

CHANGES OF A RURAL LANDSCAPE IN CZECH AREAS OF DIFFERENT TYPES

Milada Šťastná, Antonín Vaishar, Hana Vavrouchová, Miloslava Ševelová, Silvie Kozlovská, Veronika Doskočilová, Helena Lincová¹

Received 21 April 2015; Accepted 30 June 2015

Abstract: The paper deals with the macrostructural and microstructural landscape changes in six selected microregions in Moravia and eastern Bohemia. Changes of the landscape macrostructure were evaluated based on the statistical data from 1845, 1948, 1990 and 2013. Changes of the landscape microstructure were compared on the base of old maps, aerial images and field experiences. According to the available data the area of an arable land was the largest in 1845. Since then it has been decreasing – more in mountain areas, less in lowland ones where it was replaced by forests, grasslands and urban areas, depending on the vegetation period, physical character and vicinity of urban centres. Results show that the microstructure recorded great changes during the communist period: large expanses of fields, irrigation and drainage measures, windbreaks, non-rural buildings in the countryside. Contemporary changes are connected mostly with urbanisation of the landscape.

Key words: landscape changes, macrostructure, microstructure, the Czech Republic

Souhrn: Příspěvek se zabývá změnami makrostruktury a mikrostruktury krajiny v šesti vybraných mikroregionech Moravy a východních Čech. Makrostruktura krajiny byla hodnocena na základě statistických dat za léta 1845, 1948, 1990 a 2013. Změny krajinné mikrostruktury byly srovnány na základě starých map, leteckých fotografií a zkušeností z terénu. Orná půda zaujímal největší plochu v roce 1845. Od té doby jejich rozloha klesá – více na vrchovinách, méně v nížinách. Orná půda je nahrazována lesy, trvalými travními porosty a urbanizovanými územími v závislosti na období, fyzickogeografickém charakteru území a blízkosti urbánních center. Z výsledků srovnání vyplývá, že mikrostruktura zaznamenala velké změny v komunistickém období tvorbou rozsáhlých lánů polí, zavlažovacích a odvodňovacích opatření, větrolamů, nerurálních budov na venkově. Současné změny jsou spojovány hlavně s urbanizací krajiny.

Klíčová slova: změny krajiny, makrostruktura, mikrostruktura, Česko

¹ Doc. Ing. Milada Šťastná, PhD., stastna@mendelu.cz; Doc. RNDr. Antonín Vaishar, CSc., antonin.vaishar@mendelu.cz; Mgr. Ing. Hana Vavrouchová, PhD., hana.vavrouchova@mendelu.cz; Ing. Miloslava Ševelová, PhD., miloslava.sevelova@mendelu.cz; Ing. Silvie Kozlovská, PhD., silvie.kozlovska@mendelu.cz; Mgr. Veronika Doskočilová, veronika.doskocilova@mendelu.cz; Ing. Helena Lincová, helena.lincova@mendelu.cz, Department of Applied and Landscape Ecology, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 61300 Brno, Czechia

1. Introduction

Central and eastern European landscape was going through substantial changes throughout the history. This was the case of transition from hunting to agriculture, later the case of urbanization and industrialization. Unfortunately, many old cultural landscapes, despite they are of high qualities, lack the proper management regime to keep them more feasible economically (Vos and Meekes, 1999). Our attention is mostly paid to the changes happened after the WWII.

Generally, the mentioned period is characterized by the uniformity, rationality, lack of identity and personality (Antrop, 1997). In post-communist countries, the changes were connected additionally to collectivization of agricultural production resulting in industrialization of agriculture and to suburbanization, development of transportation network or tourism development in the last period. Different landscapes were impacted by changes in different ways. Suburban landscapes differ from landscapes of intensive agriculture as well as landscapes in lowlands differ from those in highlands. Moreover, historical development, which results in different relation of inhabitants to their landscape, could differ also due to the landscape changes. There are noticeable changes both in landscape macrostructure and microstructure. Macrostructure of landscape is connected mainly to land use and land cover. Such changes are investigated mostly on the base of “hard” data. Landscape microstructure contains rather relations among different landscape use, size of the pieces of land, barriers in the landscape like road, railways, fences, constructions of different types, landscape details and their maintenance. The microstructure of landscape is decisive for the landscape perception, aesthetics and throughput of a landscape.

State of the Arts

Natural processes and human land-use are identified as two distinctive processes resulting in different characteristics of patterns in landscapes (Lausch et al., 2015). Europe is formed mostly by cultural landscape with only very rare exceptions. The concept of a cultural landscape was introduced by F. Ratzel into German geography at the end of 19th century. Since 1960s it is used also in other disciplines, including landscape ecology. Later on it was discussed e.g. by Jones (2003) who highlights it due to the use of different disciplines and due to the both natural and human impacts (the term cultural landscape is applied in different ways) or by Anthrop (2005) who points out the sustainability and protection of the cultural landscape towards future generations. Taylor and Lennon (2012) stress the importance of cultural landscape for an identity in the face of globalization processes and Lindenmayer and Fisher (2013) mention its role for habitats.

Research of landscape macro and micro changes in the Czech Republic was done by Lipský (1994, 1995); Bruno and Křováková (2005) and currently Skaloš (2010, 2011) – especially using geographical approach. In the field of historical geography it is necessary to mention thematically related work by e.g. Semotanová (2002) and Jeleček (2007).

Landscape structure consists of three layers. The “primary landscape structure” (Walz, 2001) is formed by an original natural landscape. The “secondary landscape structure” or “cultural landscape” (Meyer, 1997) represents the landscape formed by man during the historical development. The “tertiary layer” is formed by landscape memory, events, relation of inhabitants to their landscape (see e.g. Lipský, 2014). The relation between culture and landscape was stressed by Nassauer (1995). Another approach applied in the analysis of landscape structure is based on the basic proposition of Forman and Godron (1993), which is also incorporated in this research. According to these authors, the landscape consists of a matrix, enclaves and corridors. To evaluate the type of landscape microstructure, partial methodology by Zonneveld (1995), which classifies the microstructure in terms of quantity, size, shape, type and arrangement of the overall compositional parts is recommended.

Sklenička (2003) states the following graphic and descriptive characteristics of Zonneveld classification:

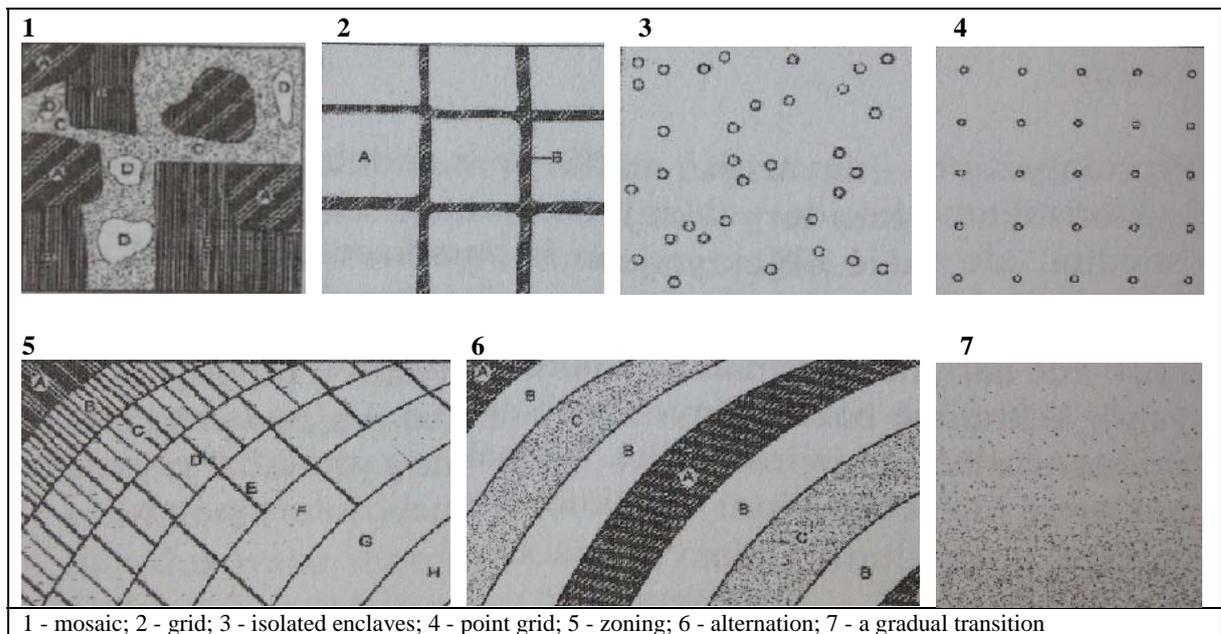


Fig 1. The classification of types of microstructure according to Zonneveld (1995). Source: Sklenička (2003, p. 152)

