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Abstract

Landscape diversity results in significant land-use differences between Slovenia's landscapes. A high-quality set of land-use data covering the period from the early nineteenth century to the present is available for Slovenia, which makes it possible to study the impact of various factors on land-use changes. In the early nineteenth century, when subsistence farming predominated, farmers on each farm or in each village had to have enough arable land to produce food, enough meadows to feed the animals, and enough forest for firewood. Therefore, the variability in land use was much greater at the local level than today but smaller between regions. Afforestation prevails in the Alpine mountains, hills, and Dinaric landscapes of western Slovenia, grass overgrowth dominates in the hills of eastern Slovenia, farming intensification characterizes the Pannonian plains, and urbanization predominates on the coast and the Alpine plains. Compared to neighboring central European countries, the sociogeographical factors of land-use change in Slovenia diverged the most between 1945 and 1990, resulting in more fragmented land and dispersed settlement.

Keywords

Regional geography · Land-use changes · Landscape diversity · Franciscan Cadaster

18.1 Land Use as a Landscape Diversity Indicator

Land use is the result of many physical-geographical, historical, demographic, and economic factors (Gabrovec and Kladnik 1997). Because of the country's great landscape diversity, natural-geographical factors are at the forefront in Slovenia. The shares of individual land-use types differ significantly by natural-geographical landscapes (Perko 2007; Perko et al. 2015). To show this landscape diversity, the shares of individual land-use categories by Slovenian landscape type have been calculated (Table 18.1).

In Slovenia (Table 18.1), fields cover just under a tenth of the territory; they are largely concentrated in the Pannonian plains, where they cover more than half of the area, whereas they account for only 0.5% in the Alpine mountains. The overall share of vineyards is 1%, but in the Mediterranean low hills, they account for 6% of the territory; there are none in the Alpine mountains and plains. The largest share of orchards can also be found in the Mediterranean low hills: they account for 5% of the territory, which is three times the Slovenian average of 1.7%. The fewest orchards can be found on Mediterranean and Dinaric plateaus and in the high mountains. Orchards are the category with the smallest variability among landscape types because traditionally all landscapes had extensive orchards next to farms. The largest share of meadows can be found in Dinaric lowlands and the smallest in the Pannonian plains. Slovenia stands out in Europe with its above-average share of forest (i.e., 61.8%). An above-average share (i.e., 82.8%) characterizes the Dinaric plateaus, where the karst relief and high elevations limit farming opportunities (Ciglič et al. 2012), and the smallest share can be found in the Pannonian plains, where forest covers only 5% of the terrain. Built-up areas cover 5% of Slovenia's territory. The majority (close to one-fifth) can be found in the Alpine plains, where the capital of Ljubljana is also located and the fewest on Dinaric plateaus. Individual landscape types also differ in terms of the processes of

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Table 18.1 Shares (in %) of individual land-use types by Slovenian landscape type in 2017

Landscape type	Arable land	Vineyards	Orchards	Meadows	Forest	Built-up	Other
Alpine mountains	0.5	0.0	0.5	13.0	74.5	1.4	10.2
Alpine hills	3.0	0.2	2.2	22.3	68.2	3.6	0.6
Alpine plains	24.5	0.0	1.4	21.6	31.6	19.5	1.4
Pannonian low hills	21.5	3.0	3.6	23.4	42.9	5.1	0.6
Pannonian plains	52.8	0.2	1.1	9.9	21.8	11.5	2.6
Dinaric plateaus	1.1	0.2	0.6	13.8	82.8	1.2	0.3
Dinaric lowlands	9.1	0.4	1.2	28.9	52.9	6.8	0.7
Mediterranean low hills	5.7	6.4	5.0	16.8	57.8	7.4	0.9
Mediterranean plateaus	1.0	1.3	0.4	25.3	68.6	3.2	0.2
Slovenia	9.7	1.0	1.7	19.0	61.8	4.7	2.2

Source: Land Use Data Base, Ministry of Agriculture, Forestry and Food
The largest shares are marked red, and the smallest are marked blue

land-use change (Gabrovec and Kumer 2019), and the variability of land use is increasing between them.

18.2 The Franciscan Cadaster as a Source of Data on Traditional Land Use

A high-quality set of land-use data spanning two centuries is available for the territory of the former Habsburg Monarchy in central Europe. The Franciscan Cadaster from the first half of the nineteenth century is unique in the world because, in addition to written records, it also includes 1:2880 cadastral maps showing land use (Bičič et al. 2001, 2015). The majority of Slovenian territory was covered in the cadaster as early as the 1820s, with the exception of Prekmurje (in northeast Slovenia), which belonged to the Hungarian part of the monarchy and was included in the cadaster around 1860 (Petek and Urbanc 2004). Land use in the Franciscan Cadaster was elaborately inventoried for the needs of tax administration. The nineteenth-century cadaster has been used (with certain modifications) until the present regardless of political changes, which makes it possible to compile a high-quality land-use database, incorporate it into a geographic information system, and determine the factors influencing land-use changes (Gabrovec and Kumer 2019).

Based on the written part of the cadaster, nineteenth-century land-use maps have been prepared (Figs. 18.1 and 18.3). The written part of the land cadaster is presented in a table (a land-use statement) for each cadastral municipality separately, featuring the areas of individual land-use types. The spatial measures are provided in the *Joch* (0.58 ha) and *Klafter* (3.6 m²). The forms for Carniola, Carinthia, Styria, and part of the Littoral are provided in German and envisage the entry of 29 land-use categories. The surveyors also added new categories to the majority of cadastral municipalities, whereby they struck out the categories that did not appear in a given cadastral municipality and added new ones on the printed form. The most frequent categories added included meadows or pastures with trees or shrubs. The forms used for

some cadastral municipalities in the Littoral region were adapted to a more detailed classification of Mediterranean crops. In Prekmurje, in the Hungarian part of the monarchy, the form used includes 46 land-use categories. The data for Carinthia, Carniola, Styria, and Prekmurje are kept by the Slovenian Archives, and the data for Gorizia and Istria are kept by the Trieste State Archives. The graphic part was often used because its large scale (1:2880) allows detailed analyses of factors influencing local land-use changes (Gabrovec 1995; Petek and Urbanc 2004; Paušič and Čarni 2012; Ažman Momirski and Gabrovec 2014; Šmid Hribar 2016). These cadastral maps have been used to present nineteenth-century land use (Fig. 18.7). The Franciscan Cadaster was revised several times in the two centuries following its creation; new land surveys were conducted, and the land-use categories were partly altered, but the basic concept has remained the same until today. The first major revision of the cadaster was performed during the 1870s (Seručnik 2009). A significant change in terms of land-use data occurred in 2011 with the enforcement of a provision from the 2006 Real Estate Recording Act requiring that the land-use data entered in the land cadaster be taken from the Land Use Data Base (Gabrovec and Kumer 2019). The Land Use Data Base is based on visual interpretation of orthophotos.

