend in the structural diversity of the landscape.

The studied region is currently (2009) dominated by a characteristic forested landscape type (with forest cover over 90%). Only the westernmost part of the region, near the village of Dragatuš, features an agricultural landscape. The characteristic structure is homogeneous, with a combination of finer and medium grains only in the west; there are few non-forest patches (pastures under spontaneous afforestation),

Figure 5: Changing landscape structure in Bela krajina (Slovenia) between 1790 and 2009. The diagram shows the observed land-use categories with added proportions of the area covered (%) and the conversion trend for individual categories during the observed time periods. ►



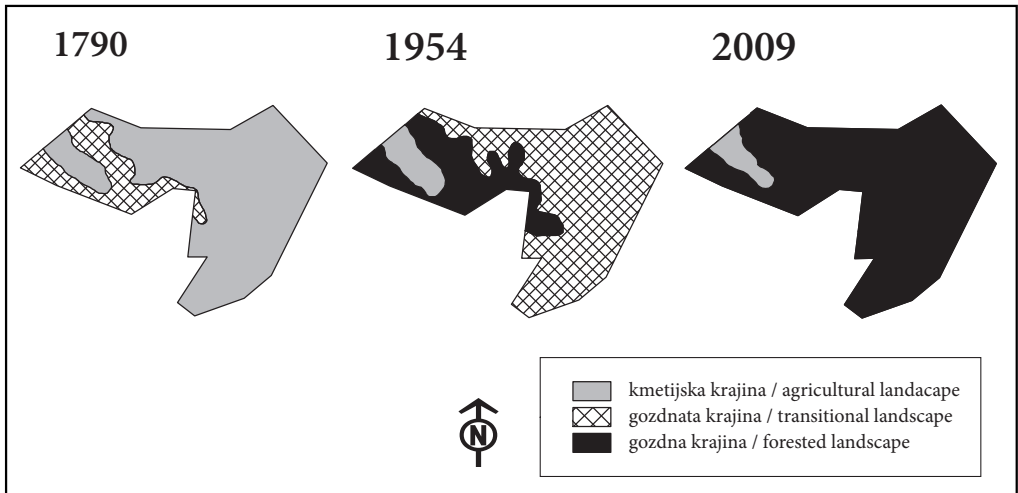


Figure 6: Changing landscape structure in Bela krajina in the period between 1790 and 2009. Presented are comparisons of the landscape structure in 1790, 1954 and 2009.

no hedgerows but a fairly homogeneous landscape structure. The proportion of basic land use categories (Figure 5) is small (only 4 categories), a notable impoverishment of landscape structure diversity.

Even though the number of inhabitants in the analyzed region has not changed very much from year 1900 on (Figure 4), despite the described demographic changes, the population is no longer as strongly agriculture or forestry-dependant as in the past. Most of the inhabitants today are employed in the tertiary economic sector in larger settlements (Črnomelj) or are engaged in supplementary activities (farm tourism, organic food and sheep production) that do not affect the structure and appearance of the landscape to the extent that traditional management did. This situation resulted in quick afforestation process and even more abandoned land.

### 3.4 Landscape fragmentation process

The mean patch size measured in year 1790 was 40.44 ha (Table 1) and there were 24 different land use parcels, where the randomised points lie. In 1823, the number of parcels rose to 170 and the mean patch size measured 2,287 ha. In 1954, we counted 197 point groups (parcels), the mean patch size measured just 0,238ha. Due to the attrition process (Forman 2006), in 2009 just 37 different parcels included all our randomized points. The mean patch size measured 43,873 ha.

The method used is represented in Figure 2, on an example of the part of study area. The observation and counting of randomized points in a changing landscape with the regard to patch size seems an efficient method for observation of the landscape fragmentation process.

Table 1: Landscape fragmentation process between 1790 and 2009.

Time interval	1790	1823	1913	1954	1986	2009
Number of points that coincide with the same patch	24	170	181	197	162	37
Mean patch size (ha)	40.44	2.287	1.782	0.238	5.321	43.873

Sheep grazing used to have a significant role in the appearance and structure of the landscape (Nagashima et al. 2002; Thomson and Simpson 2005; Wehn 2008; Carmona et al. 2010; Pipenbaher et al. 2011). We tried to link the decreasing number of sheep, the main grazers in the past (Local Lexicon of the Drava Banovina 1937) in the study area, (the villages of Bojanci, Butoraj, Dragatuš and Trubuče) with changes in the landscape structure.

We found a significant correlation between the decrease in the number of sheep and spontaneous afforestation (Figure 4, figure 5). The highest number of sheep in the region was in 1820 (562 animals). In 1931, the number had plummeted to 173. The trend continued until 1990, when the number was 20. In 2002, there were only 21 animals left. Grazing activity therefore used to have a key role in maintaining the landscape structure (Poldini and Feoli 2006; Morgan and Gergel 2010). After grazing was abandoned and spontaneous afforestation took place, this in turn changed the appearance of the landscape and its structure.