Mosaic - regular and uniform structure with minimal representation of linear compositional parts;

Grid - periodically or randomly structured linear elements creating isolated areas (it can also be considered as a matrix with respect to the impact on the landscape dynamics);

Isolated enclaves - structure is formed by faces regularly (dot grid) or by a randomly distributed faces in the landscape matrix

Diffusive structure - individual landscape elements are irregularly diffusing, the edges tend to be rugged,

Zoning - structure consists of parallel arranged of landscape elements strip character; if the elements repeatedly alternate, we talk about alternation,

The gradual transition - a gradual transition from one component to another.

The development of the Czech landscape during the period of 1945 - 1990 was impacted by two main factors. The technological development connected to industrialization of agriculture (mass using of machines, herbicides and pesticides), urbanization, development of tourism, construction of technical infrastructure and other aspects of the modernization represent the first group of aspects. These factors are common for the whole Europe – of course in a different stage of the development. Special factors which are possible to sum up as consequences of collectivization of agriculture and central planning of the production and the settlement structure form special factors connected to the former regime.

Lipský (1995), investigating consequences of the collectivization impacts on the landscape, stated: *The analysis of landscape development shows that statistics about land use can give only general information about landscape macrostructure and cannot provide a perfect idea of the actual spatial composition of landscape elements. Landscape microstructure expressed in spatial arrangements, shape, size, quality and connectivity of patches, lines and small interactive elements plays the main role in landscape dynamics and is the principal influence in landscape stability.* It seems that the microstructural changes play the most important role in the post-war period. Brady et al. (2009) show that average size of a block of fields in the Czech mountain region Vysočina is 10 - 20times larger than comparable regions in Italy and Sweden.

Blacksell (2010) states that *Collectivisation during the 40 years of communism destroyed many of the most distinctive pre-existing landscape features, in particular field boundaries, drainage systems, local track networks, mixed farming systems, including small-scale forestry, and a multitude of traditional farms buildings. Any hope that these might be resurrected as part of the post-communist transition since 1990s has gone in vain. The large farm structures and their associated man-made landscape features have remained intact; it is essentially just the management systems that had changed.*

Original imaginations of possible return to the pre-war state proved to be unrealistic (van Dijk, 2007). The post-communist period took a part in substantial reduction of the agricultural land protection which opened the landscape to different commercial interests. General development, common for Europe is represented by the suburban development and further construction of technical infrastructure, including motorways. The landscape planning has to cope with growing demands of society leading to productive, ecologically healthy and attractive multifunctional rural landscape (Bastian et al., 2006). The concept of an ecological stability of the landscape promotes increasingly (Skokanová and Eremiášová, 2012). The development is impacted also by the rules of the Common Agricultural Policy after the access of individual countries to European Union (Brouwer and Lowe, 2000). The implementation of European Landscape Convention (Olwig, 2007) will bring new impulses to the landscape rather in the future.

Těšitel et al. (2014) defined characteristics of “vital landscapes”:

- *Vital landscapes are perceived by people. They play an important role in shaping regional, local and personal identities*
- *Vital landscapes are expected to meet diverse demands. Healthy environments provide a wide range of ecosystem services.*
- *Vital landscapes are economically self-sufficient and provide the resource base for sustainable societies.*
- *Vital landscapes are home to vital communities.*
- *Vital landscapes are dynamic. Clear visioning prevents arbitrary landscape developments.*
- *Vital landscapes constitute an essential part of quality of life. Visions and action plans for vital landscapes shall be elaborated in participatory processes involving the general public.*
- *Vital landscapes are spaces of learning. They encourage social interaction and knowledge-based actions.*

The legal and organisational tool of the landscape microstructure improvement under the Czech conditions is called land consolidation (Sklenička, 2006). It consists of a set of measurements focused on rationalization of plots and their accessibility, implementation of system of ecological stability, protection from erosion and floods. Identification and clarification of the ownership were a specific aim during the post-communist period. The problem consists of a very slow course of the whole process which is hampered by many circumstances. The problem of landscape changes connects different disciplines. It could be considered a field of the landscape ecology embedded in a space (geographical approach) and time (historical approach). This fact results also in the selection of methods used for the analysis.

Research objectives

The paper is aimed at the evaluation of both macrostructural and microstructural changes of the landscape in six selected microregions with an attempt of generalization. Following Punch's (2008) statement where research is not necessarily based on the hypothesis, two research questions were placed: The *first one*: Are there just microstructural aspects as leading characteristics of recent landscape development? The *second research question* asks if macrostructural changes are evoked preliminary by economic and technological development whether the microstructural changes are connected more to social and political processes.

Comparative analysis of landscape microstructure and macrostructure was used to determine the driving forces of landscape structure changes in selected areas and understanding the functioning of the landscape. The results represent a comparative basis showing the current status and further development trends of landscape structure. The next stage of the research will be focused on completion and confrontation of obtained results with mental reflection of landscape structure and the appearance of the landscape in the memories of local people. This information will be gathered through interviews with residents.

2. Methodology

Case study areas

The investigation took a place in six case study areas (Fig. 2). They were selected according to different landscape types from the viewpoint of historical development and the distance from the regional centre (Brno). All of them consist of rural settlements and a small town which does not overpass 15,000 inhabitants in any case. The area of individual microregions is about 150 - 250 km²:

- **Šlapanice** microregion (East of Brno) as the suburbanized landscape with some historical heritage
- **Podluží** microregion (southern part of the South-Moravian Region) as the landscape with intensive agriculture and viticulture
- **Nové Město** microregion (Nové Město na Moravě and its surroundings, a part of the Vysočina Region) as representative of the highland landscape
- **Bystřice** microregion (Bystřice nad Pernštejnem on the border of Vysočina, Pardubice and South-Moravian Region) as a landscape on an inner periphery with uranium mining and its consequences
- **Hrušovany** microregion (Hrušovany nad Jevišovkou on the borderland periphery close to Austrian border) as a landscape where the after-war ethnically based population exchange disrupted the relation of population to the landscape
- **Vysoké Mýto** microregion (a part of the Pardubice Region) as a comparative territory without any serious particularity