18.3 Factors Influencing Land-Use Change in the Nineteenth and Twentieth Centuries

The Franciscan Cadaster shows land use typical of preindustrial agriculture. During that period, agriculture was solely based on local resources; no mineral fertilizers were used, and no machines powered by fossil fuels were available. The agriculture of that time can be referred to as “low input–low output” farming, which employed local resources through manual and animal labor. The “traditional” farming of that time was inevitably mixed, with farms engaging in both animal husbandry and arable farming. Therefore, “non-

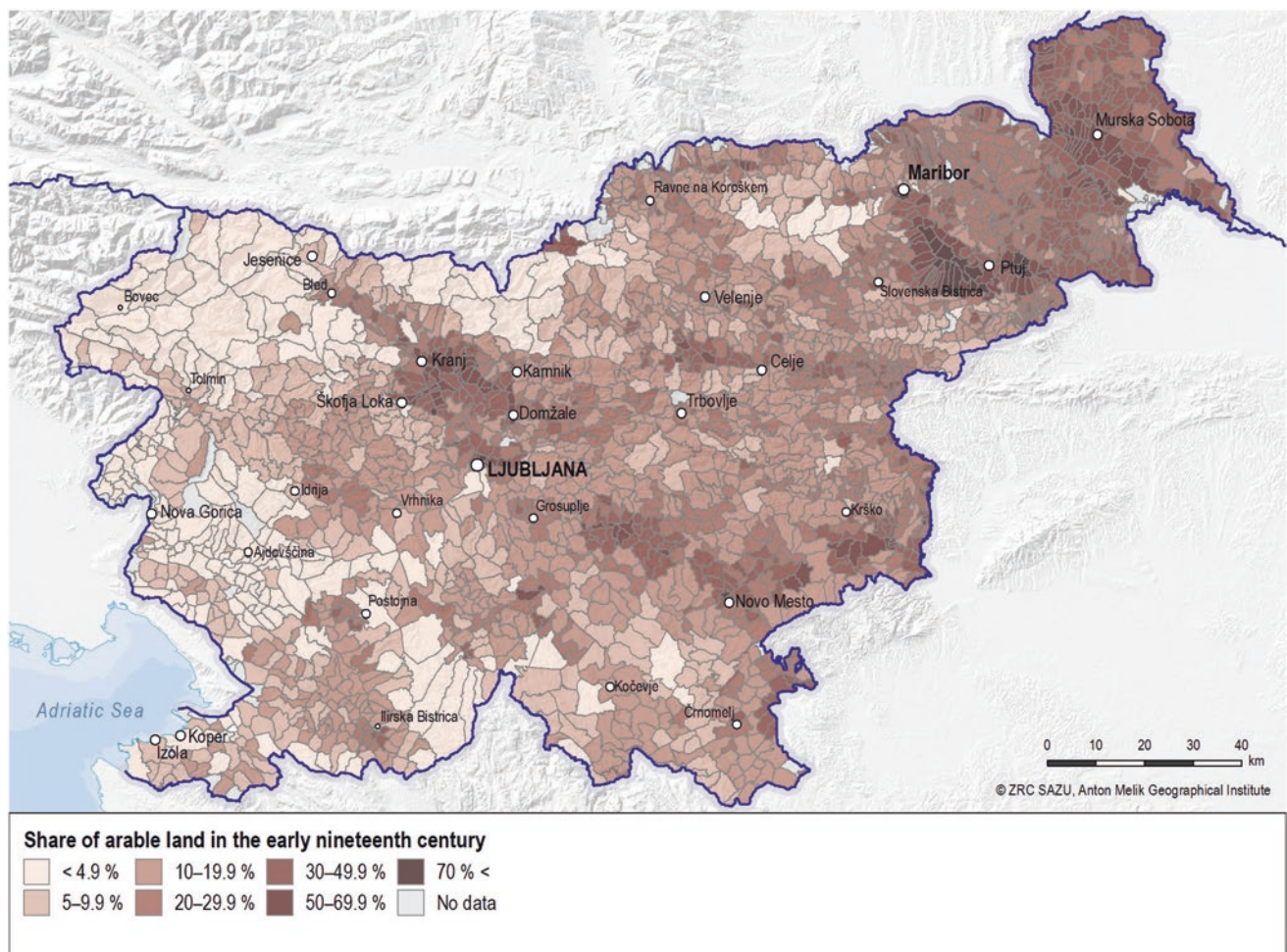


Fig. 18.1 Share of arable land in the early nineteenth century. (Source: Franciscan Cadaster)

uniform land use” was typical at the local level. Animal husbandry and arable farming complemented one another. The side products of arable farming and areas not suitable for arable land were used to produce fodder for livestock, and without the animals there was no manure for the cultivated fields. Forests were also a part of every farm; on the one hand, they were used as a source of energy and, on the other, for grazing and providing bedding for livestock (Krausmann 2006). Due to local land-use optimization, in the nineteenth century, land-use variability between landscape types was smaller than today, but the diversity of use in individual villages was greater. This difference is evident when comparing the shares of arable land in the early nineteenth century and today (Figs. 18.1 and 18.2).

In contrast to the predominantly subsistence farming, winegrowing was an exception during the nineteenth century and was already market-oriented. Vineyards were significantly larger than today (Figs. 18.3 and 18.4). The second half of the nineteenth century was affected by the deterioration of vineyards due to the *Viteus vitifoliae*, or phylloxera, plague. In France, this deterioration already began in 1868, and within a decade or a few years longer, most of the French

vineyards were destroyed. Hence, the demand for wines from other European regions increased. Olive trees were cut down in Istrian areas, and reeds were introduced as supports for grapevines. In 1880, phylloxera emerged in Slovenia and in a short time destroyed most of the vineyards, which had reached their greatest extent only a few years earlier. The Austrian authorities alleviated taxes for vineyards and thus intensely stimulated their restoration; restored vineyards were exempt from taxes for 10 years. Despite their later renovation, the vineyards never again covered an area as large as they did in the mid-nineteenth century (Titl 1965; Ažman Momirski and Gabrovec 2014).