Our study has shown that the studied region in Bela krajina used to be an agricultural (partly also transitional), fairly evenly heterogeneous, medium-grained landscape (Figure 3), the structure of which became subject to rapid change. Although these changes were only minor in the first observed periods (1790, 1823, 1913), by 1913 this region was already considerably transformed. Today, this is a homogeneous forested landscape with large patches.

## 4 Conclusion

Similar studies conducted in Europe (Antrop 2004; Bender et al. 2005; Reger et al. 2007; Linden et al. 2008), show a similar pattern in the afforestation of abandoned agricultural regions. These studies also highlight the change in the demographic structure, reflected in land use practices, as the reason for the change in the landscape structure and demonstrate a similar pattern of change in the landscape structure through the observed period of time.

Our results show an extremely dramatic change in the landscape structure around 1954. Spontaneous afforestation of the landscape after WWII was faster than in other European regions (Čarni et al. 1998; Linden et al. 2008; Garcia-Feced et al. 2011). Our results also not only indicate the significance of human interventions in the appearance of the traditional landscape in Europe but also signal the threat to these landscapes by a changed land use regime.

Numerous studies have explored the afforestation of post-agricultural landscapes (Skanes and Bunce 1997; Čarni et al. 1998; Seabrook et al. 2006; Linden et al., 2008; Zomeni et al. 2008) but rarely cover



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Figure 7: Silver Birch (*Betula pendula*) is a characteristic species occurring in the early stage of forestation.





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Figure 8: Two sessile oaks (*Quercus petraea*) near the village of Tribuče with well developed lateral branches indicate the landscape was open (pasture) 10 years ago.



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Figure 9: A vineyard in Vinišča in Bela krajina that was abandoned 40 years ago.

the long time span available in the area of Bela krajina. This is primarily due to the lack of reliable and comparable data on the spatial patterns of land-cover types in other regions. This study provides an insight into changes in land cover over a period of more than two centuries.

In terms of the preservation of landscape diversity (if landscape is considered to be a system of ecosystems with individual structures, functioning and changes (Farina 2001; Garcia-Feced et al. 2011), we can confirm impoverishment at the landscape structural level as well as at the level of impoverishment of landscape elements (forests, hedges, hedgerows, meadow and pasture complexes).

Landscape evaluation based on landscape heterogeneity and structure is considered sufficient for a general evaluation of biodiversity at the landscape level.

With severely decreasing ecosystem (ecotope) diversity in recent years, it is again possible to speak of landscape impoverishment or fast change of an agrarian and transitional landscape into a forested one (Bela krajina). The present homogeneous forested landscape of Bela krajina is certainly very different as the diverse landscape structure from the period before 1954.

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## **Spremembe krajine na območju belokrajnskega nizkega krasa v zadnjih 220 letih**

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**IZVLEČEK:** Raziskava se ukvarja s spreminjanjem krajinske zgradbe na območju Bele krajine v zadnjih 220 letih. Do leta 1913 je bila Bela krajina značilna kmetijska krajina. Po prvem emigracijskem valu (po koncu 1. svetovne vojne) se začne območje postopoma zaraščati z gozdom. Druga svetovna vojna je regiji prinesla številne spremembe: začel se je drugi val izseljevanja prebivalcev, spremenila pa se je tudi krajinska zgradba. Zaradi intenzivnega opuščanja kmetijske rabe in zaraščanja kmetijskih zemljišč dobi Bela krajina značaj gozdnate krajine. Po letu 1960 se začne v Beli krajini tretji val izseljevanja prebivalstva. Leta 1980 raziskovano območje že popolnoma porašča gozd. Krajina postane gozdna. Po letu 1981 opazimo rahel porast prebivalstva, še posebej v naseljih ob glavnih prometnicah in v večjih naseljih. Ta trend pa ni imel vpliva na spremembo krajinske zgradbe. Današnja krajinska zgradba Bele krajine je precej drugačna kot v preteklosti in je odraz ekonomskih in socialnih sprememb v pokrajini.

**KLJUČNE BESEDE:** geografija, krajinska heterogenost, krajinska zgradba, spreminjanje krajine, zaraščanje, Slovenija, Bela krajina

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**NASLOVA:**

**Andrej Paušič**

Biološki inštitut Jovana Hadžija

Znanstvenoraziskovalni center Slovenske akademije znanosti in umetnosti

Novi trg 2, SI – 1000 Ljubljana

E-pošta: andrej.pausic@zrc-sazu.si

**dr. Andraž Čarni**

Biološki inštitut Jovana Hadžija

Znanstvenoraziskovalni center Slovenske akademije znanosti in umetnosti

Novi trg 2, SI – 1000 Ljubljana

in

Univerza v Novi Gorici

Vipavska cesta 13, SI – 5000 Nova Gorica

E-pošta: carni@zrc-sazu.si

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# 1 Uvod

Človeški posegi v prostor (požigalništvo, sečnja gozdov in oblikovanje odprte krajine) so v Beli krajini opazni že v času med prazgodovino in srednjim vekom. Palinološke raziskave opozarjajo na vpliv človeka v tistem času, tako na prostor kakor tudi na dvig biodiverzitete (Andrič 2007b). Človek je s svojim delovanjem v preteklosti v Beli krajini spreminjal gozd veliko bolj, kot v drugih delih Slovenije, zato so bile tudi spremembe pokrajine (kot posledica človekovega delovanja) v Beli krajini največje (Andrič in Wallis 2003; Andrič 2007). To je tudi dokaz, da regija od prazgodovine do srednjega veka ni bila nikoli neposeljena.

