Land Use Policy 36 (2014) 554–566

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Land-use and land-cover changes in rural areas during different political systems: A case study of Slovakia from 1782 to 2006

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ARTICLE INFO

Article history:
Received 20 November 2012
Received in revised form
19 September 2013
Accepted 23 September 2013

Keywords:
Land-use change
Land-cover change
Driving force
Slovakia
Land-use policy
Mountain rural region

ABSTRACT

The paper analyses the period from 1782 to 2006 divided according to the existing political systems in three rural study sites of Slovakia. Two long, monarchy (I.LMP) and revolutionary (II.LRP), and one short new age (III.SNP) periods are compared. The magnitude of land-use and cover changes induced by related driving forces during the different historical periods are also analysed. Three different study sites were selected: cadastre of Král'ov Brod (KB), mountain cadastres: Očová and Dúbravy (OD), Liptovská Teplička (LT). Spatial data derived from historical maps were used in comparison to recent data obtained using Remote Sensing technology. The results showed that the landscape of all three sites has undergone significant changes in land-use and cover during the 224 years. From the long-term point of view there two main trends were observed. The first was significant permanent grassland conversion into arable land at KB where permanent grasslands decreased from 52.7% in 1782 to 0.7% in 2006. Gradual afforestation and permanent grassland conversion to forest land was observed at LT where forest land increased from 67.7% in 1782 to 83.7% in 2006. During the I.LMP period, demographic trends and settlement pattern supported by effective land-use policy were the dominant driving forces. Similarly these driving forces were identified as the most important also for the III.SNP period. But contrary to the I.LMP, driving forces of the III.SNP caused more negative effects (land abandonment) in mountain rural LT region where the current land-use policy seems to be insufficient. Land-use changes during the II.LRP were mostly due to technological development.

Introduction

Cultural landscapes are the result of the interaction between humans and nature (UNESCO, 2011). Antrop (2006) considers landscape as a synthetic and integrating concept that refers both to a material-physical reality, originating from a continuous dynamic interaction between natural processes and human activity, and to the immaterial existential values and symbols of which the landscape is the most significant. The European Landscape Convention (Council of Europe, 2000) recognised landscapes as a part of the European cultural heritage and key components of local, regional and national identities. Different landscapes can be recognised including rural. The rural landscapes of Europe constitute the immediate daily surroundings of many people and are particularly important in terms of territory. Development of rural areas depends on natural conditions, but their development trends could be significantly divergent (Spulerova et al., 2010).

In Europe, several breaks have occurred in the development of cultural landscape. Many completely new landscapes were created during the population explosion in the middle ages, causing important land reclamation activities. The newly created landscapes were then integrated and developed. An increase in the speed and magnitude of changes could be observed since the 18th century (Antrop, 2005).

Modern society increasingly utilises landscapes in a great variety of ways and for many purposes (Vos and Meeks, 1999). Changes varied from the spatial, temporal and processing point of view (Serra et al., 2008; Krausmann et al., 2003). Land-use changes are non-linear and are associated with other societal and biophysical system change (Lambin and Meyfroidt, 2010). Various actors and forces trigger a specific rate of change (Schneeberger et al., 2007). Various driving forces are identified by researchers as major types: socio-economic, demographic, political, technological, natural, and cultural driving forces (e.g. in Zondag and Borsboom, 2009; Brandt et al., 1999).

Rapid and large-scale nature changes i.e. sweeping changes in agricultural practices, the decline of agricultural activity in some regions, urban sprawl, the development of road and rail networks,

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http://dx.doi.org/10.1016/j.landusepol.2013.09.018

as well as the pressure of tourism and leisure activities (Feranec et al., 2000; Jongman, 2002; Van Eetvelde and Antrop, 2004) have taken place and have resulted in land-use and land-cover changes. Given this human influence, the recent period has been called the Anthropocene Age (Slaughter, 2011). According to Kondratieff, economies follow the path of long-term dynamic cycles or waves. A long wave lasts for 40–60 years, and consists of a period of rapid economic growth, followed by stagnation or depression, creating the dominant sociotechnical landscape for the next wave (Wilenius and Kurki, 2012).

But also history has recorded many landscape changes which resulted from the adopted political systems, specific laws and rules for landscape management. Ancient landscapes became fragmented and disappeared gradually while new ones have emerged.

The acceleration has spurred renewed concerns about the role of land-use changes in driving losses in biological diversity, soils and their fertility, water quality and air quality (Reid et al., 2000). Several authors highlight the impact of agricultural intensification on the rural landscape (Stoate et al., 2001; Hersperger and Bürgi, 2009), connected also with agricultural diversification. For centuries, humans have been using the earth' surface to produce food through agricultural activities. At present, new demand for land, biomass production for energy (Kanianska et al., 2010, 2011), carbon plantation and the global food market, are very significant. Through changes in agriculture and forestry practices, landscapes have suffered rapid and often irreversible changes (Jongman, 2002). The reason is extensive land abandonment (Mac Donald et al., 2000) and marginalisation of agricultural land (Fry and Gustavson, 1996; Václavík and Rogan, 2009) although there are some policies preventing these negative factors in mountain rural areas, e.g. European Landscape Convention (Council of Europe, 2000). The global context is important for future European land-use (Eickhout et al., 2007) and strategies for conservation and management must be developed (Calvo-Iglesias et al., 2006). Sustaining ordinary traditional landscapes based upon rural economies such as agriculture and forestry demands an adapted policy and supporting actions (Antrop, 2006).

Land relief in Europe shows great variation within relatively small areas. Europe is one of the most intensively used continents on the globe, with the highest share of land (up to 80%) used for settlement, production systems (including agriculture and forestry) and infrastructure (EEA, 2007). In the EU-27, rural areas (predominantly rural and intermediate regions) represented 91% of the territory and 59% of the population in 2007. Rural areas are therefore particularly important in terms of territory (EU DGARD, 2010).

Slovakia is largely located in the mountain territory of the western Carpathian arch. The mountain regions cover more than 55% of the total land territory. In 2007, the Slovak rural territory represented 86% of the total land area and the Slovak rural population represented 41% of the total population. In 2010, population density within Slovakia was 110.8 persons per km^2 (SOSR, 2011).

Slovakia as a small European country was mostly during its history part of a larger political formation and experienced different political regimes. Its territory has undergone many changes during history and as a part of Central Europe its landscape is much more diverse than Western European ones (Palang et al., 2006). Nowadays, Slovakia is one of the successor countries of the Austro-Hungarian Empire. From 1918 to 1938, Slovakia was part of the market-oriented, capitalist Czechoslovakia, which turned as a part of the east and central Europe into a socialist centrally planned system in 1948 and then back into a market-oriented economy in 1989. Thus Slovakia is an example of a present-day state that has experienced significant changes, not just through industrialisation, like in other countries, but above all in response to a number of serious political shifts. This example can help to identify and explain a knowledge gap as to how political system changes have influenced land use. How was the process of transition in rural Slovak areas and how was the magnitude of the land-use and cover changes during the politically and economically eventful history of Slovakia? What were the main trends and driving forces of these changes? Analysis of long term land-use changes and their comparison with the recent period helps us to understand the links between land-use choices, their potential impact and the quantification of this impact.

This article analyses spatial and temporal land-use and cover changes focused on selected rural areas. The aim of the paper is to assess long and short term recent land-use and cover changes from 1782 to 2006 in three selected rural cadastres located at different natural conditions of Slovakia using historical maps and high-resolution satellite data layers. The nature of the changes induced by different driving forces during different periods in history and related political systems is discussed and the causality of these changes is examined. Such analysis allows us to learn from the past and discover the integrity between long and short changes.