Over the past two centuries, the territory of what is now Slovenia belonged to various states with various sociopolitical systems, which, in addition to technological development, had a significant impact on land-use changes. Due to agrarian overpopulation, the second half of the nineteenth century was characterized by farming intensification and an increase in the share of fields (albeit not that significant). Despite industrialization and the development of transport, land use did not change significantly during the second half of the nineteenth century (Petek 2005). The most intense

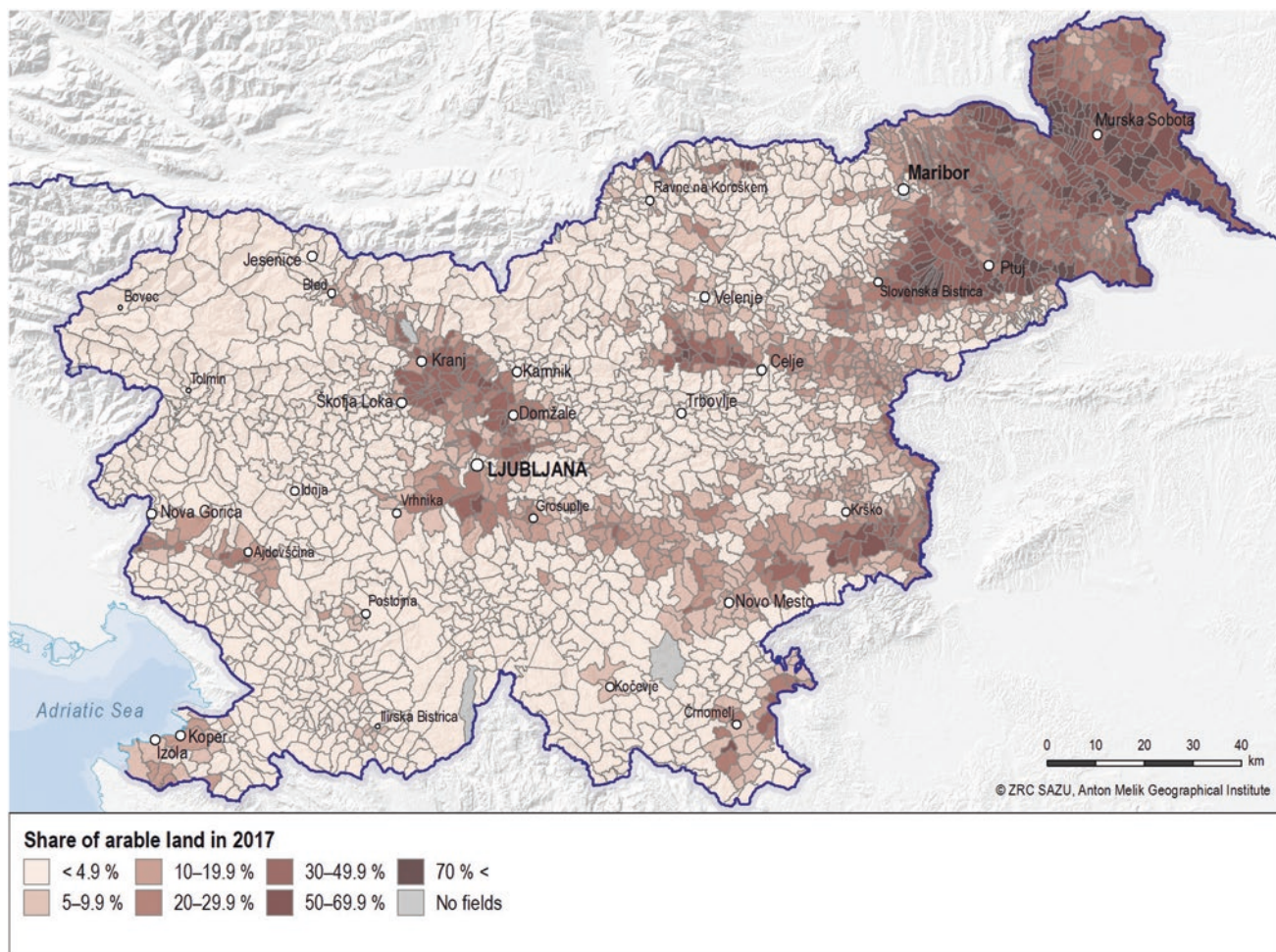


Fig. 18.2 Share of arable land in 2017. (Source: Land Use Data Base, Ministry of Agriculture, Forestry and Food of the Republic of Slovenia)

land-use changes occurred in the second half of the twentieth century. From 1945 to 1990, when Slovenia was part of the former Yugoslavia, the development of agriculture differed significantly from other central European countries. In contrast to most other communist countries, only a small share of Slovenian farmland was subjected to nationalization, and the share of private land remained above 85%. However, because a maximum of 10 ha of cultivated land (20 ha in hilly regions) and 15 ha of forest was imposed, land fragmentation continued to be a problem, preventing economical farming. Therefore, most members of rural households also worked in industry (Jepsen et al. 2015). With Slovenia's entry into the European Union and a uniform European agricultural policy, during the twenty-first century, the factors influencing land-use change are again comparable to those in other Central European countries. Nonetheless, Slovenia stands out with its land fragmentation, dispersed settlement, and small share of urban population.

In individual cadastral municipalities, changes in specific land-use types occur in different shares of their total area. The predominant process is presented on the map of typol-

ogy of land-use changes (Fig. 18.5), which was produced based on Medved's methodology (1970). He distinguished between the following four main processes: afforestation, grass overgrowth, urbanization, and intensification. Considering the increase in the area covered by forests during the period studied, it is obvious that afforestation is the predominant process. Pannonian landscapes in Eastern Slovenia are more diverse. Grass overgrowth predominates in the lower hills, and intensification dominates in the plains. Strong urbanization is typical primarily along the Adriatic coast, in Ljubljana Basin, in the Lower Savinja Valley, and in Maribor and its surroundings (Gabrovec and Kumer 2019).