Bela krajina postane del Kranjske vojvodine v 15. stoletju, v 16. stoletju pa jo ogrožajo turški vpadi. Površina gozdnih območij je bila v tem času majhna in last plemiških družin. Po prvi kmetijski reformi konec 18. stol. dobi takrat svobodno belokranjski kmet pravico nakupa lastne posesti, od katere še zmerom plačuje dajatve plemstvu. Iz tega obdobja je opazna večja razdrobljenost nekoč homogene kmetijske posesti (Kos 1991).

Zato se širše območje Bele krajine oblikuje v mozaično krajino, v začetku 20. stoletja pa prične intenzivnost obdelave zemljišč naglo upadati.

Poglavitni vzrok za opuščanje obdelave zemljišč v Beli krajini v 20. stoletju je izseljevanje prebivalcev. Potrebno je omeniti tri pomembnejša obdobja izseljevanja. Najprej v začetku 20. stol. (pred prvo svetovno vojno), ko se prebivalstvo izseli v države zahodne Evrope ter v obe Ameriki. Temu valu izseljevanja je med 2. svetovno vojno sledil drugi val. V 60. letih pa omenjamo še tretji val izseljevanja prebivalstva, ki je posledica zakasnele industrializacije, ko se lokalno prebivalstvo preseli v večja industrijska središča (Orožen Adamič in ostali 1995).

Zato se je pokrajina med in po obdobjih izseljevanja postopno zaraščala zaradi prenehanja kmetijske obdelave zemljišč, s tem pa se je spremenila tudi krajinska zgradba in raznolikost.

Številne raziskave v evropskem prostoru opisujejo spremembe pokrajin v času opuščanja kmetijske rabe v odvisnosti od izseljevanja prebivalstva (Skanes in Bunce 1997; Aničič in Perica 2003; Eetvelde in Antrop 2004; Urbanc in ostali 2004; Kaligarič in ostali 2006; Schneeberg in ostali 2006; Sirami in ostali 2010; Persson in ostali 2010; Tempesta 2010; Ignacio-Diaz in ostali 2011; Paušič in Čarni 2012). Omenjene študije analizirajo dejavnike, ki določajo izrabo prostora ter izgled pokrajine kot celote, torej krajinske zgradbe (Calvo-Iglesias in ostali 2006; Sirami in ostali 2010).

Naša raziskava preučuje spreminjanje krajinske zgradbe, heterogenosti in strukture skozi izbrano časovno obdobje. Obravnavali smo spremembo naslednjih značilnosti pokrajine (Farina 2001; 2007):

- spreminjanje deleža obdelovanih in nekmetijskih površin v obravnavanem obdobju (gozd, travnik, pašnik, njiva, vinograd in poseljena območja);
- spreminjanje heterogenosti v pokrajini (homogen prostor, heterogen drobno deljen; heterogen z večjimi zaplatami; heterogen mešan), spreminjanje krajinskih tipov skozi opazovano časovno obdobje (kmetijska ali agrarna, gozdnata in gozdna krajina) (Anko 1982).

Raziskava je imela naslednje cilje:

- določiti (in ovrednotiti) prostorske spremembe v Beli krajini v zadnjih 220 letih, ki so posledica demografskih sprememb,
- povezati spremembe krajinske zgradbe z demografskimi spremembami in
- ugotoviti raven sprememb v pokrajini med procesom emigracije lokalnega prebivalstva ter opuščanja kmetijske dejavnosti.

Dodatno so nas zanimali odgovori na naslednja vprašanja:

- Kako vpliva pašništvo (ovčereja) na spreminjanje krajinske zgradbe in krajinske heterogenosti, oz. kakšen vpliv ima opustitev pašništva na krajinsko zgradbo in strukturo.

Raziskali smo nihanje števila prebivalstva na raziskanem območju in želeli ugotoviti

- ali obstaja povezava med nihanjem števila prebivalstva in stopnjo gozdnosti pokrajine.

## 2 Metodologija

### 2.1 Območje raziskav

Raziskava je potekala v Beli krajini, jugovzhodno od mesta Črnomelj. Proti jugu razdvaja Belo krajino od Hrvaške reka Kolpa, na severu južna pobočja Gorjancev in na zahodu Kočevski Rog s Poljansko Goro.

Pokrajina je odprta proti vzhodu in jugovzhodu. Belokrajinski ravniki je s svojo povprečno nadmorsko višino med 190 in 220 metri najzahodnejši del nizkega krasa (Gams in ostali 2011) v zaledju Karlovca. Proti severovzhodu Bela krajina polagoma prehaja v gričevnat svet z vrhovi do 626 metrov. Zgornji višinski pas gojenja vinske trte dosega tukaj 400 metrov (Gams in ostali 2011).