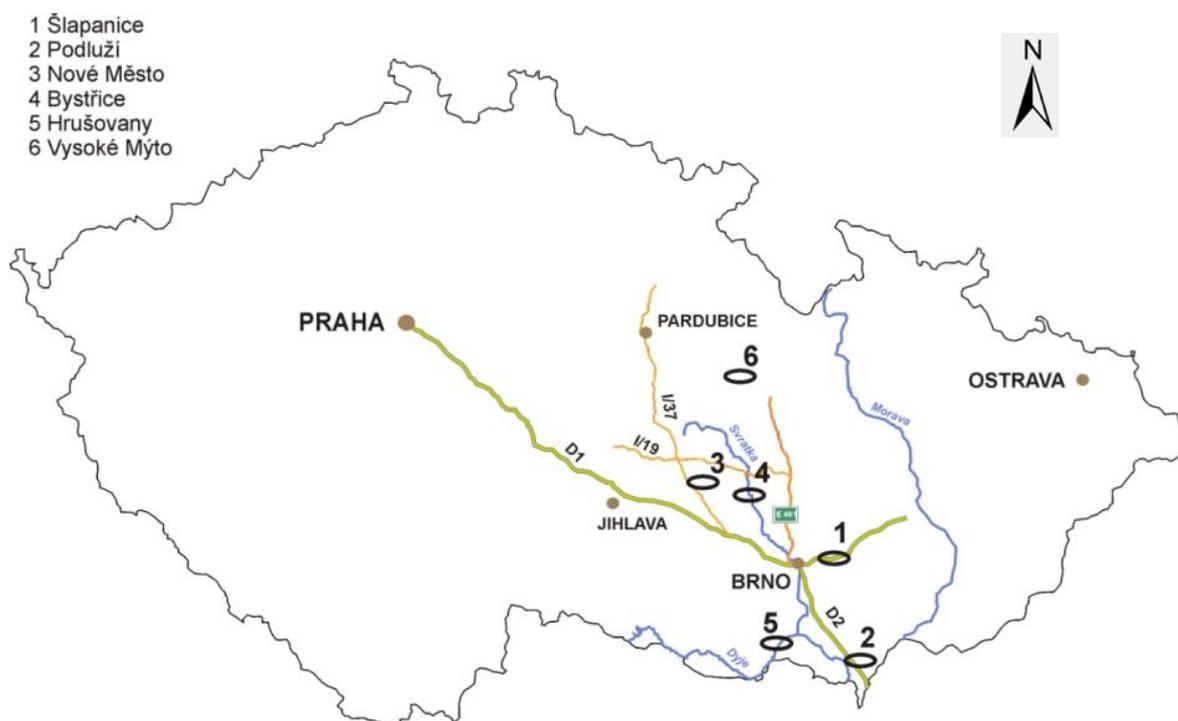


Fig 2. Geographical positions of case study areas selected within the Czech territory. Drawn by J. Pokorná

There are many approaches to the evaluation of a landscape and its existing values, e.g. Crofts and Cooke (1974); Daniel and Vining (1983); Buhyoff et al. (1995); Skaloš et al. (2011) and others. Some of them are based on the comparison of original (or alternatively pre-industrial) landscape with the current state. GIS based evaluation of the landscape changes is relatively frequent (Gulinck et al., 2001). However, it concerns mostly the macrostructural changes. Several methodologies - e.g. Landscape Character Assessment and its Implementation by

State Administration - Methodological Recommendations (Míchal et al., 1999) or Assessment of Effects of Intended Constructions, Activities or Changes in Land Use on Landscape Character (Vorel et al., 2004) were developed for the landscape protection purposes.

The evaluation of macrostructural landscape changes are based on statistics of land use. A database of land use changes for the Czech Republic during the period of 1845 - 2000 exists as a result of activity of the IGU Commission on Land Use and Cover Changes. Main driving forces (Bürgi et al., 2004) within individual periods were evaluated by Bičík et al. (2013). Shares of individual categories (Tab. 1) were collected for the years 1845, 1948, 1990 and 2000. Except for the last one, more topical data of 2013 were used in our research.

Arable land	Forests
Permanent crops ²	Water reservoirs and flows
Meadows	Built-up areas
Pastures	Other areas ³
Agricultural land	Non-agricultural land

Tab 1. Structure of land use data collected in the database. Source: Databáze dlouhodobých změn využití ploch Česka (1845 - 2000).

There is a small methodological problem consisting of a territorial comparability on the municipal level. Due to the changing administrative situation during the 155 years' period, some cadastral areas were united. That is why there are data available for more than one cadastral area in some cases.

Current data for the Czech Republic are available in the public database of the Czech Statistical Office and updated at the end of each year. The methodological problem consists of the fact that the data is collected under administrative documents which could be far from the reality in cases of individual plots – thus they are rather data of the official land use than of the realistic land cover.

The land use data were completed by other indicators related to the landscape as a population density or an average size of the rural settlement. The share of natives may relate to the tertiary landscape structure. The data are based on the 2011 population census or other data sets from public databases. Simple indicators like the coefficient of ecological stability⁴ or trends of the population development were also taken into consideration.

Evaluation of the landscape microstructure was based on visual comparison of old maps and aerial photographs (see Guidelines for Landscape and Visual Impact Assessment, 2013). Following sources for the GIS visualisations were at the disposal: Stable cadastre maps from the half of the 19th century, aerial photographs from the half of 20th century; current aerial photographs available on internet: The current information was completed by the field research and photographic documentation. The attention was paid to the size and distribution of the landscape elements in the territory, their interrelationships (contrast or continual ones), an ecotone effect, connectedness or solitude of elements and a fragmentation of the landscape.

3. Empiric research

General characteristics of the landscape development in Šlapanice microregion.

Šlapanice microregion represents the suburban landscape. Its natural conditions are suitable for an intensive agriculture. It is characterized by a big share of arable land and minimum of

² Orchards, gardens, vineyards, hop-gardens

³ Mixture of different areas – rocks, barren land, handling areas, recreation and sport areas, mines, landfills, cemeteries, nature reserves etc.

⁴ The share of ecologically stable land (meadows, pastures, forests, waters) to ecologically instable land (Míchal, 1982).

forests. Present development is impacted by both residential and commercial suburbanization and by the development of technical infrastructure, namely Brno-Tuřany airport and D1 motorway. The microstructure of landscape is typical by large tracks of fields' instead of smaller fields in the past. The landscape has become dull. New constructions (houses of urban type, commercial facilities, and technical infrastructure) form unoriginal elements in the rural landscape. The tertiary structure is connected to the Austerlitz battle (1805). It is not visible (except of some monuments and memory sites) but it lives in the memory of people and it is supported each year by the reconstruction of the event.

Arable land clearly prevails in the microregion. It covers 75.6% of total territory and 91.7% of agricultural land (Fig. 3). It is followed by so called other areas representing most probably infrastructural objects. The coefficient of ecological stability of the landscape has an extremely low value (0.06). Despite it is relatively rough indicator, it has its predicative value.

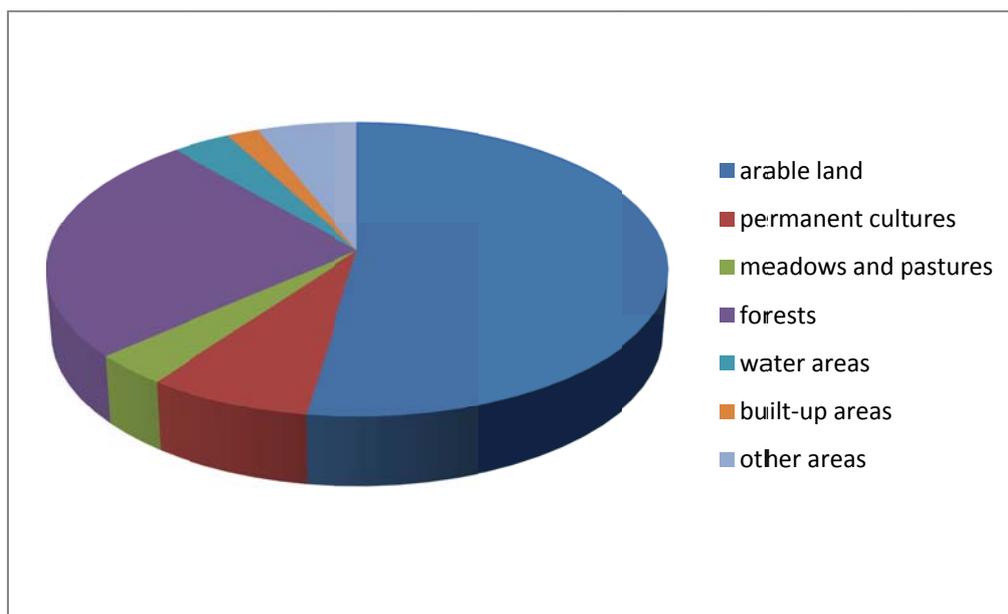


Fig 3. Šlapanice microregion – land use in 2013. Source: Czech Statistical Office, own elaboration.