The historical background of Slovakia

The history of Slovakia reaches back to the 5th and 6th centuries when Slavic tribes migrated into the region south of the Carpathian Mountains. Despite the fact that 80% of the territory was covered by forest vegetation naturally, there were suitable conditions for agricultural development. Slavic tribes established villages and developed an agricultural economy in the Middle Danube Basin. In the middle of 9th century Slavs from Bohemia, Moravia and the Danube region joined to form the Great Moravian Empire. In 10th century Magyars, a semi-nomadic people from northeast, invaded the Empire and established the Hungarian Empire. In 16th century, after the Ottoman Turks conquered the southern section of its kingdom, Hungary became part of the Habsburg Monarchy. Maria Theresa (from 1740 to 1780) with her son Josef II (from 1780 to 1790) introduced reforms leading to socio-economic development of the Empire including land cadastres. In 1848, the wave of revolutions which swept across Europe, reached the Austro-Hungarian Empire. The achievements of the revolution produced economic, social and intellectual effects, which promoted the gradual adoption of capitalism. The Austro-Hungarian Compromise of 1867 established the Dual Monarchy of Austria – Hungary. After the collapse of the Austro-Hungarian Empire and the end of the World War I in 1918, the First Czechoslovak Republic (1918–1938), and then the Second Czechoslovak Republic (1938–1939) were established. During World War II (1939–1945) the Slovak State was set up. The political model and culture introduced by one dominant political party deliberately favoured a pattern of centralised leadership with a strong ruler. This one-party Slovak State ended in 1944, when democratic and communist forces organised an armed revolt (Ivantysyn, 1999). In 1948, few years after World War II, dramatic changes like nationalisation of land and private estates took place. The communist period lasted from 1948 to 1989 in the different political-administrative forms, the Czechoslovak Republic (1945–1960), the Czechoslovak Socialistic Republic (1960–1990), the Czechoslovak Federative Republic (1990–1992). In 1989, land use again began to change dramatically, this time as a result of the Velvet revolution and establishment of parliamentary democracy. In 1993, the Czechoslovak Federative Republic split into two independent republics, the Slovak Republic and the Czech Republic. Slovakia joined the European Union in 2004.

Table 1
Time scale of historical periods, events, mapping and evaluated periods.

Historical periods (political systems)	10th – 1918 Hungarian and later, from 1867 Austro – Hungarian Empire (Constitutional Monarchy)	1918–1938 First Czechoslovak Republic/(Parliamentary democracy) 1938–1939 Second Czechoslovak Republic/(Fascism) 1939–1945 Slovak State (Totalitarian dictatorship – Fascism) 1945–1960 Czechoslovak Republic (People' democracy 1945–1948, Socialist democracy/Communism 1948–1960) 1960–1990 Czechoslovak Socialist Republic/ (Socialist democracy/Communism)	1990–1992 Czechoslovak Federative Republic (Parliamentary democracy) Since 1993 Slovak Republic/ (Parliamentary democracy)
Historical events	1848 – European Revolution 1914–1918 World War I.	1939–1945 World War II. 1948 Nationalisation	1989 Velvet Revolution
Mapping	1782 I. Military mapping 1846 II. Military mapping 1876 III. Military mapping	1956 Czechoslovakian military topography mapping	1990 CLC 2000 CLC 2006 CLC
Evaluated periods	First Long Monarchy Period (I.LMP, 1782–1876)	Second Long Revolutionary Period (II.LRP, 1782–1990)	Third Short New age Period (III.SNP, 1990–2006)

Materials and methods

Spatial data derived from historical maps and by Remote Sensing technology

Spatial data derived from historical maps in comparison to recent data received were analysed using Remote Sensing technology.

Historical maps of the first, the second and the third military mapping of the Hungarian Empire (the years 1782, 1846, 1876) and the Czechoslovakian military topography mapping from the year 1956 were processed and digital layers prepared. Historical maps form the first military mapping from the years of 1764–1787 of the Habsburg Monarchy during the reign of Joseph II called Josephine mapping (Marek and Nejedlý, 2006), was the first continuous topographic mapping of the current Slovakia territory. The maps of the second Habsburg Monarchy military mapping from the years 1810 to 1869 are called Francis mapping. The third military mapping in the years of the period 1875–1884 was based on trigonometric points with rectangular coordinates in the Gellérthgy system.

After the collapse of the Austro-Hungarian Empire in 1918 the Czechoslovak Republic was established, and in the period of 1952–1957 Czechoslovakian military topography mapping was realised. A geodetic Krasovsky ellipsoid was used to transform the coordinates of the Czechoslovak trigonometric network in coordinate system S-42 that was marked as "coordinate system S-52" (Marek et al., 2007).

Because of historical maps compatibility with the recent data layers, sections of military mapping were exported in the coordinated system S-42 in the 4th meridional belt. Historical maps of the first, the second and the third military mapping and the Czechoslovakian military topography mapping distinguish the following land use categories: arable land, permanent grasslands, forest land, built-up areas, wetlands, and water bodies.

More recent land-use and cover changes were deduced by Remote Sensing technology considering data of the years 1990, 2000, 2006. Satellite images obtained by visual interpretation from satellites LANDSAT 4TM, LANDSAT 7ETM+, SPOT 5 and IRS-P6 were an essential basis derived from space satellites, which were further processed and analysed during the projects CORINE Land-cover (CLC). The CLC methodology and results are widely used in several other projects and are of relevance to policies in land management, nature conservation and water management (Feranec et al., 2007). The aim of producing CLC-changes is to have European coverage of real land cover changes that are larger than 25 ha and are wider than 100 m (EEA, 2007). Therefore the CLC methodology is limited for land-use change analysis at regional scale. To identify more precise regional land-use changes we delineated more detailed 1990, 2000, 2006 data layers from satellite images. The next step was to develop the legend maps. The following five categories distinguishable and subsequently comparable to the historical maps and satellite images were analysed: (1) arable land and permanent crops, (2) permanent grasslands, (3) forest land, (4) built-up areas, (5) others.

To understand and compare past and recent land-use and cover changes, three periods have to be recognised in the study since 1782–2006. The total period of 224 years was divided according to existing political systems. Although the mapping periods are not fully in line with historical events and periods, we tried to split the total period relevantly to be able to give evidence of the fundamental changes. Thus two long and one short period were considered and labelled by us as: the First Long Monarchy Period (I.LMP), the Second Long Revolutionary Period (II.LRP) and the Third Short New age Period (III.SNP). Spatial data was used for the I.LMP from the first, second, third military mapping (94 years long period of years 1782, 1846, 1876), for the II.LRP from the third military mapping, Czechoslovakian military topography mapping, CLC1990 (114 years long period of years 1876, 1956, 1990) and for the III.SNP from the CLC1990, 2000, 2006 (16 years long period of years 1990, 2000, 2006) (see Table 1).

The research was focused not only on the identification of the magnitude of the land-use changes during the different historical period but also on determination and overview of related driving forces. The study of driving forces is problem oriented and in practice not restricted to a specific method or framework (Bürgi et al., 2004). We assessed four key driving forces: (1) natural conditions, (2) demography (colonisation, land abandonment), (3) technological development, and (4) land-use/agricultural policy.