Območje raziskav se nahaja na kraškem ravniku, katerega grade večinoma karbonatne kamnine, apnenici in dolomiti. Na površju omenjene kamnine preperevajo v kromičen kambisol in luvisol, ki velikokrat popolnoma prekrivata matično podlago.

Povprečna letna količina padavin v Beli krajini znaša med 900 in 1200 mm, povprečna letna temperatura zraka pa znaša 10.2 °C (Internet). Potencialna vegetacija območja je gozd hrasta in gradna (Čarni in ostali 2007).

Za območje raziskav smo izbrali 1000 ha velik predel med Bojanci, Tribučami, Dragatušem in Butočajem (45.514535°–45.539406° N in 15.209397°–15.246939° E) (slika 1), kjer znaša povprečna nadmorska višina terena med 160 in 420 m. n. v.

Slika 1: Območje raziskav v Beli krajini.

Glej angleški del prispevka.

## 2.2 Viri podatkov – prostorski podatki

Jožefinska vojaška karta (1 : 28.000), izdelana za vojaške namene konec 18. stoletja (1784–1790) (Rajšp in Ficko 1996; Rajšp in ostali 1997) je služila kot vir prostorskih podatkov za leto 1790. Naslednje informacije smo pridobili iz Franciscejskega katastra (1 : 1440, 1 : 2880), ki je dober vir podatkov o krajinski zgradbi, heterogenosti in izrabi tal za leto 1823 (Petek in Urbanc 2004). Vojaška karta (1 : 75.000; Militärgeographisches Institut, 1913) pokriva območje Bele krajine za leto 1913.

Leta 1918 pride do formiranja Jugoslavije, ki je vlagala veliko truda v izdelavo specialnih kart in načrtov, Belo krajino pa zajema posebna vojaška karta (1 : 25.000) iz leta 1937 (V.G.I. 1937).

Od leta 1954 do danes uporabljamo posnetke cikličnih letalskih snemanj slovenskega ozemlja. Letalski posnetki kakor tudi digitalizirani ortofoto (DOF) posnetki so dober vir informacij o izrabi tal in krajinski zgradbi. V raziskavo smo vključili letalske posnetke in DOF-e iz let 1954, 1975, 1986, 1999 in 2009 (GURS 2009).

Kljub temu pa prostorski viri iz omenjenih obdobj ne zajemajo celotnega območja Bele krajine. Zato smo se odločili za območje raziskave v obliki črke L, za katero so zbrani prostorski podatki iz vseh navedenih obdobj.

## 2.3 Analiza in obdelava prostorskih podatkov

Katastrske načrte, vojaške karte in letalske posnetke smo digitalizirali in georeferencirali s programskim paketom *ArcInfo 9.2* (ESRI 2008). Omenjeni prostorski viri so dali dober vpogled v dinamiko sprememb krajinske heterogenosti in zgradbe med leti 1790 in 2009.

Jožefinski katastrski načrt (1 : 28.000) je po sami izdelavi kakor tudi obsegu razpoložljivih prostorskih informacij precej nenatančen, zato je tudi georeferenciranje le-tega težavno. Načrt ima priložen kratek pisni del, zato je natančna določitev kmetijske rabe tal (travnik ali pašnik, njiva ali travnik) težavna in nenatančna. Omenjen vir prostorskih podatkov je zgolj približek dejanskega stanja iz tistega časa.

Franciscejski zemljiški kataster (1 : 1440, 1 : 2880) je zanesljiv vir informacij o krajinski zgradbi in kmetijski izrabi tal iz 1823. Katastru je dodan opisni del, kjer so opisane posamezne parcele skupaj s kmetijsko rabo tal. Številne meje parcel so ostale do danes skorajda nespremenjene in so v veliko pomoč pri georeferenciranju samega katastra.

Prostorski viri, nastali leta 1913 in kasneje, so dober vir informacij o kmetijski izrabi tal in krajinski zgradbi, kakor tudi letalski posnetki iz leta 1954 in viri iz novejšega časa.

V študijo smo vključili prav tako spremembe, dinamiko zaraščanja gozdnih površin, pašnikov, travnikov, njivskih površin, vinogradov ter dinamiko razvoja urbanih območij med leti 1790 in 2009. V ta namen smo izbrali 200 med seboj enako oddaljenih točk (150 m). Točkam smo v nadaljevanju s pomočjo prekrivanja prej navedenih digitaliziranih prostorskih virov pripisali rabo tal v določenem obdobju in skleпали na čas opustitve kmetijske rabe (primerjava med prostorskimi viri različne starosti).

V nadaljevanju smo izdelali diagram premene krajinske heterogenosti (in zgradbe) skupaj z matriko premene posamezne točke (obdelovalne parcele). Diagram nam nudi natančen vpogled v hitrost in dinamiko spreminjanja krajinske zgradbe med letoma 1790 in 2009 ter omogoča analizo krajinske zgradbe v določenem, izbranem časovnem obdobju (Reger in ostali 2007).