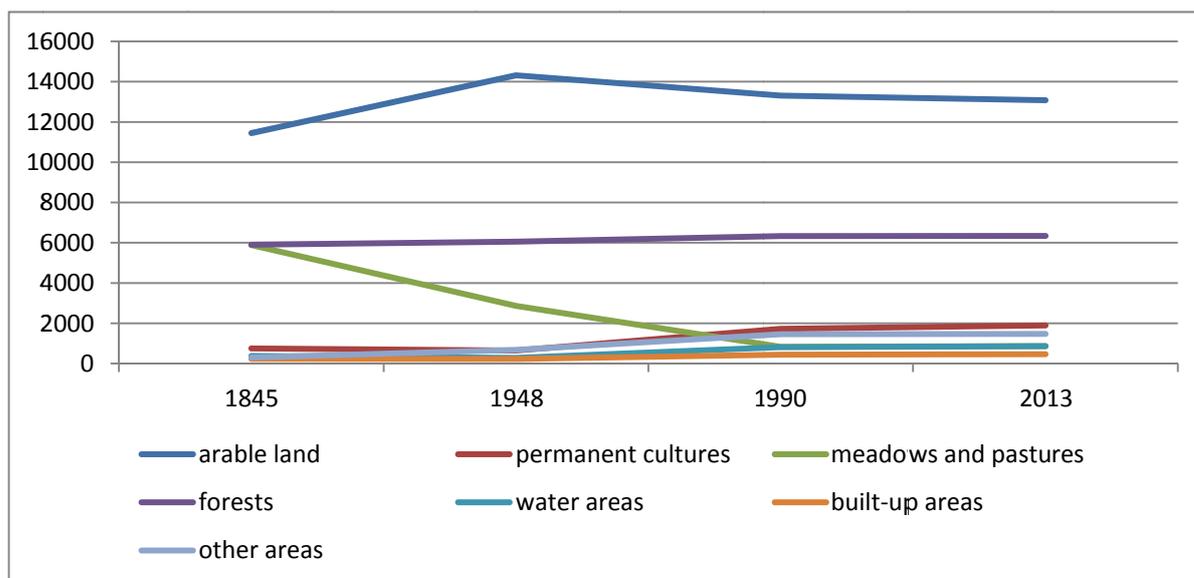


Fig 4. Šlapanice microregion: Long-term development of the landscape macrostructure [ha]. Source: Databáze dlouhodobých změn využití ploch Česka 1845 - 2000, Czech Statistical Office. Own elaboration.

The long-term development shows that the arable land has always substantially prevailed in the microregion (Fig. 4). Nevertheless, the area of the arable land has been increasing during the capitalist period until 1948 when it reached its peak. It occurred mostly at the expense of meadows and pastures. Drainage of fishponds started in 19th century (Demek et al., 2007). During the communist period the area of arable land decreased whereas the share of “other” areas grew up.

Current period is characterised by the newly increase of an arable land (Fig 5). The issues connected to urbanization permanently grew: built-up areas, other areas, gardens. However, the main growth of areas connected to urbanization was recorded during the communist period though we take into account that the communist period was almost twice as long as the post-communist one. Although the increase of built-up areas in Šlapanice microregion is the highest in the surroundings of Brno, it manifests only 3.4% of the total area in the last 15-year period (Havlíček and Dostál, 2010). The microregion has minimum forests. Whereas the communist period brought some afforestation, the present time is characterized by slight deforestation.



Fig 5. Large fields of arable land in Podolí cadastral area. Photo A. Vaishar

The changes after 1948 (communist period) consist of the unification of small fields to large tracks at the first place. This evoked other changes like liquidation of scattered greenery, opening the fields to water and wind erosion, straightening of small streams, decrease of biodiversity etc. The landscape lost much of its aesthetical value. Development of technical infrastructure brought new structures to the original rural landscape which has continued also after 1990.

General characteristics of the landscape development in Podluží microregion

Podluží is the microregion containing intensive agriculture and vineyards (Fig. 6) on the right bank of Morava river which forms the border with Slovakia and left bank of Dyje river (border with Austria). Valuable landscape of floodplain forests can be found forming a part of the UNESCO biosphere reserve Dolní Morava in its southernmost part. Wind erosion occurs in particular parts of the microregion. Large and medium-sized settlements prevail. The microregion disposes with mineral sources as crude oil, gas, lignite, sands – of which oil and gas are mined (Hrušky mining area since 1950s) whereas the lignite mining has terminated. Hodonín spa benefits of iodine water which is used there. The area is an exposed traffic space. European directions from northwest to southeast (Hamburg – Istanbul) and from the north to the south (Warsaw – Vienna) cross here, which is manifested by D2 motorway, two main railway corridors and a set of the 1st class roads. The territory is called “painted region”. The tertiary landscape layer is connected to the culture of wine and living folklore. The area of villages frequently contains wine cellars.

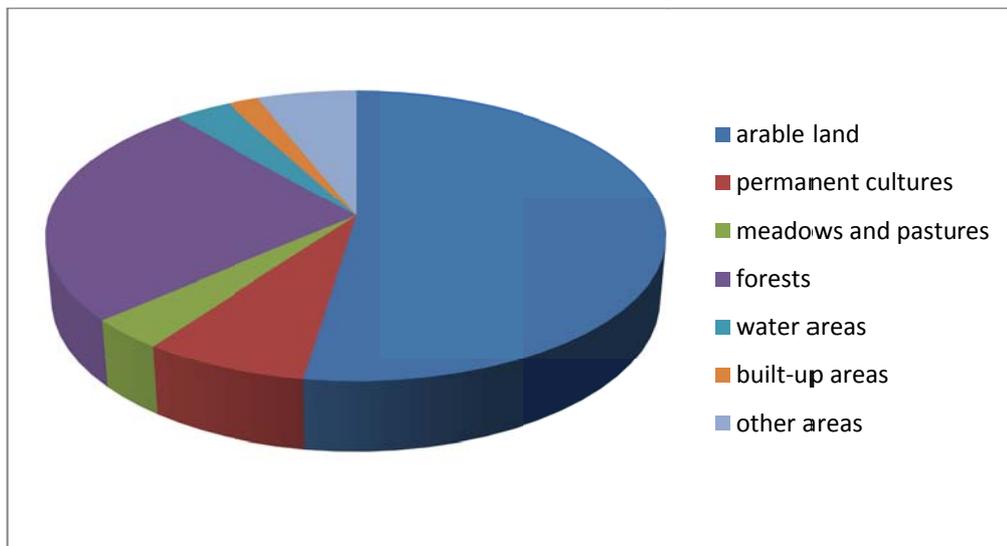


Fig 6. Podluží microregion – land use in 2013. Source: Czech Statistical Office, own elaboration.