18.4 "Forest Transition"

Forests cover more than 60% of Slovenia's territory. The theory of forest transition, proposed by Mather (1992), is characterized by the change from shrinkage to expansion of forest. This process has occurred in most of the developed world (Mather and Needle 1998) including the territory of

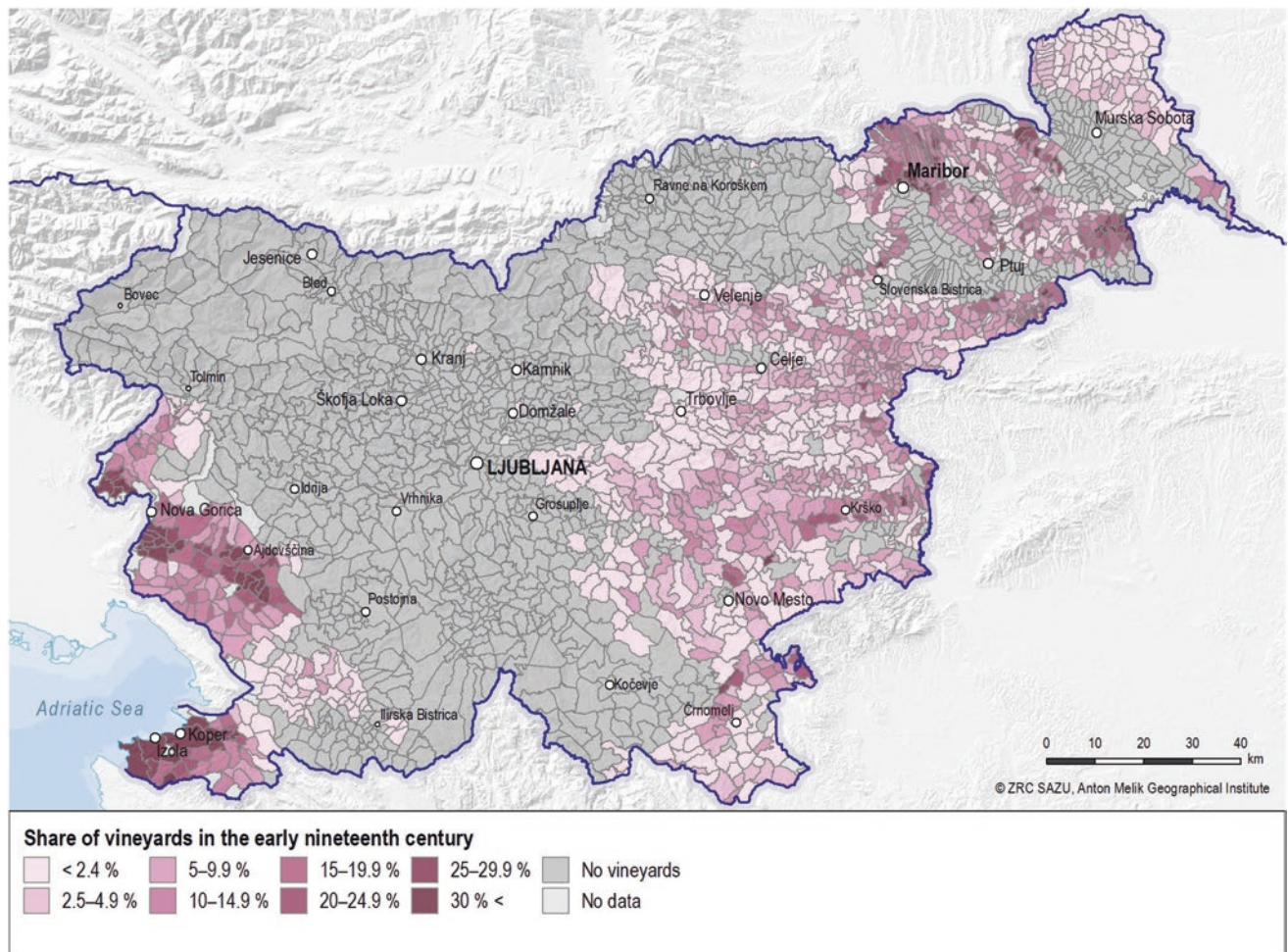


Fig. 18.3 Share of vineyards in the early nineteenth century. (Source: Franciscan Cadaster)

present-day Slovenia. Andrič (2004) found that after the last ice age, the vegetation in what is now Slovenia went through three major changes. The first change took place when a warm period occurred after the ice age some 11,000 years ago. The second change occurred some 9000 years ago after the climate changed (presumably due to an increase in precipitation), and the first anthropogenic effects were identified. Beech and fir became the prevailing species. This change led to differences between regions in forest types. The third change in forest type occurred in the second half of the Holocene due to growing human influence on land use as well as change in the paleoclimate. The share of oak increased and the share of beech and fir decreased.

In prehistory, forest use was limited to hunting and gathering. One can speak of a genuine cultural region only at the end of the Bronze Age and the transition into the Iron Age (Ciglencčki et al. 1998). At that time, forests were felled to build settlements and produce metal, especially iron. The Romans built roads, along which they cleared forests, and they developed timber transport on these roads as well as on the rivers and sea. With the emergence of more productive

farming, the forests were used for extensive livestock grazing, or they were burned to create arable land in clearings (Mihelič 2008).

People began extensively clearing forests during the tenth-century colonization of the lowlands, when the increase in population resulted in a lack of arable land. During the thirteenth century, colonists began clearing forests at higher elevations. Compared to fields, forests were considered of lower value, and so they shrank to half of their original size (Müllner 1902; Blaznik et al. 1970; Mihelič 2008). Forests were initially cleared to create agricultural land because clearings generated more income than wooded land. With the development of mining and ironworking, wood became an important energy resource.