Site characteristics

Because of highly diversified land territory of Slovakia, three study sites of rural territories differing in size, developmental trends, geopolitical settings, socio-economic situation and located in various natural and climate conditions were selected. The study areas represent a good example of land-use changes in Slovakia because they cover three different socioeconomic and environmental settings: cadastre of Král'ov Brod (KB) – lowland, characteristic of agricultural land uses; cadastres Očová and Dúbravy

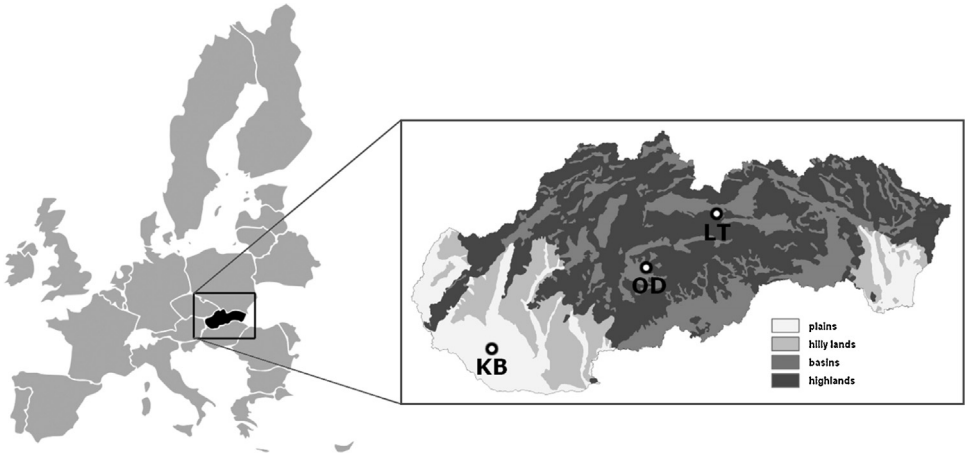

Fig. 1. Map of the location of Slovakia in the EU and three study sites.

Table 2
Site characteristics.

Study area	Geographical location	Altitude (m a.s.l.)	Cadastre area (km^2)	Annual average temperature (°C)	Long-term average annual rainfall (mm)	Dominant soil type
KB	The southern part of Slovakia, in the Danube Lowland, about 75 km from the capital city Bratislava	110	23.7	9.6	550	Chernozems
OD	The central part of Slovakia at Zvolen basin and Pol'ana Mountain, about 210 km from the capital city Bratislava	350–960	108.4	8.3	714	Cambisols
LT	The northern part of Slovakia where the Low Tatras mountain range adjacent to the Liptov basin, about 325 km from the capital city Bratislava	Over 900	98.2	5.0	900	Rendzinas and Cambisols

Abbreviations: KB – Král'ov Brod; OD – Očová Dúbravy; LT – Liptovská Teplička.

(OD) – mountainous area with mixed agricultural and forestry land uses, Liptovská Teplička (LT) – mountainous area dominated by forests (see Figure 1 and Table 2).

Results and discussion

Long land-use and land-cover changes at three study sites

Historical maps and Remote Sensing technology allowed us to reconstruct long-term changes in land-use and cover from 1782 to 2006 in three rural territories.

As Rumsey and Meredith (2002) point out, historical maps record the geographical information that is fundamental to reconstructing past places, whether town, region, or nation. Historical maps often hold information retained by no other written source, such as place-names, boundaries, and physical features that have been modified or erased by modern development. Geographic Information Systems (GIS) provides digital tools allowed us to analyse the spatial information on these maps and to layer them with modern spatial data. Because features on the scanned original historical maps are just images, these features need to be digitalized as points, lines, and polygons to create vector GIS layers in order to perform spatial analysis using GIS.

The value of some historical maps should not be judged solely in terms of their accuracy because geodetic precision might not be the original intent of the map markers. The value of these maps cannot be underestimated because of their positional inaccuracy (Hu, 2010).

Overall, the accuracy of historical maps is affected by several reasons. Some points or features in historical maps may have disappeared over time. Even though some of them still exist today, their names may be different from those indicated on the early map. Further difficulties are caused by place names which are the same as the old ones, but represent different features at the present time. Historical maps were hand-drawn coloured map sheets, in a scale of 1:28,800 (Podobnikar, 2009). According to Marek et al. (2007) the position precision of the planimetric features of historical maps of the first, the second and the third military mapping is from tens to hundreds of metres, and of the Czechoslovakian military topography mapping twelve metres. Historical maps include the names of hills, valleys, and rivers written in local languages. Altitudes are presented with hatching to indicate relief. Distribution of forests and grasslands, directions of river currents, cultivated land, and other features are also mapped. The cultural landscape is presented by showing settlement type, buildings, roads, stone bridges, and even roadside shrines. The clarity of the maps is achieved through various colour casts. The sites of natural resource activities such as mines, and iron foundries are not marked with symbols but rather with descriptive text (Zimova et al., 2006). Historical maps distinguish 13 land use categories: (1) settlements, (2) buildings, (3)

Table 3
Correspondence between CORINE Land Cover, historical maps and used nomenclature.

CLC nomenclature		Historical maps nomenclature	Used nomenclature
Level 1	Level 2		
1. Artificial surfaces	11 Urban fabric 12 Industrial, commercial and transport units 13 Mine, dump and construction sites 14 Artificial, non-agricultural vegetated areas	Settlements Buildings Roads	Built-up areas
2. Agricultural areas	21 Arable land 22 Permanent crops	Arable land Gardens Orchards Vineyard	Arable land and permanent crops
	23 Pastures 24 Heterogeneous agricultural areas	Meadows Pastures	Permanent grasslands
3. Forest and semi natural areas	31 Forests 32 Scrub and/or herbaceous vegetation associations 33 Open space with little or no vegetation	Forests Stones	Forest land
4. Wetlands	41 Inlands wetlands 42 Maritime wetlands		Others
5. Water bodies	51 Inlands waters 52 Marine waters	Rivers Lakes	

roads, (4) arable land, (5) gardens, (6) orchards, (7) vineyard, (8) meadows, (9) pastures, (10) forests, (11) stones, (12) rivers, (13) lakes.

More recent land-use and cover data compared to spatial data derived from historical maps were deduced by remote Sensing technology and analysed during the projects CORINE Land-cover (CLC). The choice scale (1:100,000), minimum mapping unit (MMU) (25 hectares) and minimum width of linear elements (100 m) for CLC mapping represents a trade-off between production costs and level of detail of land cover information (Heymann et al., 1994). These two basic parameters were the same for CLC1990, CLC2000 and the subsequent CLC2006 (EEA, 2007). The most important novelty of CLC2000 was the creation of a database of Land Cover Changes (LCC). It was a policy requirement to map LCCs smaller than the 25 ha MMU size of CLC. The MMU of the LCC database was set to 5 ha, the minimum of 100 m width is also valid for the LCC polygons for practical reasons (Büttner et al., 2002).

The standard CLC nomenclature includes 44 land cover classes. These are grouped in a three-level hierarchy. The five main (level-one) categories are: (1) artificial surfaces, (2) agricultural areas, (3) forests and semi-natural areas, (4) wetlands, and (5) water bodies.

The total reliability of CLC2000 is $87.0 \pm 0.8\%$. The two largest CLC classes (arable land and coniferous forest) were estimated to have a high level of reliability (between 90 and 95%). Two other agricultural classes also enjoyed a high level of reliability: agro-forestry and permanently irrigated land (Büttner and Maucha, 2006). In order to identify more precise regional land-use changes a set of generalisation rules were adopted including delineation of more detailed CLC1990, 2000, 2006 data layers based on terrain survey.