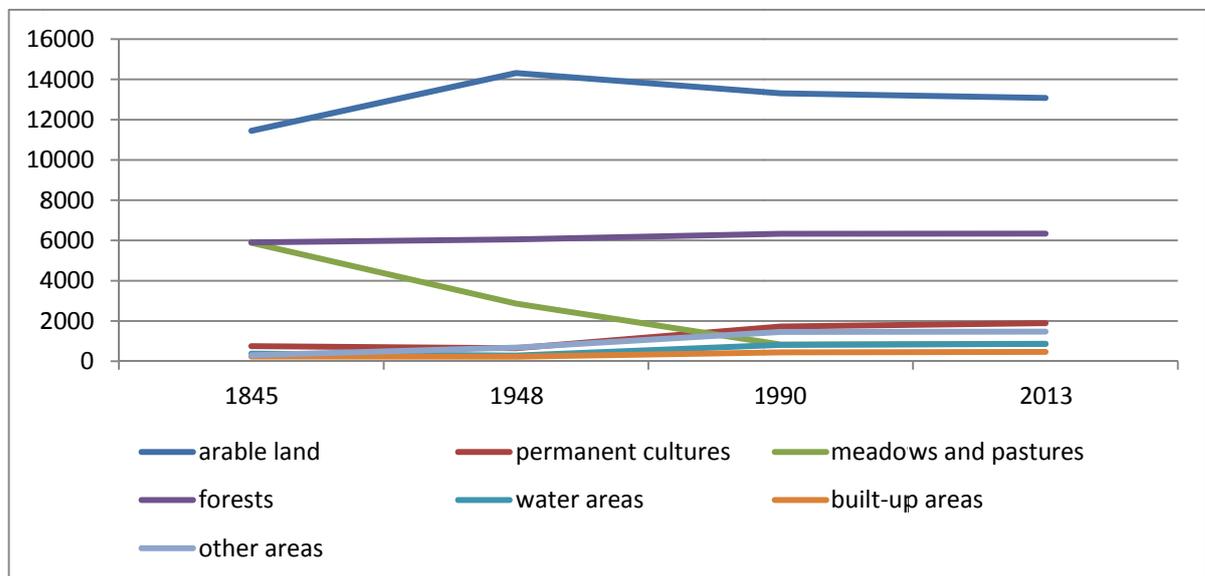


Fig 7. Podluží microregion: Long-term development of the landscape macrostructure [ha]. Source: Databáze dlouhodobých změn využití ploch Česka 1845 - 2000, Czech Statistical Office. Own elaboration

The shares of arable land substantially increased in Podluží microregion before 1948 and later slightly decreased during the communist period (Fig. 7). A very slow decrease of arable land continues also in the recent period. The proportion of arable land out of the agricultural land reaches 83%. The share of forests is more or less stable. Forests cover floodplain areas near the confluence of Morava and Dyje rivers and they are under protection. The decrease was recorded mostly in the case of permanent vegetation (meadows and pastures) which formed similar part of the landscape as forests in 1845, whereas their present area represents only 15% of original size. Permanent vegetation (mostly vineyards and orchards) occupies the third position after arable land and forests. Built-up areas and “other” areas permanently increase. However, their faster grow accounted for the communist period and recently slowed down. The coefficient of ecological stability of the landscape is 0.48 which is considered as unsustainable.

Similarly as in other areas, the landscape microstructure has been impacted by creating large tracks of fields with related consequences (Fig. 8). Buildings and equipment connected to the mining of oil (active or abandoned drilling workplaces, or probes) manifest specific microstructural elements inside the landscape.



Fig 8. Landscape of Podluží micro-region. Photo V. Hubačíková

General characteristics of the landscape development in Nové Město na Moravě microregion

Nové Město na Moravě is a centre of a typical highland microregion with frequently alternating mosaic of fields, forests, fishponds and small villages. The landscape is suitable for extensive agriculture and soft tourism both during summer and winter. A cross-country skiing area of the European importance can be found there. The throughput of the landscape is more difficult due to the relief. A part of the territory is under large scale protection in Žďárské vrchy hills Protected Landscape Area. The population is stabilized for the long term. The share of inhabitants who were born in the microregion is the highest (57.8%) between all case study areas.

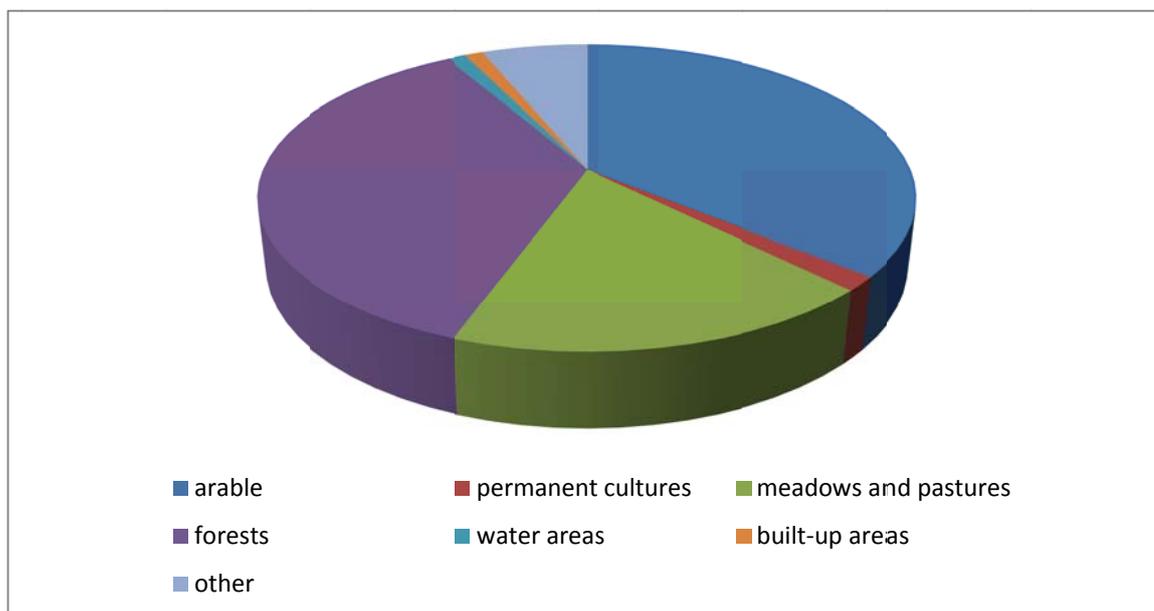


Fig 9. Nové Město na Moravě microregion – land use in 2013. Source: Czech Statistical Office, own elaboration.

Recent landscape macrostructure shows relatively same area of arable land and forests with an important representation of grasslands. The landscape is much more stable, the coefficient of ecological stability is equal to 2.04. On the other side, elements connected to the urbanization intact less important area.

The area of arable land has been permanently decreasing since 1845. On the other side afforestation is in progress for a long time. The area of meadows and pastures fluctuates on the same level. Built-up, and especially other areas, increased most intensively during the communist period.

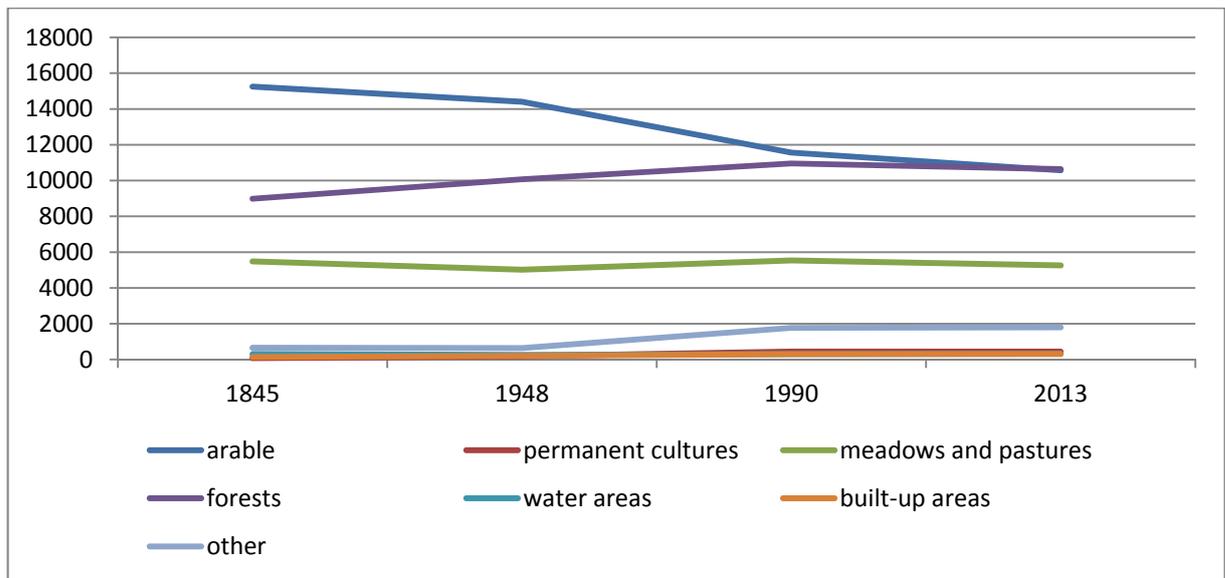


Fig 10. Nové Město na Moravě microregion: Long-term development of the landscape macrostructure [ha]. Source: Databáze dlouhodobých změn využití ploch Česka 1845 - 2000, Czech Statistical Office. Own elaboration