According to some sources, forests covered the smallest area in the eighteenth and nineteenth centuries (Petek 2005). Since then, areas covered by forest have grown continuously (Fig. 18.6): from 39% in the first half of the nineteenth century to a full 61% in 2015. The increased share of forests in the hills and mountains of the Alpine macro-region is connected with the abandonment of farmland and old-field

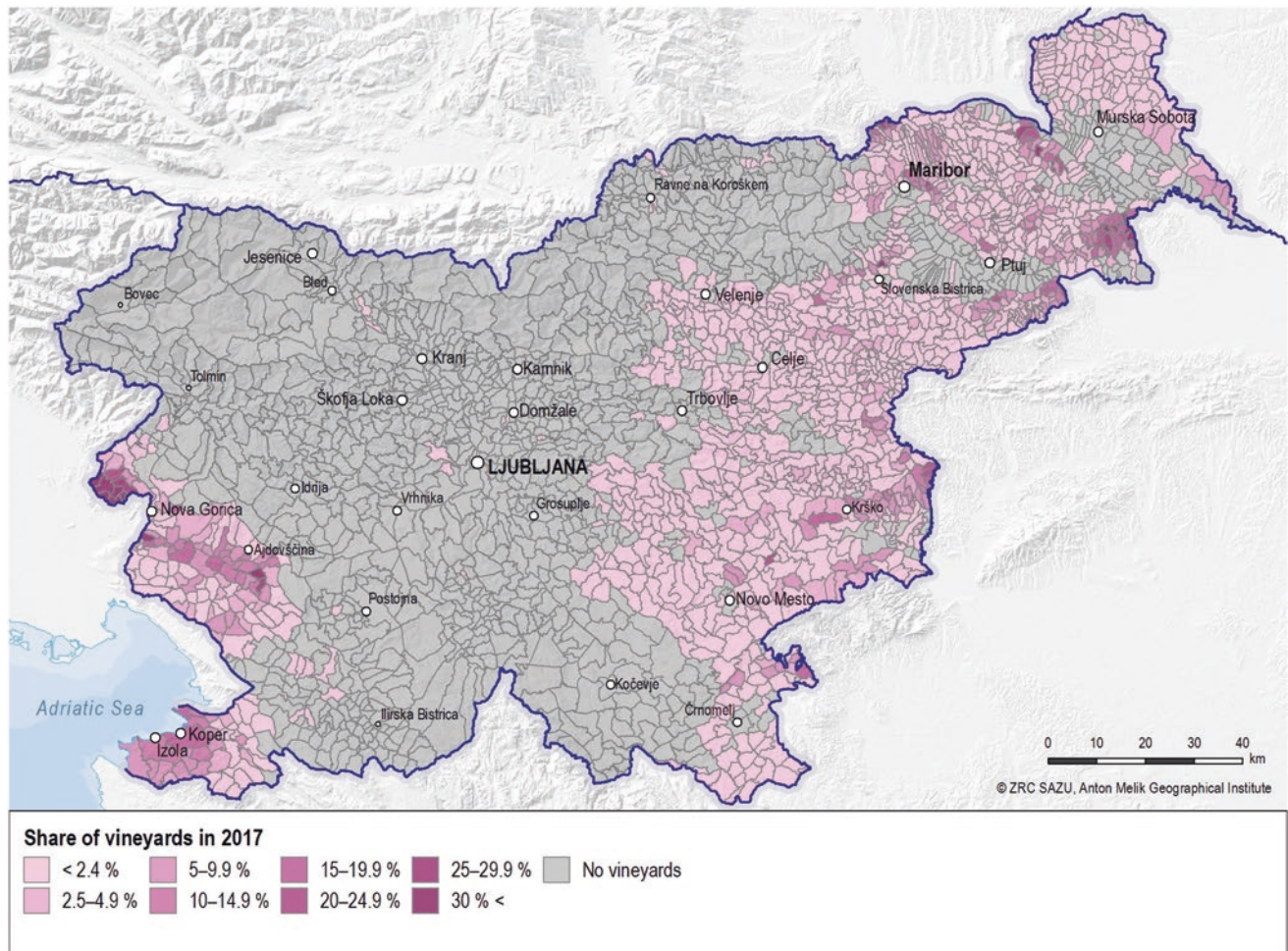


Fig. 18.4 Share of vineyards in 2017. (Source: Land Use Data Base, Ministry of Agriculture, Forestry and Food of the Republic of Slovenia)

succession (Gabrovec and Kumer 2019). The Franciscan Cadaster shows that among all Slovenian regions, natural forest vegetation was cleared the most on the Kras Plateau in southwest Slovenia (Fig. 18.6). Today forest covers more than half of the Kras Plateau, which is the result of planned reforestation at the end of the nineteenth century (Kladnik et al. 2008; Zorn et al. 2015) and abandonment of farmland in the twentieth century.

18.5 Bela krajina (White Carniola)

The European Union has defined types of landscapes with natural limitations for agriculture. With its karst relief (part of the Dinaric karst), Bela krajina, a region in southeast Slovenia, is a typical example of such a landscape. Generally, agriculture in these landscapes does not provide a sufficient income, there is a lack of jobs in nonagricultural industries, and these areas have poor connections to administrative centers and service activities cease (Cunder 2001). Due to these unfavorable economic and social conditions, people

move away from the region. Consequently these areas are being abandoned, overgrown with grass, and later afforested. Karst conditions are a very important limiting factor for agriculture in Slovenia, where more than 44% of the country has a karst character. Ciglič et al. (2012) have identified the limiting factors due to karst terrain as fine terrain dissection, primarily with dolines; a lack of surface water due to rapid drainage through karst rock; discontinuous, rocky, shallow, and loamy soil of uneven depth and with frequent protruding rocky outcrops; and dispersion of small plots of agricultural land, hampering mechanical cultivation and use of modern agricultural methods. As a result of the karst landscape features, cultivation in Bela krajina is connected to great investments in land improvement, commonly by clearing loose stone. The natural conditions do not permit the development of intensive agriculture in the region, and the most favorable natural conditions for agriculture are limited to a narrow belt along the Kolpa River (Plut et al. 1984). In addition to this area, cultivated fields are commonly located at the bottom of dolines. The spatial processes and patterns across temporal and spatial scales to reveal the landscape