It is noticeable, that the CLC categories do not correspond with historical maps categories. But combination of selected CLC (level-two) classes allows good comparison with historical maps categories. Thus, the following five distinguishable and comparable categories were analysed: (1) arable land and permanent crops, (2) permanent grasslands, (3) forest land, (4) built-up areas, (5) others (see Table 3).

Digitalised spatial data show changes in areas of different land categories, dynamics of ebb and flow in land-use and land-cover during the 224 years period in three rural study areas (see Table 4, Appendix A – Figs. A.1–A.7, Appendix B – Figs. B.1–B.7, Appendix C – Figs. C.1–C.7).

In 1782, KB lowland landscape was predominantly formed by permanent grasslands (52.7%), arable land 41.0% and forest 5.1%. Built-up areas accounted for 0.1%. At that time, land-use categories in OD mountain landscape were forest (57.8%), arable land (21.0%) and permanent grasslands (20.4%), built-up areas (0.5%). Mountain LT landscape was created mainly by forest land (67.7%) and permanent grasslands (31.8%). Arable land and built-up areas covered only 0.1% and 0.2%.

In 2006, at KB arable land covered 88.6% and permanent grasslands 0.7%. At OD, forests covered 49.1%, arable land 31.7% and permanent grasslands 16.2%. At LT, forests covered 83.7%, permanent grasslands 11.7% and arable land 3.6%. Built-up areas represented 4.6% at KB, 2.7% at OD, 0.8% at LT. Other land-use categories were of less importance.

The landscape of all three study sites has undergone significant changes in land-use comparing the years 1782 and 2006. Two main trends were observed during the period of 224 years at KB and LT: (a) significant permanent grassland conversion into arable land at KB where permanent grassland decreased from 52.7% in 1782 to 0.7% in 2006, (b) gradual afforestation and permanent grassland conversion to forest at LT, where forest increased from 67.7% in 1782 to 83.7% in 2006. At OD, a main significant trend was not observed and the overall changes were not so remarkable as in the case of KB and LT.

Land use structure and its changes are influenced by a wide range of factors, the so-called "driving forces" (Jeleček, 2002). According to Mather (2002) economy, technology, politics, institutions and culture work on a general level – as "underlying" factors. They determine general functioning of landscape and nature-society interaction in a broader system (e.g. country). On the other hand, each locality has its own specific characteristics that work as "proximate" factors.

Land-use and land-cover changes and related driving forces during the First Long Monarchy Period

The I.LMP corresponds to the pre-industrial period that is the first stage in society' development.

The pre-industrial period was characterised by an employment in the primary sector – agriculture and slow dynamics of change. Natural conditions were the important determinants of inhabitant distribution. The limited role of towns in the settlement system led

to a low level of hierarchical organisation. In comparison with the next stages, the inhabitants were distributed relatively equally and individual settlements had a low size range (Hampl et al., 1996; Hampl, 1998).

Such situation reflected in the land-use patterns during the I. LMP at three study sites. The I. LMP was characterised by an enlargement of arable land not only in the agriculturally favourable region (KB) but also in the mountain region (LT) with worst natural and climatic conditions. At KB arable land increased from 41.0 to 82.3%, at LT from 0.1 to 7.2%. Thus, permanent grassland conversion into arable land was observed in these two areas. At KB, permanent grasslands decreased from 52.7 to 10.1%, at LT from 31.8 to 16.5%. Forest land increased at LT from 67.7 to 76.0% at the expanse of permanent grasslands.

In comparison to KB and LT, less important changes were observed at OD, where a moderate decrease of arable land from 21.0 to 19.5% in favour of permanent grasslands was recorded. Forest land underwent at OD reversible changes with the overall decrease of 3.8%.

Built-up areas recorded a gradual increase at KB from 0.1 to 1.8%, at OD from 0.5 to 0.6%. At LT reversible change was recorded from 0.2% in 1782 to 0.1% in 1846 and to 0.2% in 1876.

All these changes were determined by various natural, socio-economic and political factors. Main driving forces of this period were demographic trends, mainly settlement of mountain areas supported by the policy and land reform introduced by the empress Maria Theresa and her son Joseph II.

Technological development was of minor importance. Till 1848, all the agricultural work was done manually (Demo et al., 2001). Subsequently, attention was almost entirely devoted to harnessing animal power to perform operations formerly done by hand. New technologies were implemented slowly and had no important impact on land-use during the I.LMP. The development of machinery has made progress mainly after the World War II.

Excellent natural conditions together with high soil quality favoured agricultural development and arable land utilisation in KB before less favoured areas (LFA) in OD and LT. In spite of this fact during the I. LMP increase in population and effective policy measures led to colonisation of mountain regions having a major influence on land-use changes. The number of inhabitants in Slovakia increased, from 1.9 million in 1786 to 2.1 million in 1800, 2.4 million in 1848, and 2.5 million in 1869 (Marek, 2011, ŠÚ SR, 2008). Such an increase in number of inhabitants caused arable land expansion in the territories with favourable natural conditions (KB) similarly to less favoured mountain regions (LT, OD).

Intensive settlements of Slovak mountain regions took place earlier – in the 14th century during the period of Wallachian colonisation, and later on by Slovak colonisation of mountain regions under Wallachian law (OD). In this period the number of villages raised to 3000, and number of inhabitants increased to 400–450 000 on Slovak territory (Demo et al., 2001). The Wallachian cattle grazing method was brought by the Wallachians who came to Slovak territory from what is nowadays Romania. The Wallachians were establishing their own settlements, but gradually they merged with native Slovak inhabitants. They saturated the mountain and sub-mountain areas and introduced specific types of land use (Olah et al., 2009).

Later, in the 17th century, started settlement of others mountain areas including LT by Goral colonisation. The Gorals settled the territory in the upper reach of the Kysuca River, upper Orava and a part of the northern Spiš (where LT is located) (Stankoviansky and Barka, 2007). The origin of the Gorals has been not clarified yet from historical or ethnological point of view. According to one of the hypotheses the Gorals came to Slovak territory from the middle Wisla river in nowadays Poland.

The main effort during the colonisation was to utilise uninhabited mountain areas. Forests were cut down by the Gorals and converted mainly to permanent grasslands (pastures), to a lesser extent to arable land. In these periods in LT the farm units' were established and in that form existed until collectivization (Dobrovodská, 2000).

In 1782 permanent grasslands covered 31.8% of LT, arable land 0.1%. In 1876 arable land covered 7.2% and permanent grasslands 16.5%. Decrease in permanent grasslands and arable land increase were probably caused by the changes in style of life of the Gorals. Their pastoral nomadic style of life was gradually changing into a more settled one. Minor changes in OD land-use during the I.LMP, compared to LT, were due to the longer existence of settlements with typical features of a meadow grazing system.

Land policy had an important impact on land-use changes at all three study areas. In the 18th century, the Theresian and later Josephin cadastres gradually brought order into land ownership, primarily for tax reasons. The reform effort was also intended to stabilise rural settlement, to establish new villages, and split large farmsteads among an increasing number of settled farming families. The rural population was understood to be an important social group, and farming ranked among the major structural components of the national economy (Majerová, 2000).

In 1817, Francis I. introduced the stable cadastre based on scientific principles. On the one hand, land and real estate cadaster was originally created for state and taxation policy purposes including reviewing the revenue from all fertile land parcels. On the other hand, there was the factual land registry involving the negotiable and mortgaged real estates. The land registers were aiming at the security of ownership, the protection of land transactions as well as the creditors' interests. This fact determined the organisational arrangement of land use categories and cadaster administration units (PCC, 2008).