## 2.4 Demografski podatki, podatki o številu ovac

Sprememba števila prebivalcev na opazovanem območju kot tudi števila drobnice (ovac) je podatek, ki olajša razumevanje vzrokov in procesov sprememb v prostoru. Spontano zaraščanje je v literaturi velikokrat opisano kot zakasnel pojav, ki sledi izseljevanju ali migracijam prebivalcev v lokalnem okolju (Scozzafava in ostali 2004). Skupno število krav ali drobnice v določenem časovnem obdobju odraža izrabo tal ter narekuje krajinsko zgradbo in heterogenost (Lang in Blaschke 2007).

SURS (2012) (Internet 1) in Šifrer (1969) ponujata podatke o številu prebivalcev na raziskanem območju. Podatke o številu ovac kot glavne pašne vrste na območju pa povzemamo za leto 1823 iz opisnega dela Franciscskega katastra (Franciscan land cadastre for Kranjska 1823–1869) za leto 1913 in 1931 (Local Lexicon of the Drava Banovina 1937), in za leta 1971, 1981, 1991, 2002 iz SURS 2012 (Internet 1).

Podatke o številu prebivalcev kakor tudi o številu ovac na opazovanem območju smo prikazali kot skupno število prebivalcev in ovac, zbranih iz štirih okoliških vasi (Tribuč, Butoraj, Dragatuš in Bojanci).

## 2.5 Analiza sprememb krajinske strukture

Izbrali smo 300 naključno določenih točk po celotnem območju raziskav ter le-tim pripisali atribut kmetijske izrabe za vsako časovno obdobje (1790, 1823, 1913, 1954, 1986 in 2009). Izdelali smo preglednico (preglednica 1), ki prikazuje (1) povprečno površino zemljišča z enako kmetijsko rabo, na kateri točka leži, in (2) število vseh skupin točk, ki ležijo na zemljišču z enako kmetijsko rabo (poligonu).

Tako dve točki, ki ležita na območje enake rabe tal (skupnem poligonu), a sta bili ločeni v predhodnem opazovanem časovnem obdobju, jasno kažeta na novo, (bolj homogeno) manj mozaično stanje (slika 2).

Slika 2: Primer analize sprememb krajinske zgradbe. Stanje A (1823) prikazuje 9 skupin točk (naključno ležeče točke ležijo v devetih poligonih). Stanje B (1954): zaradi spremenjene krajinske zgradbe (opuščanja kmetijske rabe) imamo le 5 skupin točk (na petih različnih poligonih). Stanje C (2009): točke ležijo znotraj 2 poligonov, torej imamo dve skupini točk. Opazni je trend zaraščanja prostora in povečanja homogenosti krajinske zgradbe.

Glej angleški del prispevka.

Krajino obravnavamo kot prostorski izraz funkcionalnega sklopa ekosistemov in njihovega anorganskega okolja, ki je sicer odprt, vendar sposoben lastne samoregulacije (odvisno od intenzitete človekovih vplivov). Ločimo naravno in kulturno krajino (Anko 1982).

V študiji smatramo za gozdno krajino tisto, kjer površina gozda dosega 85 % celotne površine območja. Gozdnata krajina je krajina, kjer delež gozda obsega med 40 in 85 % njene celotne površine. V kmetijski ali agrarni krajini pa gozd porašča 20 do 39 % celotnega območja, krajina pa je preplet kmetijskih in urbanih območij (Anko 1982; Pirnat 2000).

Heterogenost krajinske strukture razumemo kot neenakomerno in naključno razporeditev njenih elementov (Farina 2007). Označuje jo velikost (in kombinacija) posameznega elementa krajine znotraj celote, mozaika. Iz ekološkega vidika je optimalna heterogena krajina z večjimi zaplatami, ki pa vsebuje tudi drobno mozaična območja (Lang in Blaschke 2007; Ahlqvist in Shortridge 2010). Taka struktura naj bi po raziskavah zagotavljala primerne habitate za številne rastlinske in živalske vrste, njihove migracijske koridorje, kakor tudi pravilno postavitve kmetijskih površin v prostoru (Farina 2007).

Pogosto je ocena (heterogenosti) krajinske zgradbe subjektivna. Ločimo med a) homogeno krajinsko strukturo, b) homogeno krajinsko strukturo z majhnim deležem drugih krajinskih tipov (rabe tal) med 1–5 % celotne površine, c) zgradbo, ki jo grade večje površine in zaplate, d) mozaično krajinsko strukturo in e) prehodi omenjenih tipov (Lang in Blaschke 2007).

### 3 Rezultati in diskusija

S pomočjo analize digitaliziranih prostorskih podatkov smo pridobili podatke o krajinski heterogenosti, strukturi in deležih posamezne kategorije kmetijske rabe tal in stanju krajinske zgradbe na območju raziskave med letoma 1790 in 2009 za vsako opazovano obdobje posebej (slika 3).

Sprememba in dinamika števila prebivalcev ter glav ovac med leti 1823 in 2002 na območju raziskav sta predstavljeni s sliko 4.