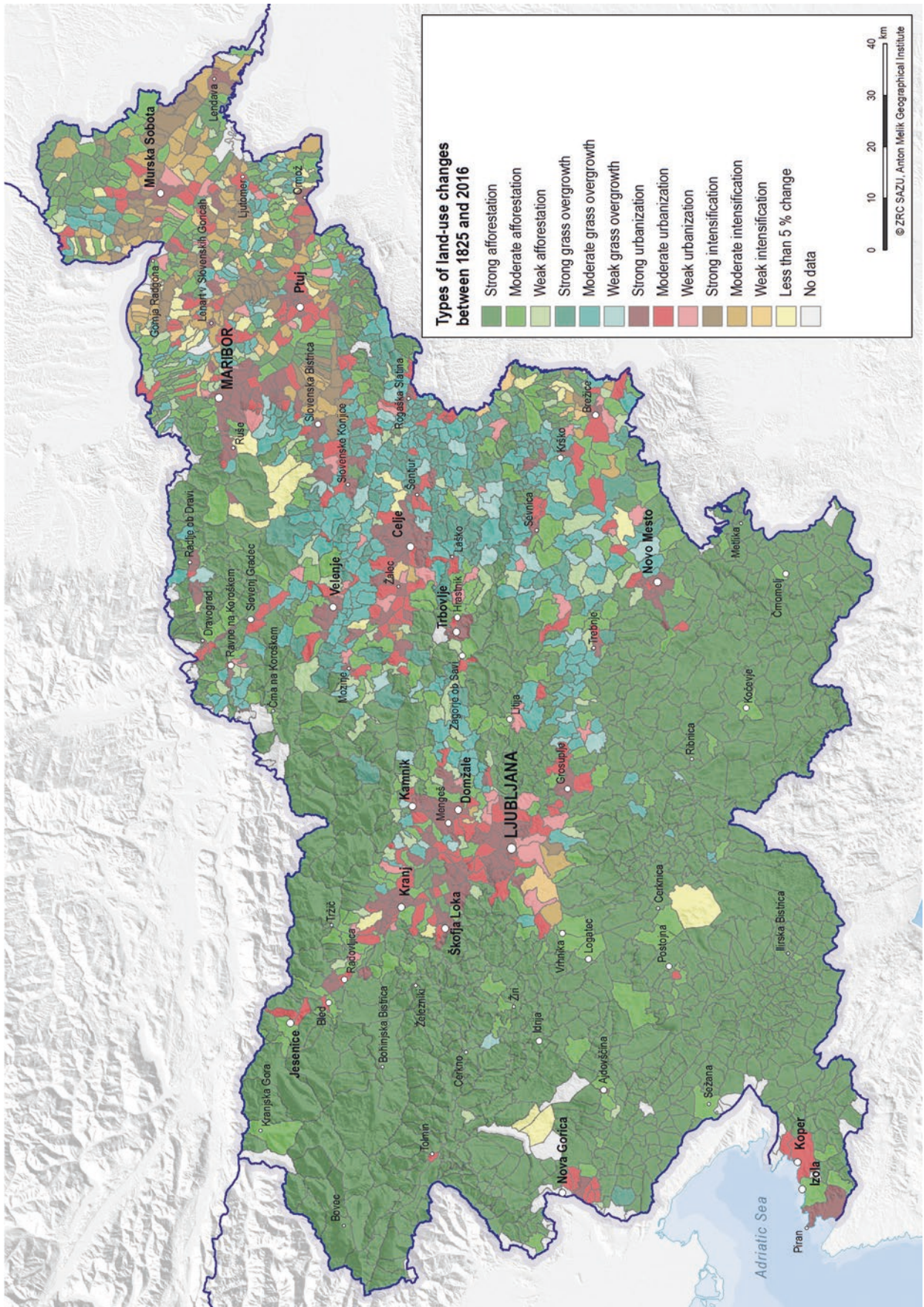


Fig. 18.5 Types of land-use changes between 1825 and 2016

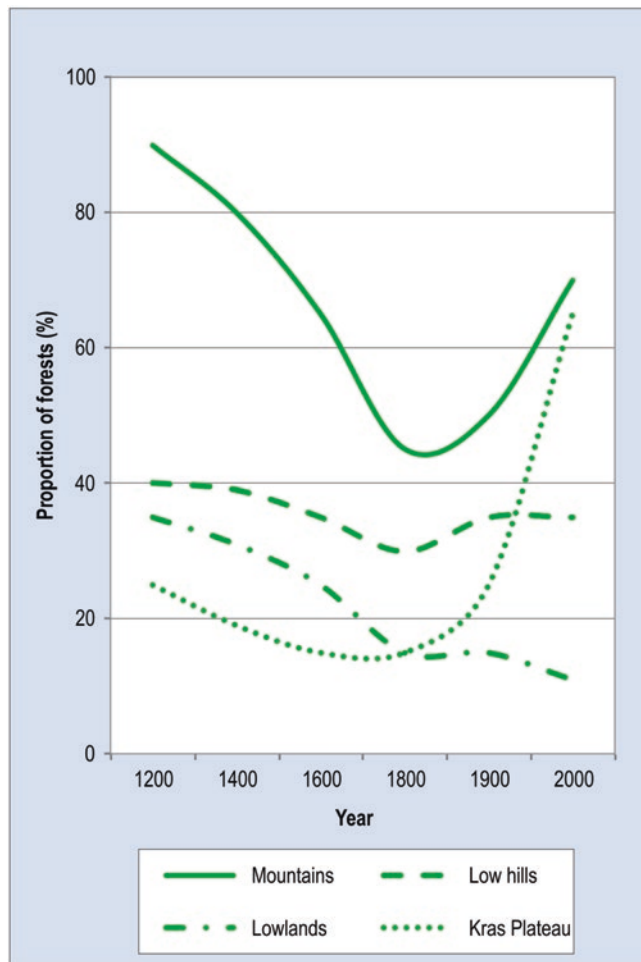


Fig. 18.6 Estimated changes in the share of forests on some types of relief and on the Kras Plateau, shown by trend lines. (Gabrovec et al. 2012)

changes are shown in a case study of the village of Bojanci (Fig. 18.7). For a variety of reasons, emigration from this area was common. As a result of out-migration, the population continuously declined (Dražumerič 1987), with a consequent increase in land abandonment. Today the region is grappling with significant social challenges, resulting in the loss of cultural traditions and practices that influence the landscape structure (Ribeiro 2017).

Studying land-use changes shows that the spread of forests is a general phenomenon (Fig. 18.7). The major landscape changes took place between 1860 and 1987 (Ribeiro 2017).