Land-use and land-cover changes and related driving forces during the Second Long Revolutionary Period

During the 20th century at least four major turnarounds can be registered: (a) the agrarian crisis at the turn of the century, (b) the land reform of 1919, (c) the collectivisation after 1949, (d) the transformation after 1989 (Majerová, 2000). The political-administrative form changed in Slovakia seven times. Therefore we labelled this period as 'revolutionary' (II.LRP). The influence of policy on land-use changes was mitigated by its rapid changing (Table 4).

This period is predominantly characterised at three study areas by discontinuous non-linear land-use and cover changes resulting from the data received from the mapping in the years 1876, 1956, and 1990. Unfortunately, the interwar period was not mapped in Slovakia; only rough actualisation of the map from the third military mapping was done. The mapping year 1876 gives a picture of the land use at the end of the Monarchy period and is a good tool to compare this situation with the incipient collectivisation after 1949 (mapping year 1956) and transformation after 1989 (mapping year 1990).

During the period 1876–1956, a moderate expansion of arable land continued in KB fertile region from 82.3 to 90.7%. An arable land increase was observed also in less fertile OD during the period 1876–1990 from 19.6 to 31.2%. In contrast, in the mountain LT cadastre arable land was converted into permanent grasslands and partially into forest (7.2% of arable land in 1876 to 3.6% in 1990). Slight increase in forest land was recorded only at LT from 76.0% in 1876 to 81.7% in 1990.

The changes in the mountain LT cadastre resemble forest transition processes (Mather, 1992) which have been taking place for at least 150 years in the entire mountain area of Europe due to

Table 4
Portion of different land-use categories during 1782–2006 (in %).

Land-use category	Study site	Mapping years						
		1782	1846	1876	1956	1990	2000	2006
Arable land and permanent crops	KB	41.0	67.0	82.3	90.7	87.0	88.0	88.6
	OD	21.0	21.1	19.5	23.8	31.2	31.7	31.7
	LT	0.1	6.1	7.2	5.1	3.6	3.6	3.6
Permanent grasslands	KB	52.7	27.5	10.1	0.7	0.8	0.6	0.7
	OD	20.4	27.7	25.8	31.2	16.8	16.3	16.2
	LT	31.8	19.0	16.5	19.5	13.7	13.3	11.7
Forest land	KB	5.1	3.5	4.0	2.2	3.2	3.0	2.8
	OD	57.8	50.7	54.0	43.5	49.0	49.1	49.1
	LT	67.7	74.6	76.0	74.6	81.7	82.1	83.7
Built-up areas	KB	0.1	1.2	1.8	2.7	4.8	4.7	4.6
	OD	0.5	0.4	0.6	1.5	2.7	2.7	2.7
	LT	0.2	0.1	0.2	0.4	0.8	0.8	0.8
Others	KB	1.1	0.8	1.8	3.6	4.3	3.7	3.4
	OD	0.3	0.1	0.1	0.1	0.2	0.2	0.2
	LT	0.3	0.2	0.1	0.4	0.2	0.2	0.2

Abbreviations: KB – Král'ov Brod; OD – Očová Dúbravy; LT – Liptovská Teplička; I.LMP – First Long Monarchy Period; II.LRP – Second Long Revolutionary Period; III.SNP – Third Short New age Period.

extensive land abandonment (Mac Donald et al., 2000). The process is generally defined as a reversal of decreasing forest area to increasing forest cover and it is usually accompanied by other socioeconomic processes (Rudel et al., 2010; Plieninger et al., 2012). In Slovakia, after World War II, socialist industrialisation started and there were dramatic changes in agriculture. In KB and OD the agricultural production increased because of favourable natural conditions while in the less favourable natural conditions of LT extensive land management took place. Agriculture was heavily subsidised and production was mainly targeted at socialist markets (Kuemmerle et al., 2009).

Settlement patterns during this period were of less importance in comparison to the I.LMP. Despite the adverse war circumstances, the population gradually grew in number. In 1900 in Slovakia lived 2.8 million inhabitants, in 1921 after World War II 3 million (ŠÚ SR, 2008). But the agrarian crisis towards the end of the 19th century and the deterioration of living conditions in villages drove out a part of the poor population mainly from the least favourable regions (case of LT) to seek work in America. The agricultural land in LT decreased at that time at the expense of permanent grasslands. After the World War II, in 1946, in Slovakia lived 3.3 million inhabitants, and this number grew to 5.3 million in 1991 (ŠÚ SR, 2008). Population growth contributed to the increase of the rural population but also led to the growth of urban areas that was induced by the start of industrialisation.

Industrial society is distinguished by the development of the secondary sector and a distinct change dynamic. Natural determinations are overcome and the role of socio-geographic and economic factors increases. The process of urbanisation becomes more intensified, and is linked with a large spatial mobility of citizens (Hampl et al., 1996; Hampl, 1998). With the start of the industrial society the significance of physical-geographic factors was diminishing while the role of social factors, particularly economic ones, became of key significance (Blažek and Hampl, 2009).

Alongside the influx of people into the village (KB), an outflow of village people into towns (LT) also continued, and agriculture began to feel a shortage of skilled labour. As a consequence of industrialisation, smaller production companies were established not only in urban but also in rural territories at the expense of arable land. In addition the decrease of arable land area was a consequence of setting up large-scale cooperative farms (large-scale stables, large-scale utility sheds). Thus, built-up areas increased at all three study sites. We observed the biggest increase in built-up areas at KB from 1.8 to 4.8%, and the smallest one in the least favourable LT from 0.2 to 0.8%.

Growing population caused pressure on agricultural production which was reflected in the expansion of arable land in KB and OD during the period 1876–1956. This increase was connected with the intensification supported by technological development that we consider as the main driving force of this period. In the less favoured mountain region (LT) there were no suitable conditions for large-scale agricultural production based on co-operatives and state farms. The main result was the afforestation of agricultural land.

In the middle of the 20th century, the most effective intensification factors in Slovak agriculture were mechanisation and application of fertilisers. This trend had further socio-economic consequences and affected the number of people working in agriculture. According to statistical data, in 1921 in Slovakia 60.4% of the working population was engaged in agriculture; after 1945, it was 48.1% with a permanently decreasing trend.

Land-use policy played an important role in land-use patterns and the main aim was to provide food and other supplies to the population, and to build the new republic' economic self-sufficiency system. In 1919, after the establishment of the Czechoslovak Republic (1918), land reform was implemented including impoundment of large estates. The National Land Office had the role of implementing the land reform. Appropriation of farmland over 150 ha and any land over 250 ha was allowed. 'Legionnaires', agricultural workers and small peasants were preferred. Through strengthening small and middle farmers, the rural population's social structure changed. Land reform helped to stabilise political and economic conditions in the Czechoslovak Republic. Till 1948, land was cultivated predominantly by small-holder farmers. From the viewpoint of land ownership, there were two groups. The first was represented by individual persons, churches or foreign corporations that owned larger estates. Individual farmers formed the second group. They managed areas of 1–10 ha The ratio of total land area utilised by small farmers and large-scale landowners was app. 70%:30%.

Important changes occurred after World War II. Czechoslovak politics and economy were fully oriented towards the Soviet Union under Communism. In 1948, the state became a full land owner and private ownership was cancelled. Forest land was exclusively owned and managed by state. Management of agricultural land was influenced by forced collectivisation which was linked with

Table 5
Number of polygons in arable land and permanent crops and permanent grasslands categories during 1956–1990 period in the three study sites.