Slika 3: Sekvence digitaliziranih katastrskih načrtov, vojaških kart in letalskih posnetkov (za leta 1790, 1823, 1913, 1954, 1986 in 2009). Glej angleški del prispevka.

Slika 4: Spremembe v številu prebivalcev in glav ovac (razpoložljivi podatki za leta 1820, 1900, 1931, 1971 in 1981) med leti 1823 in 2002 na območju med Bojanci, Butorajem, Tribučami in Dragatušem.

Glej angleški del prispevka.

Diagram (slika 5) prikazuje spreminjanje deleža posamezne rabe tal na opazovanem območju med leti 1790 in 2009. Diagram prikazuje dinamiko spreminjanja krajinske zgradbe (spremembe posamezne kategorije kmetijske rabe tal). Na osnovi premene posamezne kategorije kmetijske rabe tal (v drugo) skozi opazovano časovno obdobje ločimo 3 stopnje spreminjanja krajinske zgradbe (in funkcije):

- krajinska zgradba se med leti 1790 in 1913 skorajda ni bistveno spremenila. 80 % površin ima skozi obravnavano obdobje enako rabo tal. Izjema so zgolj njivske površine, ki jih do leta 1913 prerase gozd.
- krajino med leti 1913 in 1954 zaznamuje premena oz. začetno zaraščanje večine kmetijskih površin in s tem ekspanzija gozdnih površin.
- letu 1954 je jasen trend zaraščanja pokrajine. Nad 60 % vseh negozdnih površin iz obdobja B se v tem obdobju zarase z gozdom.

Slika 5: Spreminjanje krajinske strukture na območju Bele krajine med leti 1790 in 2009. Diagram prikazuje premeno kmetijske rabe tal s prikazanim odstotkom površine posamezne kategorije kmetijske rabe tal glede na celotno območje. Dodan je tudi trend premene rabe tal. Glej angleški del prispevka.

#### 3.1 Krajinska zgradba, struktura in krajinski tip v obdobju med leti 1790 in 1913

V obdobju med leti 1790 in 1913 predstavljajo pašniki prevladujoč tip izrabe tal, kar jasno nakazuje na gospodarsko pomembnost pašništva v tem času. Gozdnih površin je leta 1790 malo in po površini ne presegajo ene tretjine celotnega območja. Leta 1790 je bil gozd izkrčen na najmanjši obseg.

Naslednje obdobje sta leti 1823 in 1913. Pašne površine se začno po letu 1823 manjšati (še intenzivneje leta 1913), v nasprotju pa se skupna površina obdelovalnih površin (njive) povečuje. Skupna površina vinogradov je leta 1823 ter 1913 znašala pod 2 % celotne površine. Gozdnih površin je več kakor leta 1790. Med letoma 1823 in 1913 se krajinska zgradba in krajinski tip skorajda nista spreminjala, krajina je še zmeraj značilna kmetijska z majhnim deležem urbanih površin (slika 3). Urbane površine, naselja se v prostoru pojavljajo na zahodnem delu območja raziskav. Krajinsko strukturo v opisanem obdobju označuje značilen mozaični preplet območja z manjšimi zaplatami ter nekoliko bolj homogenega prostora na vzhodnem delu (slika 3). V splošnem prevladujejo manjše, sklenjene zaplate gozda. Gozdni rob je v tem obdobju jasen in nefragmentiran, kar nakazuje intenzivnejšo obdelanost kmetijskih zemljišč. Leta 1790 je tip krajine med Bojanci, Butorajem, Dragatušem in Tribučami značilen kmetijski (agraren).

#### 3.2 Krajinska zgradba, struktura in krajinski tip v obdobju med leti 1913 in 1954

Leta 1913 predstavljajo gozdne površine že tretjino celotnega območja. Območja pašnikov se začno zaraščati (površina zaraščenih kmetijskih površin se je po letu 1913 podvojila).

Leta 1954 površina gozdnih površin doseže polovico celotnega območja, površina kmetijskih površin (njiv) pa ostaja enaka kot leta 1937. Pašne površine do leta 1954 popolnoma zaraste gozd. Travnikov je bilo leta 1954 18.5 % celotnega območja (slika 5).

V obdobju med leti 1913 in 1954 (leta 1937) doseže strukturiranost krajine svoj višek. Sliki 3 in 5 prikazujeta dinamiko premene krajinske zgradbe in strukture. Opazen je trend večanja gozdnih površin (52 % celotne površine območja leta 1954) na račun drugih tipov rabe tal, predvsem pašnikov in travnikov. To je eden izmed vzrokov hitre rasti gozdnih površin v 40. in 50. letih ne le v Beli krajini, ampak tudi drugod v Evropi in poteka na območju raziskav še danes (Poldini 1989; Antrop 2004; Morgan in Gergel 2010). Pospešen proces transformacije krajinske zgradbe je opazen prvih nekaj let po koncu 2. svetovne vojne.