Because the peak of out-migration from Bela Krajina was between 1912 and 1927, it was expected that the scale of land abandonment also peaked in this period. In 1830, grasslands dominated in Bojanci; this land use significantly increased until 1860. After this, the share of grassland decreased due to the increase in forests. Cultivated fields showed a dramatic decrease from 1830 to 2012, although

this change is more evident from 1860 to 1987; during this period gardens also decreased. The changes in cultivated fields are closely related to demographic changes. The slight increase in these areas between 1830 and 1860 was accompanied by a population increase in Bojanci for the same period. The pronounced decline in cultivated fields between 1860 and 1987 is parallel to a pronounced decline in population due to emigration, continuing to 2012. From 1987 to 2012, forests and overgrown areas continued to increase, whereas grasslands and cultivated fields continued to decrease. These data show how population decline influences land-use changes (Ribeiro 2017).

18.6 Ljubljana Marsh

Ljubljana Marsh in Central Slovenia was once the southernmost raised bog in Europe. In contrast to Bela krajina, mentioned above, the marsh is characterized by farming intensification and urbanization. As part of efforts to make Ljubljana Marsh the granary of the Habsburg Monarchy, in the early nineteenth century, drainage projects were begun. After almost 200 years of drainage, an area of approximately 160 km² became the largest complex of wetland meadows in Slovenia. Due to its exceptional biotic diversity, in 2008 a major part of the area was proclaimed a protected landscape area. The village of Črna vas was one of the last settlements colonized in the marsh and in Slovenia as a whole. The area of what was previously wet pastures began to be settled in 1830. The settlement was planned along the road with drainage canals to the left and right, and behind them houses, farms, fields, and meadows (Melik 1927). Frequent floods—a problem that has never been entirely solved in this region—forced the residents to switch to animal husbandry. Building dwellings on wooden foundation piles was a way of adapting to frequent floods. Because the marsh-dwellers mostly did not own any forest, they made the support piles from alders obtained from hedges that the original settlers had planted along the canals (Melik 1927). Together with the trenches and land parcellation, the hedges created a mosaic landscape (Fig. 18.8).

By 1870, the area was already dominated by cultivated fields, meadows, and canals, although there were still some lower-quality forests and peatland left. The following decades saw intensive peat extraction, which lowered the land's surface and radically changed the landscape. The once extensive areas of wet pastures were broken up into fragments and significantly reduced in size, and new houses, fields, canals, and roads were built on them. With technological development, farming in Črna vas increasingly intensified (Šmid Hribar 2016).

Around 1900, the area was dominated by medium-intensive meadows, with considerably fewer cultivated fields and rare

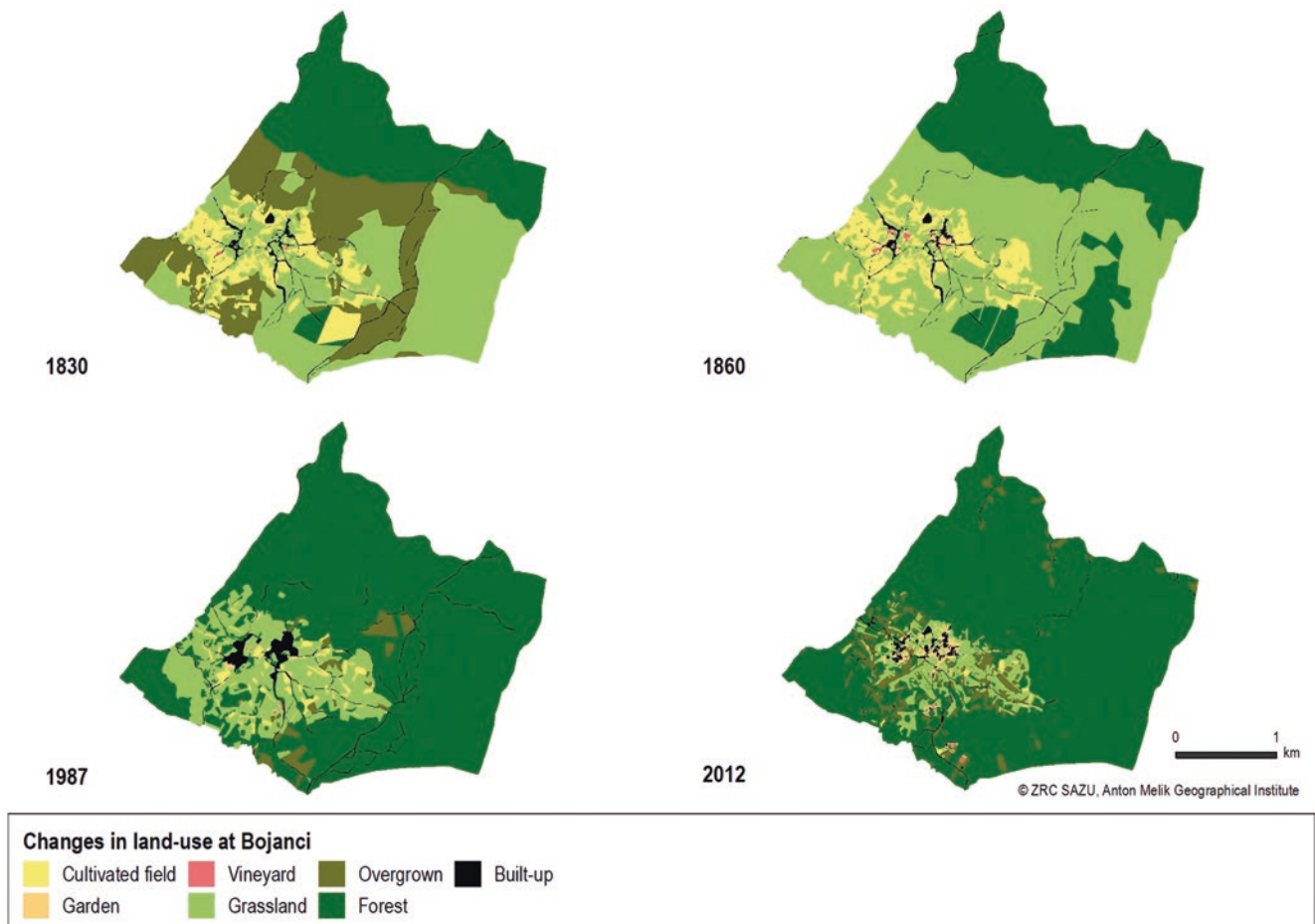


Fig. 18.7 Changes in land-use categories at Bojanci from 1830 to 2012. (Ribeiro 2017)