Land-use category	Study site	1956	1990
Arable land and permanent crops	KB	26	7
	OD	105	10
	LT	15	2
Permanent grasslands	KB	6	2
	OD	88	20
	LT	82	29

Abbreviations: KB – Král'ov Brod, OD – Očová Dúbravy, LT – Liptovská Teplička.

further intensification of agriculture. Traditional extensive farming with individual farmer attitude to landscape was transformed to collectivisation with overall interest in land exploitation (Bezák and Petrovič, 2006). Collectivisation caused small-scale parcels managed by individual farmers to be consolidated into large blocks (polygons) managed by large co-operative farms and resulted in a decrease of the mosaic of arable land and grasslands. The number of polygons at all three study sites during 1956–1990 decreased (see Table 5).

An important aspect was that of the massive subsidies to agriculture in the early 1970s, oriented towards enlarging agricultural enterprises and co-operatives also in KB and OD. In the 1980s the heavily subsidised system reached maximum and made no further growth progress. After peaking in the second half of the 1980s, production grew no further and went into decline until 1989 and the Velvet Revolution broke out (GrešlováKušková, 2013).

Land-use and land-cover changes and related driving forces during the Third Short New Age Period

The recent III.SNP is relatively short so land-use and cover changes are not so significant in comparison to the long period changes. Although the determination of driving forces for such a short period is not completely certain, the most significant driving forces seemed to be land-use and agricultural policy instruments and settlement patterns. Technological development has recorded no dramatic shift in Slovak conditions during III.SNP.

After the Velvet Revolution in 1989 that ushered in a new political regime, all land-use changes were induced mainly by new land-use policy which brought the restitution of private property nationalised under Communism (including agricultural land, farms, forests), the partial privatisation of state property, and the transformation of agricultural co-operatives (Jeleček, 1995). The old system including central directives, price controls, subsidies, state ownership was destructed. During socialism, Slovakia intensified agricultural production considerably thanks to subsidies and capital investment by the government, sometimes even pushing cultivation into marginal and mountain areas (case of LT) (Kuemmerle et al., 2009).

However, after 1989, the situation changed dramatically. Since 1989, the share of support to agriculture and food industry has declined sharply (Csaki et al., 2003). State support diminished, former export markets within socialist sphere of influence disappeared, prices were liberalised, and farmers suddenly faced the necessary inputs (e.g. fertilizers) and technology (e.g., access to machinery) to sustain high yields. Land reform was carried out to restructure the farming sector, individualise land use, and privatise farmland (Lerman et al., 2002). However, former landowners were in many cases urban dwellers not interested in farming (Mathijs and Swinnen, 1998) and young people migrated to cities (Palang et al., 2006). It resulted in the bankruptcy of many state agriculture corporations and the abandonment of agricultural landscape. Farmland abandonment rates were higher in Slovak mountain valleys (case of LT) where production is limited by environmental conditions (e.g. at high altitudes, steep slopes) and where considerable emigration to urban areas occurred in the post-socialist period (Izakovičova and Oszlany, 2007).

Thus at the mountain LT region forest land increased from 81.7% in 1990 to 83.7% in 2006, permanent grasslands dropped from 13.7% in 1990 to 11.7% in 2006. Conversely, at the most fertile and agriculturally favourable KB region a slight increase in arable land from 87.0% in 1990 to 88.6% in 2006 was observed at the expense of permanent grasslands and forest land. At OD, arable land increased from 31.2% in 1990 to 31.7% in 2006 and permanent grasslands dropped from 16.8% in 1990 to 16.2% in 2006. There were no important changes in built-up areas.

In Slovakia, the return of land to its original owners or to their heirs was supported by national legislation. Forest land owners have created communities to manage their estate. However, large forest areas have remained without original owners and have continued to be managed by state. Many agricultural landowners have leased the land to cooperative farms which already existed. Thus, we distinguish users and landowners. In 2005, there were in Slovakia 3564 cadastres, 5 948 850 parcels (Marek and Nejedlý, 2006). One parcel was owned by 12 and much more co-owners. Original owners often live far from their land. Those who live close to their land very often do not have the necessary technical infrastructure for soil management and are insufficiently skilled in this field. Large cooperative farms have been in many cases divided into smaller ones linked to the original villages. However, the continuation of large units is not unusual and they have managed to keep their dominant position in agriculture, although their share of the total acreage of agricultural land has fallen.

The issues of land reform, land policies, land market, land leasing arrangements and emerging market economies in Central and Eastern European countries have been the subject of much research of this period (Csaki and Lerman, 2000; Lerman et al., 2002; Bičík and Jančák, 2006; Bojnec, 2011).

Slovakia is now open to competition on global markets. Agriculture is moving towards more intensive use of fertile land (KB). Less fertile soils (LT) are gradually going to be reconverted into permanent grassland or forests, and financial support is given to non-productive functions of agriculture. Both intensification and extensification in agriculture have been largely assisted by changes in policy measures. Intensive production practices have, to a great extent, been largely assisted by Common Agricultural Policy price subsidies (in Slovakia fairly low compared with older EU-countries) and other types of aid, which concentrate support on the more productive farms (case of KB region), rather than those which contribute more to environmental or social goals (case of LT region). In consequence, these same support measures induce extensification – i.e. abandonment or marginalisation – in upland regions where less favourable areas (LFA) are found (Caraveli, 2000).

The LFA support plays an important role for the creation of profit of the LFA agricultural enterprises (case of OD). The share of the LFA payments in the Gross Farm Income in mountain area is at 20%. The Sectoral Operational Programme Agriculture and Rural Development has been one of the most utilised programmes in Slovakia. The beneficiaries of subsidies achieved a faster rate of growth of income and labour productivity and the support contributed to the mitigation of the decline in employment and helped to preserve the employment in agriculture (Buchta and Buchta, 2009).

Conclusions

In spite of the fact that this paper has explored changes within three land areas in Slovakia as a case study, the findings have a wider relevance and can be applied in a broader context to the

other sites in Slovakia as well as regions of the Eastern and Central Europe with similar historical development. The importance of the findings also lies in the length of the evaluated period, which is rarely assessed because of data availability.

The landscape of all three study sites has undergone significant changes in land-use and cover during the 224 years. From the long-term point of view two main trends were observed. The first was the significant permanent grassland conversion into arable land at KB located in lowland, and the second was the gradual afforestation of permanent grasslands and change to forest land in the mountainous area of LT.

We found that during the different historical periods land-use changes were affected by different driving forces. During the I.LMP demographic trends and settlement pattern (land colonisation) supported by effective land-use policy were dominant driving forces.

Demographic trends and settlement patterns during the II.LRP were of less importance. The influence of policy on land-use changes was mitigated by its rapid changing. The main driving force of this period was technological development including intensification of agriculture, entrance of mechanisation, and fertiliser applications.

During the III.SNP demographic trends and settlement pattern including land-use policy were identified as the most important driving forces similarly to the I. LMP. But in contrast to the I.LMP, driving forces of the III.SNP caused more negative effects (land abandonment) in mountain rural regions where the actual land-use policy seems to be insufficient.

LFA policy was conceived as a structural policy aimed at the prevention of land abandonment, to preserve the farming population in those areas and conserve the countryside. In this respect, the LFA scheme was out of the first measures to address environmentally beneficial farming systems at least indirectly. Extensive farming regions and regions with small-scale farming are most susceptible to marginalisation, with major environmental consequences (Baldock et al., 1996).