Fig 11. Typical landscape of Nové Město micro-region. Photo H. Vavrouchová

The territory of the micro-region can be divided into two different parts. The northern part is mostly covered by forests where spruce monocultures prevail. Mosaic of forests, permanent grasslands, fishponds and dispersed settlements is typical. Arable land is represented minimally. Transitions between landscape elements are gradual with an abundant ecotone effect. The southern part exhibits more intensive agricultural activity (Fig. 10). Arable land takes relatively large territory, forests are less represented, transitions are sharp, and settlements have a compact character (Fig. 11).

General characteristics of the landscape development in Bystřice nad Pernštejnem microregion

The landscape in the neighbouring microregion of Bystřice nad Pernštejnem has similar natural characteristics but different geographical position and social development. It is remote both from regional centres and important communications. Local roads are often in a bad condition. The landscape is impacted by the uranium mining which is ending its activities in Rožná. The consequences of the mining are rectified by reclamation in different stage of artificial or

spontaneous development. Vír water reservoir supplying the city of Brno (among others) is situated there. In contrast with Nové Město region a part of population moved in due to the mining. It could indicate different relation of the people to the landscape.



Fig 12. Landscape of Bystřice nad Pernštejnem microregion. Photo H. Lincová

The structure of land use in Bystřice nad Pernštejnem microregion is very similar to the previous one (Fig. 13), only the arable land still prevails over forests and the share of the “other” land use is slightly higher which could be connected with the mining.

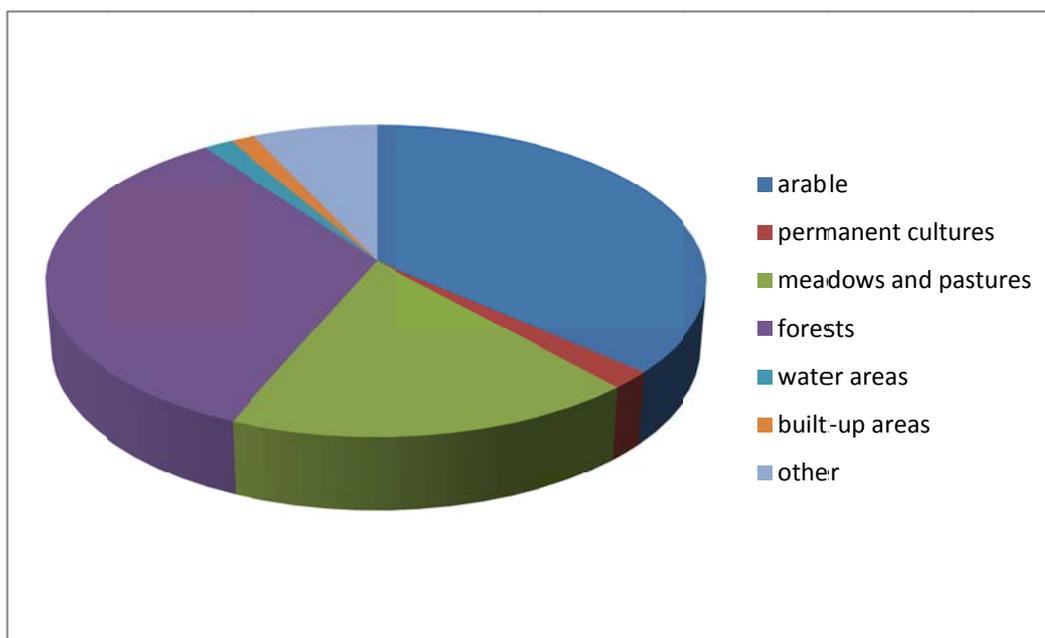


Fig 13. Bystřice nad Pernštejnem micro-region – land use in 2013. Source: Czech Statistical Office, own elaboration.

Also the development of the land use is similar to the micro-region of Nové Město na Moravě. It means permanent decrease of the arable land with the top in the socialist period 1948 - 1990, permanent afforestation, decline of meadows and pastures in the first period before 1948 which has later changed to a growth and permanent growth of built-up and particularly other areas accelerated in the period 1948 - 1990 (Fig. 14). The construction of Vír water reservoir was manifested with more than doubling of water areas in the communist period but their share remained to be low.

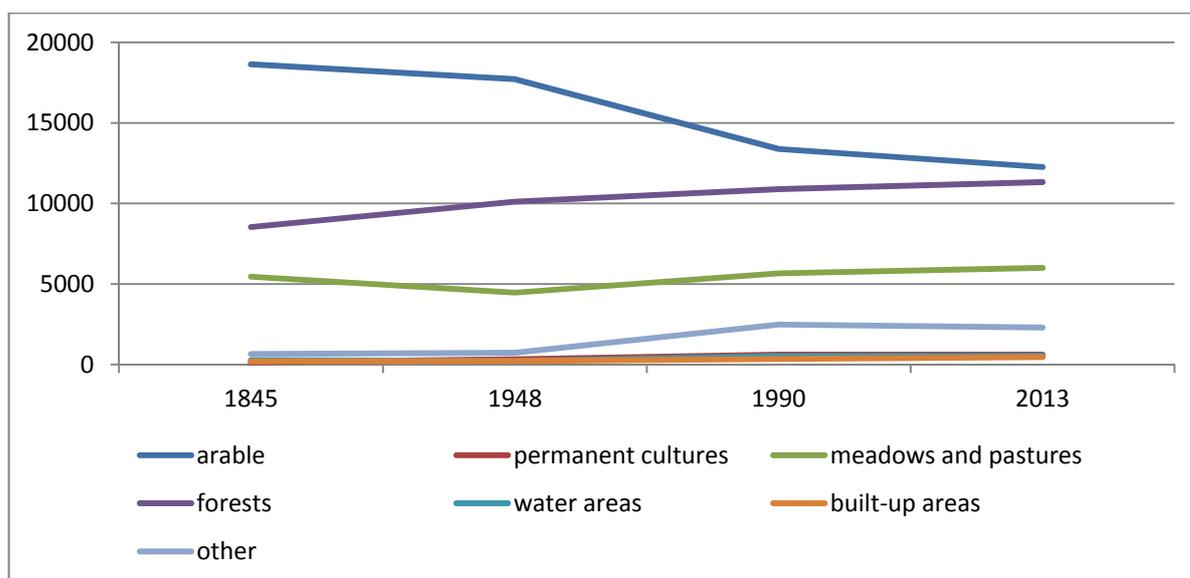


Fig 14. Micro-region Bystřice nad Pernštejnem: Long-term development of the landscape macrostructure [ha]. Source: Databáze dlouhodobých změn využití ploch Česka 1845 - 2000, Czech Statistical Office. Own elaboration

The micro-structure of the landscape has been impacted both by general trends and by the consequences of the mining. Bukáček et al. (2008) evaluate the landscape as a picturesque landscape from which the mining activities defies with the scale of atypical constructions (mining towers, tailings ponds). However, it is necessary to state that these activities cover a relatively small area of just a few km².