Pomemben družbeni dejavnik, ki je vplival na krajinsko zgradbo v tem obdobju, je druga svetovna vojna. Med in po končani vojni se namreč številni prebivalci izselijo iz Bele krajine (2. val migracij), migracija pa je imela vpliv tudi na opuščanje kmetijskih površin in obdelanost tal. Število prebivalcev je bilo na območju raziskav najnižje leta 1948 (slika 4).

Krajinska struktura je bila leta 1913 značilno heterogena z občasno večjo zrnatostjo in kombinacijo homogenega območja z večjimi zaplatami gozdov na jugovzhodnem delu in osrednjem delu. Govorimo o krajinskem tipu gozdnate krajine (Anko 1982). Prevladuje fragmentiran gozdni rob (zaraščanje). Krajina je leta 1954 gozdnata, v osrednjem območju že gozdna. Na vzhodu se pojavlja mozaik pašnih površin in travnikov v stanju zaraščanja.

### 3.3 Krajinska zgradba, struktura in krajinski tip od leta 1954 do danes (2009)

Leta 1999 gozdne površine predstavljajo 84 % celotne površine območja, 15,5 % pa površine v zaraščanju (slika 5). Po letu 1990 se pojavljajo na območju raziskave zgolj 3 različne kategorije kmetijske rabe tal (leta 1937 še 6), kar je ponovno dokaz hitrega procesa zaraščanja ter zmanjševanja raznolikosti krajinske strukture. Danes je območje med Bojanci, Butorajem, Dragatušem in Tribučami krajina z 90 % deležem gozdnih površin na celotnem območju. Za območje raziskav je značilna homogena krajinska struktura s kombinacijo večje zrnatosti ter z nekaterimi negozdnimi zaplatami na zahodu (pašniki v fazi zaraščanja). Število kategorij kmetijske rabe tal na območju je znašalo leta 2009 4 (slika 5). Diverziteteta in strukturiranost krajine sta nizki.

V zadnjem opazovanem obdobju prevladuje na območju krajina gozdnega tipa (Topole in ostali 2006) z grmišči (zaraščajočimi se površinami), ki leta 1986 predstavljajo tretjino celotnega območja (slika 5). Pašne površine, njive in travniki so se močno skrčili na račun gozdov, po letu 1986 pa zaradi hitrega procesa zaraščanja krajine teh površin na območju raziskav na najdemo več.

Večina prebivalcev območja je danes zaposlenih v sekundarnem in terciarnem gospodarskem sektorju, predvsem v večjih mestih. Kmetijstvo predstavlja le še dopolnilno dejavnost. Zato prebivalstvo nima vpliva na krajinsko podobo in strukturo kot nekoč, kar se odraža tudi v stopnji gozdnatosti prostora.

### 3.4 Spreminjanje krajinske strukture

V obdobju 1790–2009 se je pokrajina spremenila; iz homogene (1790) do mozaično fragmentirane (1954) in nazaj v homogeno (2009) (slika 3). Skozi opazovano obdobje se število skupin točk, ki ležijo znotraj istega poligona, poveča s 24 na 197 ter naposled zmanjša na 37. Leta 1790 je bilo tako vseh 300 naključno postavljenih točk deljenih v zgolj 24 poligonov. Povprečna velikost parcele je bila 40,44 ha (preglednica 1). Leta 1823 se število poligonov poveča na 170, leta 1954 pa na 197. Po letu 1954 se je začela homogenizacija krajinske strukture, s tem pa pride do »združevanja« parcel (Forman 2006). Leta 2009 je bilo tako vseh 300 točk deljenih zgolj v 37 različnih parcel (prostor se zarašča, mozaičnost pa zmanjša).

Izbrano metodo predstavljamo s sliko 2, ki zajema zgolj del celotnega območja raziskav. Opazovanje in štetje skupin točk v spreminjajoči se pokrajini (v odvisnosti od povprečne površine kategorije kmetijske rabe tal) se je izkazalo za učinkovito metodo analize sprememb krajinske strukture skozi izbrano obravnavano obdobje.

Slika 6: Spreminjanje krajinskih tipov v Beli krajini v letih 1790, 1954 in 2009. Glej angleški del prispevka.

Ker ima pašništvo velik vpliv na videz pokrajine in vpliva na krajinsko zgradbo (kakor tudi strukturo), smo v študiji raziskali odnos med upadom števila ovac na območju Tribuč, Bojancev, Dragatuša



Preglednica 1: Spreminjanje krajinske strukture med leti 1790 in 2009.

obdobje	1790	1823	1913	1954	1986	2009
število zemljišč, kjer se točke nahajajo	24	170	181	197	162	37
povprečna površina zemljišča (ha)	40.44	2.287	1.782	0.238	5.321	43.873

in Butoraja kot glavne pašne vrste v Beli krajini некоč (Local Lexicon of the Drava Banovina 1937). Upad števila drobnice smo nato povezali s spreminjanjem krajinske zgradbe in strukture. Številne raziskave kažejo, da je ovčereja ključen faktor, ki narekuje poteze pokrajine (Nagashima in ostali 2002; Thomson in Simpson 2005; Wehn 2008; Carmona in ostali 2010; Pipenbaher in ostali 2011), po opustitvi paše pa se spremenita tako krajinska struktura kot tudi njena zgradba. Podoben proces smo ugotovili tudi v naši raziskavi; še posebej po postopnem zmanjšanju števila ovac na območju raziskave (po letu 1931) (slika 4; slika 5).