As mainstream CAP support is not oriented to these farming systems, expenditures per farm are especially low in small-scale farming regions and cannot suffice on their own to counteract marginalisation. At the same time, the widespread occurrence of low agricultural incomes and of less developed regional economies in LFAs (Brouwer and Lowe, 2000) points to the need for a broader policy perspective. It underlines the requirement to integrate future rural policies in general and to adopt a common strategy across different policy sectors (agriculture policy, energy policy, environment policy) in order to combat the marginalisation tendencies in regional development.

Acknowledgments

The authors acknowledge the Slovak Research and Development Agency for the financial support given via contract No. APVV-0098-12. The insightful and constructive comments of anonymous reviewers are appreciated.

Appendix A.

See Figs. A.1–A.7.

Appendix B.

See Figs. B.1–B.7.

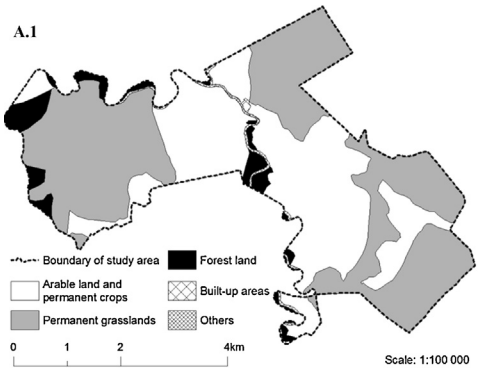

Fig. A.1. Land-use map of Král'ov Brod in 1782.

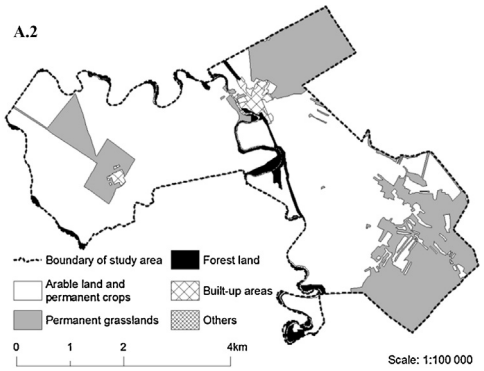

Fig. A.2. Land-use map of Král'ov Brod in 1846.

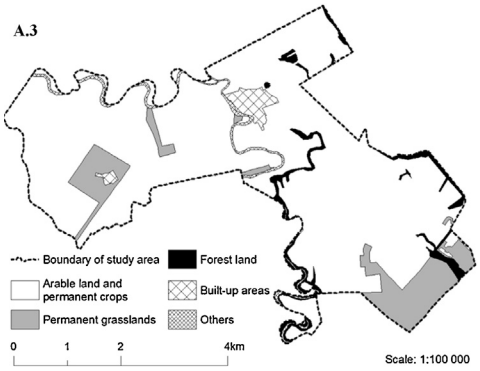

Fig. A.3. Land-use map of Král'ov Brod in 1876.

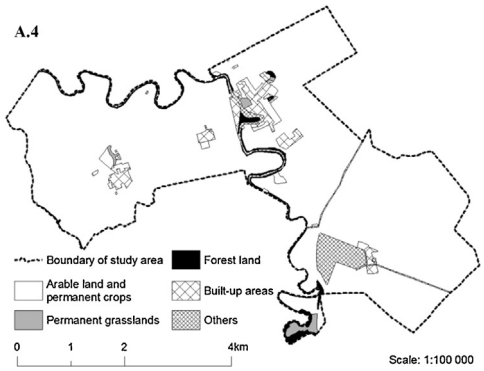

Fig. A.4. Land-use map of Král'ov Brod in 1956.

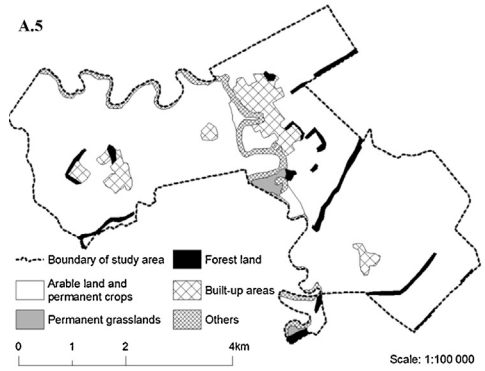

Fig. A.5. Land-use map of Král'ov Brod in 1990.

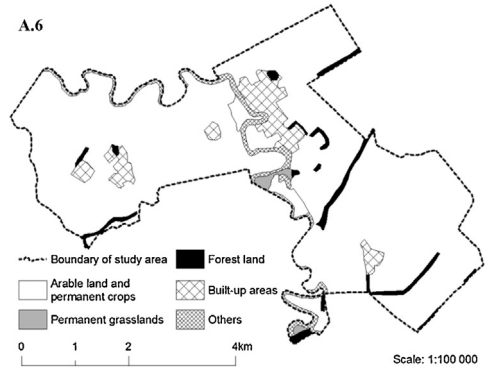

Fig. A.6. Land-use map of Král'ov Brod in 2000.

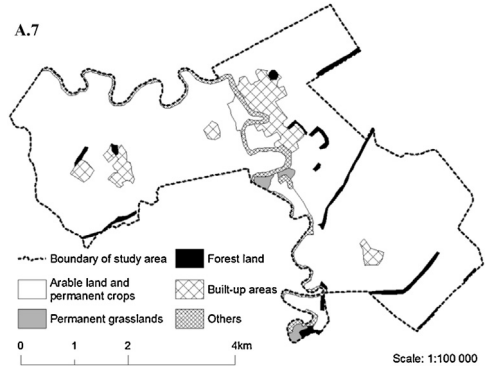

Fig. A.7. Land-use map of Král'ov Brod in 2006.

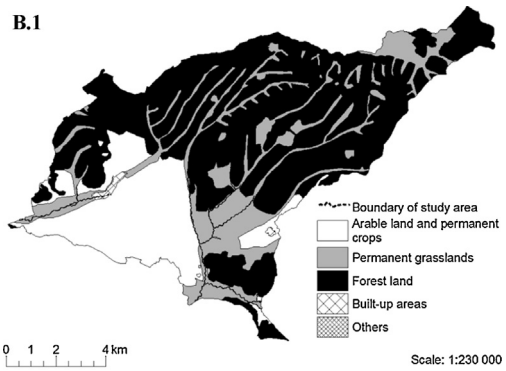

Fig. B.1. Land-use map of Očová Dúbravy in 1782.

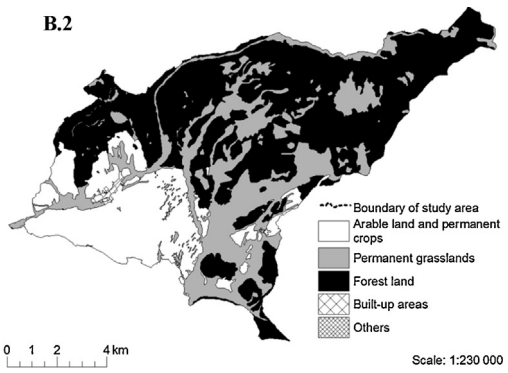

Fig. B.2. Land-use map of Očová Dúbravy in 1846.