General characteristics of the landscape development in Hrušovany nad Jevišovkou microregion

Hrušovany nad Jevišovkou microregion is situated within the region on the Austrian border from which German (and Croatian) population (forming decisive majority in the past) was evacuated as a result of the WWII. By such a way, the long-term relation of the people to the landscape was interrupted and population density decreased. The ethnic based population exchange impacts the tertiary landscape structure. The soil is fertile but social conditions did not allow such a successful farming in comparison to Podluží microregion. The water streams, including Dyje and Jevišovka rivers are mostly guided by floodplain forests. The sugar industry and vineyards have a long tradition there. A new village Velký Karlov found in 1953 is a peculiarity of the microregion.

The land use of the micro-region responds to the lowland character of the territory (Fig. 16). Arable land takes more than 75% of the area. The “other” land use is almost approaching the area of forests (Fig. 15).

The development of the first investigated period is characterized by an increase of the arable land to the detriment of meadows and pastures. Meadows and pastures have decreased from the second most frequent use at the beginning of the whole period to the last but one place at its end. Since 1948, the area of arable land has slowly decreased whereas the area of forests has slowly increased. The share of water areas marked an unbalanced development. It could be a consequence of the micro-region position between two large water works: Vranov and Nové Mlýny water reservoirs.

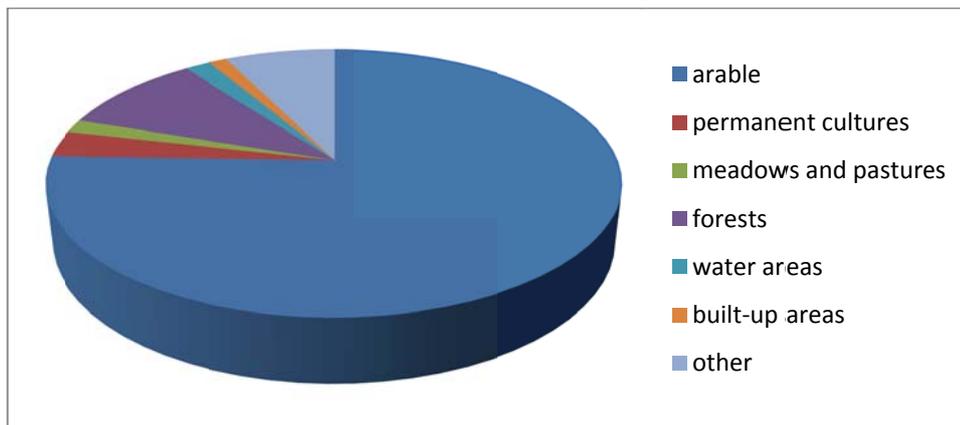


Fig 15. Hrušovany nad Jevišovkou micro-region – land use in 2013. Source: Czech Statistical Office, own elaboration



Fig 16. Municipality Božice – agricultural landscape with vineyards, enriched by water features along the Jevišovka river. Photo S. Kozlovská

The landscape matrix has consisted of arable land for more than 150 years (Fig. 17). Vast tracts are seen in the maps from the 19th century; however, due to small land holdings it assumed a greater richness of crops and more dirt roads. The consolidation of land in the 1950s brought higher loss of dirt roads. Nevertheless windbreaks that still support eco-stability and a control of the erosion were established that time.

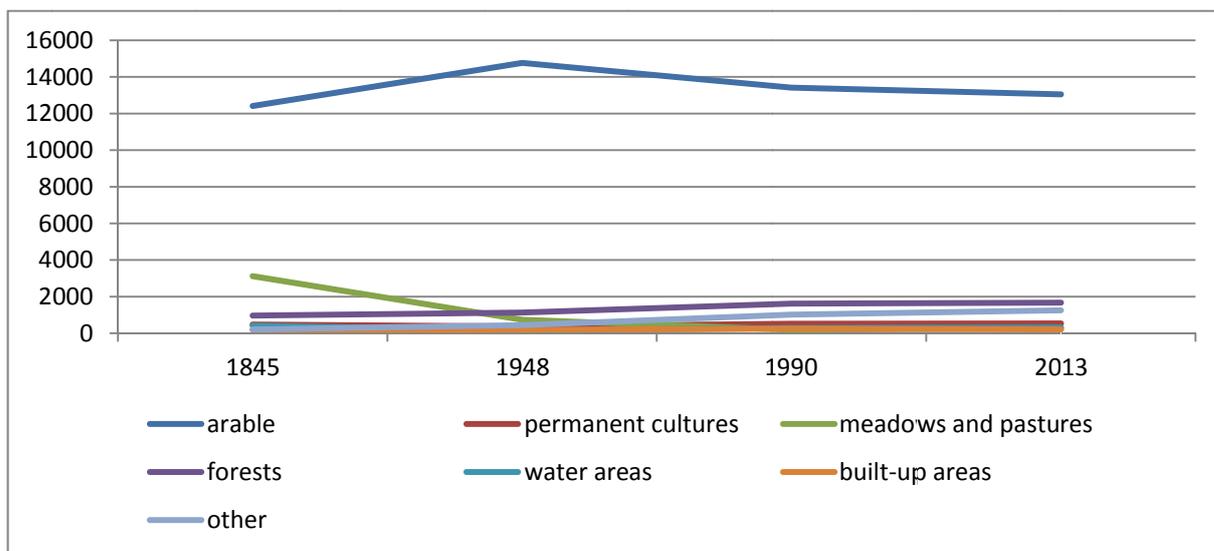


Fig 17. Hrušovany nad Jevišovkou micro-region: Long-term development of the landscape macrostructure [ha]. Source: Databáze dlouhodobých změn využití ploch Česka 1845 - 2000, Czech Statistical Office. Own elaboration

The vegetation is dominated nearby watercourses, wetlands and artificial reservoirs originated either for the purpose of accumulation of water for irrigation, for fishing or in a former sand pit. Non-native black locust and pine prevail in the forest vegetation. We can find popular plantations, but also preserved fragments of floodplain vegetation with native species there.

Conversion of grassland near watercourses to cropland probably preceded drainage. Conversely, existing arable land is irrigated by the network of irrigation canals from rivers and reservoirs since 1950s. Concreted irrigation channels, which were built in later already through pipelines, are a significant but not positively acting element of the landscape. Transitions between arable land and other elements (tie, windbreakers etc.) operate contrast, only vineyard blend of arable land smoothly. An interesting special feature of a high historical value are the remains of the border fortifications from 1930s - the concrete bunkers at various locations within the landscape, overgrown by a vegetation and thus forming hot spots of diverse plant and animal species.

The energy production from renewables (solar power plants and a wind parks) is developing. The interest in local orchard tradition declined. Abandoned orchards and vineyards can be found in the landscape. Species composition of woods and hedgerows is usually unoriginal. Some activities of the current leadership of municipalities can be assessed positively, e.g. the creation and restoration of wetlands, planting alleys and restoration of native vineyards (and associated traditions).

General characteristics of the landscape development in Vysoké Mýto microregion

Vysoké Mýto microregion is the only one situated in Bohemia. It was chosen as an ordinary territory from the viewpoint of natural conditions, intensity of agriculture, size of rural settlements, social development and cultural events. The microregion is a part of so called intermediate countryside (it means not suburban, not peripheral). The land is covered mostly by agricultural land (Fig. 18). Forests are rare and dispersed (except for the northernmost part). Meadows and pastures are is equal to forests.