woods. The region continues to be characterized by modest arable farming (e.g., corn) and animal husbandry (e.g., horses and donkeys), and there are hardly any proper farmers left. The locals, who largely commute to Ljubljana for work, engage in plot gardening and some also in market gardening, different services, and transportation. Despite land-use intensification, in 2013 the area also included abandoned land, which is quickly becoming overgrown and difficult to traverse. In turn, the share of urbanized areas has increased significantly because, being only a few kilometers away from Ljubljana, Črna vas has become attractive for new residents. Construction of a second row of houses was approved, although this deviated from the originally planned layout mentioned above. Rather than renovating old houses, the newcomers have built new ones on the meadows and green areas within the settlement. Some of them are cutting down the hedges, and new ones are usually no longer planted. All of this is changing the character of the settlement and increasing the risk of floods (Zorn and Šmid Hribar 2012; Šmid Hribar 2016).

18.7 Land Use in Slovenia Today

Slovenia's present land use is the result of the factors and processes described above (Fig. 18.9). Concentrations of individual land-use types are clearly visible. Fields predominate in the Pannonian plains, whereas in the Alpine plains, their share is smaller. The largest concentration of vineyards is typical of the Gorica Hills in Mediterranean Slovenia, followed by individual locations in the Pannonian low hills. Orchards and olive groves only rarely cover large contiguous areas. The largest shares of meadows can be found in the Alpine valleys, Dinaric lowlands, and hills of eastern Slovenia. A high share of forests is typical of the Dinaric plateaus and Alpine mountains. The largest concentration of built-up land can, understandably, be found in Ljubljana and the surrounding area, on the coast, and in regional centers.



Fig. 18.8 The landscape of the Ljubljana Marsh is largely composed of various meadows, fields, pastures, canals, hedges, tall herb communities, shrubs, and thickets. The Ljubljanica River gives the marsh its key character. (Photo by Viktor Šmid)

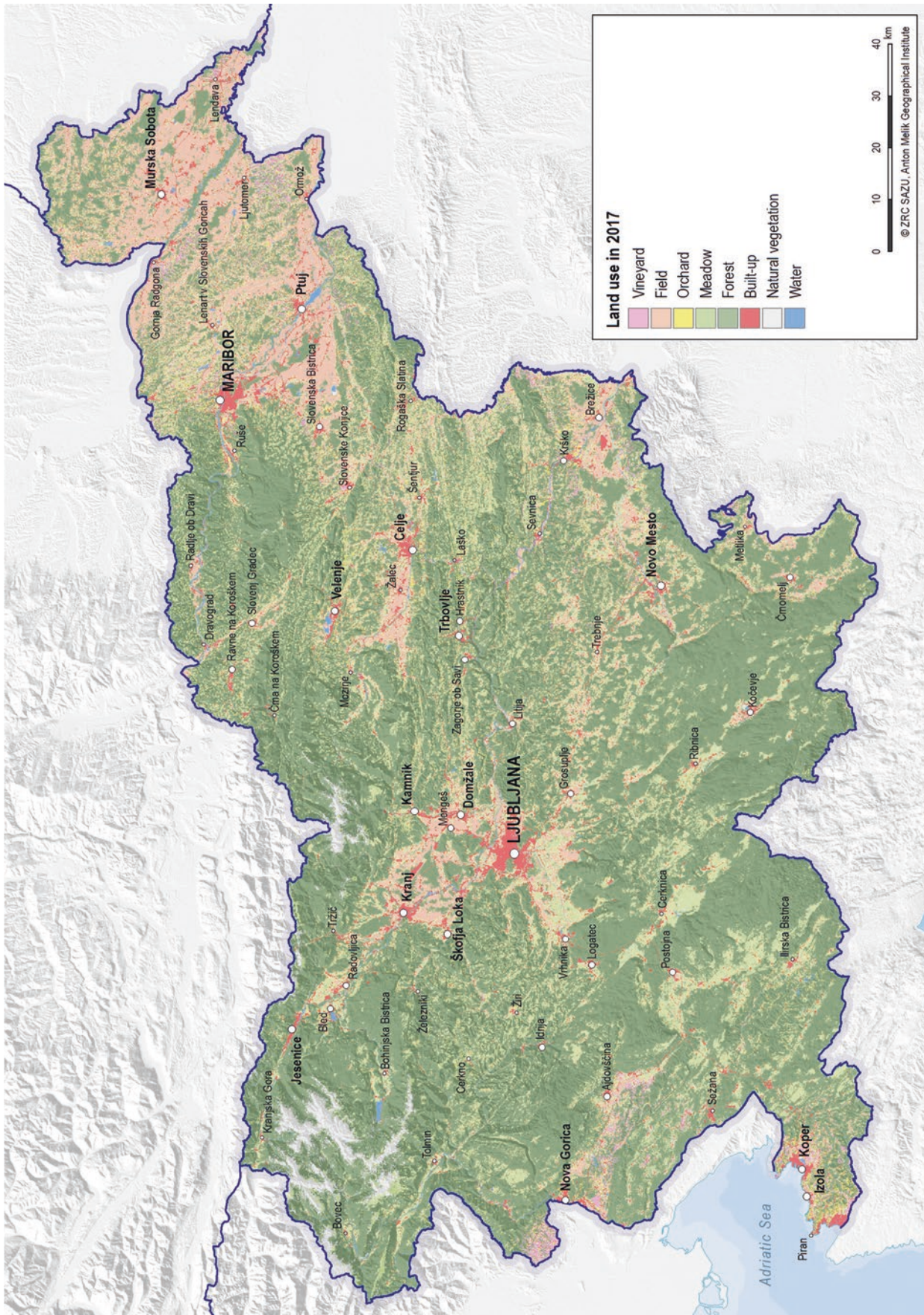


Fig. 18.9 Land use in 2017. (Source: Land Use Data Base, Ministry of Agriculture, Forestry and Food of the Republic of Slovenia)

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