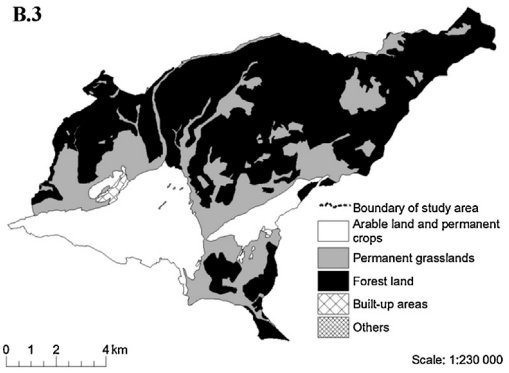

Fig. B.3. Land-use map of Očová Dúbravy in 1876.

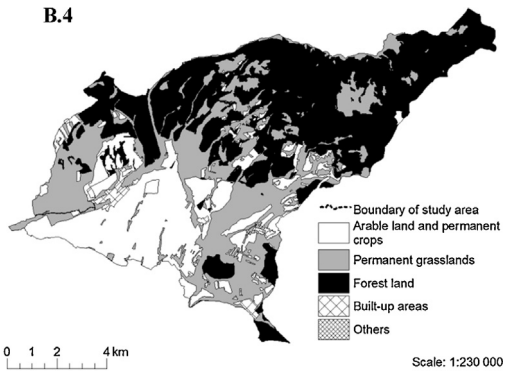

Fig. B.4. Land-use map of Očová Dúbravy in 1956.

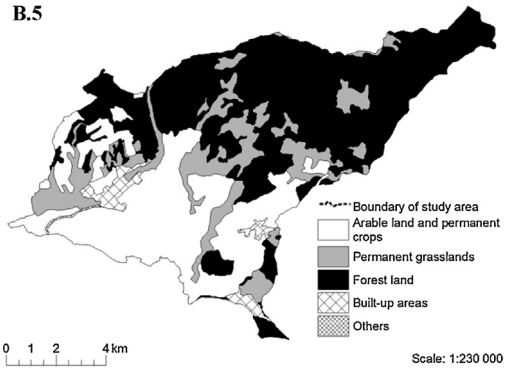

Fig. B.5. Land-use map of Očová Dúbravy in 1990.

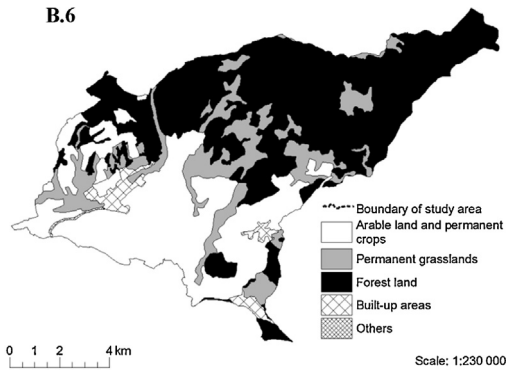

Fig. B.6. Land-use map of Očová Dúbravy in 2000.

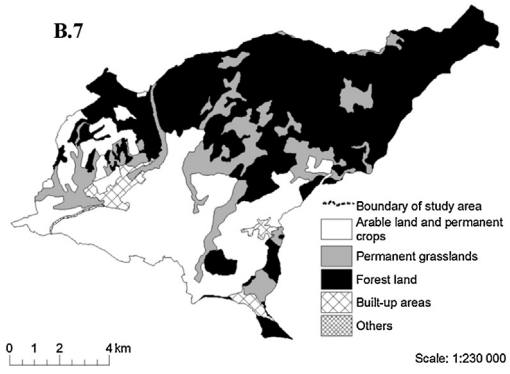

Fig. B.7. Land-use map of Očová Dúbravy in 2006.

Appendix C.

See Figs. C.1–C.7.

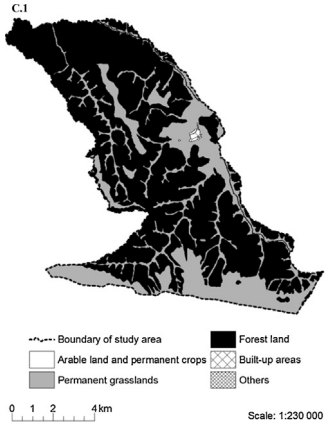

Fig. C.1. Land-use map of Liptovská Teplička in 1782.

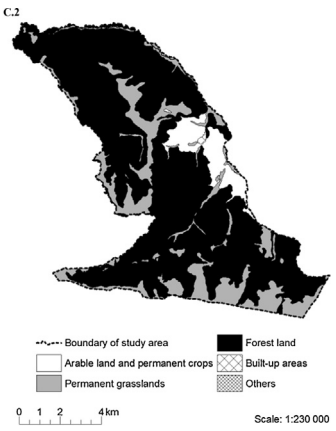

Fig. C.2. Land-use map of Liptovská Teplička in 1846.

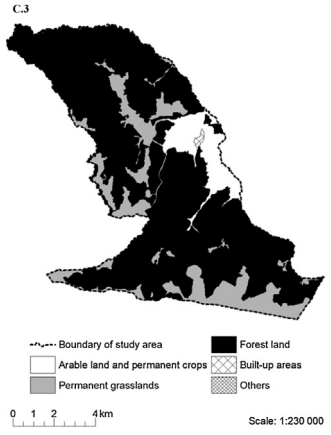

Fig. C.3. Land-use map of Liptovská Teplička in 1876.

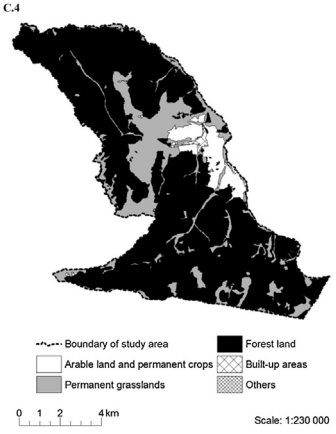

Fig. C.4. Land-use map of Liptovská Teplička in 1956.

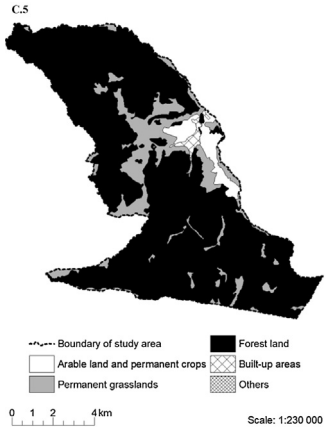

Fig. C.5. Land-use map of Liptovská Teplička in 1990.

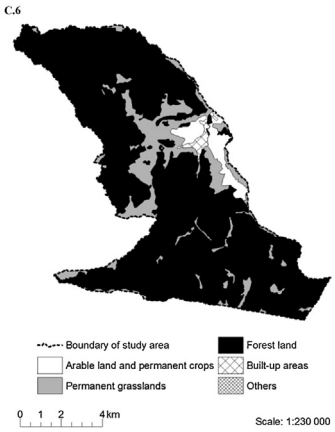

Fig. C.6. Land-use map of Liptovská Teplička in 2000.

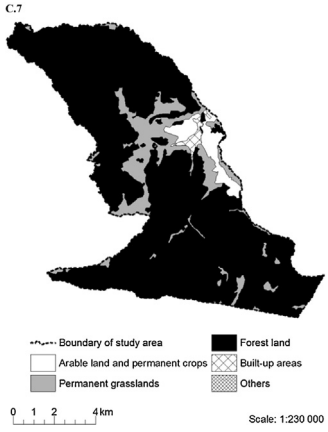

Fig. C.7. Land-use map of Liptovská Teplička in 2006.

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