Ovac je bilo na območju štirih vasi največ leta 1820 (562 glav). Leta 1931 je število živali strmo padlo na 173, trend upadanja pa se je nadaljeval vse do leta 1990 (20 glav) oziroma 2002 (21 glav).

Raziskava kaže na ključno vlogo pašništva pri ohranjanju odprte kulturne krajine in mozaične krajinske strukture (Poldini in Feoli 2006; Morgan in Gergel 2010). Po ukinitvi ali opustitvi pašne dejavnosti se odprt prostor zaraste z gozdom, kar se hitro odrazi v spremenjeni krajinski zgradbi in strukturi. Pokrajina se spremeni iz mozaične v homogeno – sklenjeno (slike 3, 4 in 5).

Rezultati raziskave kažejo, da je bila krajina na območju Bele krajine некоč kmetijskega tipa, enakomerno heterogena, struktura pa srednje zrnata (slika 3). Le-ta se je skozi opazovano obdobje zaradi opuščanja pašništva, kmetijske dejavnosti ter kot posledica izseljevanja hitro spremenila v homogeno krajino gozdnega tipa.

Podoben potek transformacije prostora prikazujejo tudi druge raziskave, ki pa ne zajemajo tako dolgega časovnega intervala (Antrop 2004; Bender in ostali 2005; Reger in ostali 2007; Linden in ostali 2008). Omenjene raziskave obravnavajo problematiko zaraščanja prostora po opustitvi kmetijske rabe in zajemajo tudi spremembe v demografski strukturi ter gospodarski dejavnosti, ki se kažeta v spremembah videza pokrajine.

## 4 Sklep

Naša raziskava prikazuje izjemno hitro spremembo krajinske strukture in zgradbe v obdobju med leti 1790 in 2009. Zaraščanje prostora kot posledica opuščanja kmetijske rabe je v Beli krajini veliko hitreje kot v drugih delih Slovenije in Evrope (Čarni in ostali 1998; Linden in ostali 2008; Garcia-Feced in ostali 2011). Rezultati raziskave na primeru Bele krajine kažejo močan vpliv človeka na strukturo in funkcijo pokrajin v Sloveniji ter poudarjajo hkrati človekovo dejavnost kot močno gonilo pri samem vzdrževanju in ohranjanju krajine danes.

Slika 7: Breza (*Betula pendula*) je drevesna vrsta, značilna za zgodnjo fazo zaraščanja kmetijskih zemljišč. Glej angleški del prispevka.

Številne študije obsegajo problematiko zaraščanja prostora v opuščeni kmetijski krajini (Skanes and Bunce 1997; Čarni in ostali 1998; Seabrook in ostali 2006; Linden in ostali 2008; Zomeni in ostali 2008), a le redke zajemajo spremembe, nastale v daljšem časovnem obdobju. Vzrok so največkrat slabi ali nenatančni prostorski podatki. Naša raziskava opisuje spremembe v prostoru kot posledico demografskih in ekonomskih sprememb v daljšem časovnem obdobju, v obdobju 220 let.

Če pokrajino razumemo kot del ekosistema z lastnimi zakonitostmi in delovanjem (Farina 2001; Garcia-Feced in ostali 2011), lahko v kontekstu ohranjanja le-tega potrdimo na primeru Bele krajine zmanjšanje krajinske zgradbe, kakor tudi spremembo, nastalo v njeni zgradbi, spremembe v elementih krajine (število in oblika travnikov, gozdnih robov, pašnikov).

Ocenjevanje in opis pokrajine, ki temelji na poznavanju krajinske strukture in zgradbe, je lahko zadošten kriterij o splošni oceni diverzitete pokrajine.

Slika 8: Široka krošnja in razrast dveh gradnov (*Quercus petraea*) pričata o njunem nekoč precej bolj odprtem rastišču (pašnik), ki se je zaradi prenehanja paše pred desetimi leti zaraslo. Danes razen redkih travniških vrst zeli v sestoji in debeline drevesnih debel skorajda ni dokazov, ki bi nakazovali na do nedavnega odprto krajino.

Glej angleški del prispevka.

Slika 9: Opuščen vinograd, Vinišča. Nekoč obdelane terase danes prerašča sklenjen gozdni sestoj, star približno 40 let.

Glej angleški del prispevka.

## 5 Zahvala

Za tehnično pomoč se zahvaljujemo g. Iztoku Sajku. Zahvaljujemo se g. Iztoku Vraničarju (Geodetska uprava RS, geodetska pisarna Črnomelj) za pomoč pri zbiranju prostorskih podatkov. G. Martin Cregeen je lektoriral angleško verzijo.

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## 6 Literatura

Glej angleški del prispevka.