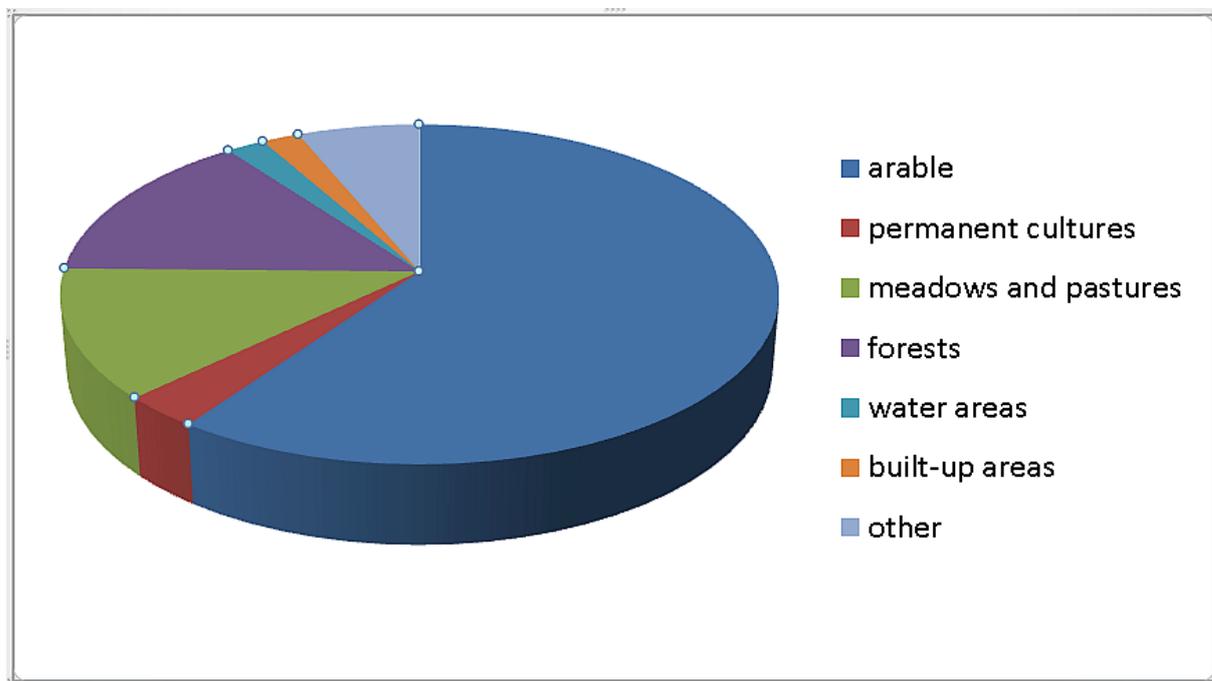


Fig 18. Vysoké Mýto micro-region – land use in 2013. Source: Czech Statistical Office, own elaboration.

Land use of Vysoké Mýto microregion is the most stable of all the case study areas. The decrease of the arable land as well as the increase of forests is not very expressive (Fig. 18). The area out of urbanized ones doubled during the last 170 years but their share is relatively low.

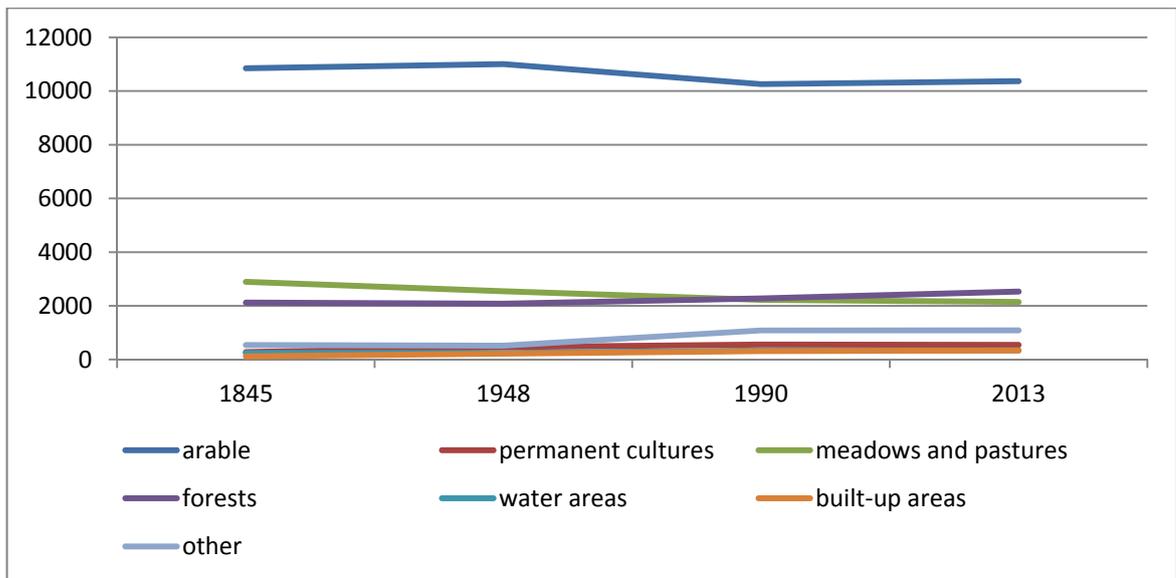


Fig 19. Vysoké Mýto micro-region: Long-term development of the landscape macrostructure. Source: Databáze dlouhodobých změn využití ploch Česka 1845 - 2000, Czech Statistical Office. Own elaboration

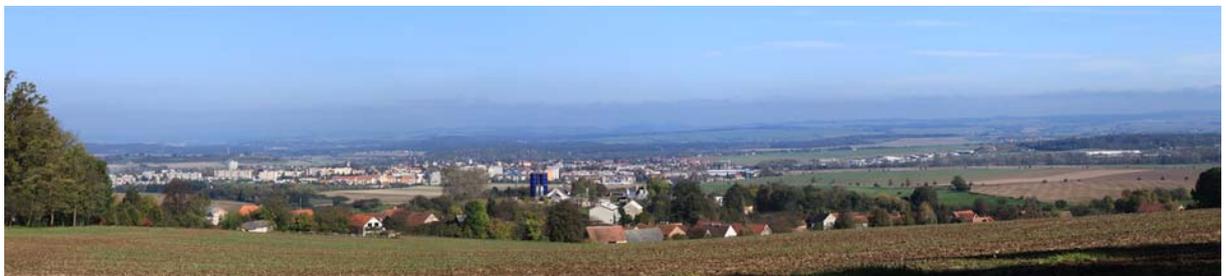


Fig 20. Panorama of the landscape in Vysoké Mýto area. Vanice village in the foreground and Vysoké Mýto town behind. Photo V. Doskočilová

Comparative analysis

Population density belongs to indicators which illustrate the landscape load by the people. Of the case study microregions, Šlapanice case is characterized by a high population density, crossing rural limits. Podluží and Vysoké Mýto microregions have an average population density, slightly crossing the value of 100 persons per km². Lower population density is true not only for the mountain microregions but also Hrušovany border microregion in spite of the fertile soils. Here the situation is caused by the historical development.

	Šlapanice	Podluží	Nové Město na Moravě	Bystřice n. P.	Hrušovany n. J.	Vysoké Mýto
Population density	252	107	66	60	63	114
Average size of a rural seat ⁵ (inhabitants)	1,387	1,778	159	124	1,371	218
Ecological stability	0.06	0.48	1.24	1.14	0.15	0.41

Tab 2. Average values of selected indicators for individual microregions. Source: own calculations based on statistical data (Czech Statistical Office).

⁵ Rural seat: a part of a municipality (statistical unit) except of urban cores.

Average size of a rural seat signalizes rather landscape microstructure. It is seen that it depends on physical conditions. In general, rural settlements in lowlands (Šlapanice, Podluží and Hrušovany microregions) are larger in comparison to the mountain seats (Nové Město and Bystřice microregions). Vysoké Mýto microregion manifests some mean value.

The coefficient of ecological stability is extremely differentiated. Šlapanice micro-region with predominance of arable land and urban use is ecologically unstable and unsustainable. Hrušovany microregion has also a big share of arable land but less urban areas and takes the second place – it is also ecologically unstable. Vysoké Mýto and Podluží microregions manifest some average in our set but they are ecologically unstable too. Only mountain microregions mark some level of ecological stability – Nové Město slightly better than Bystřice.

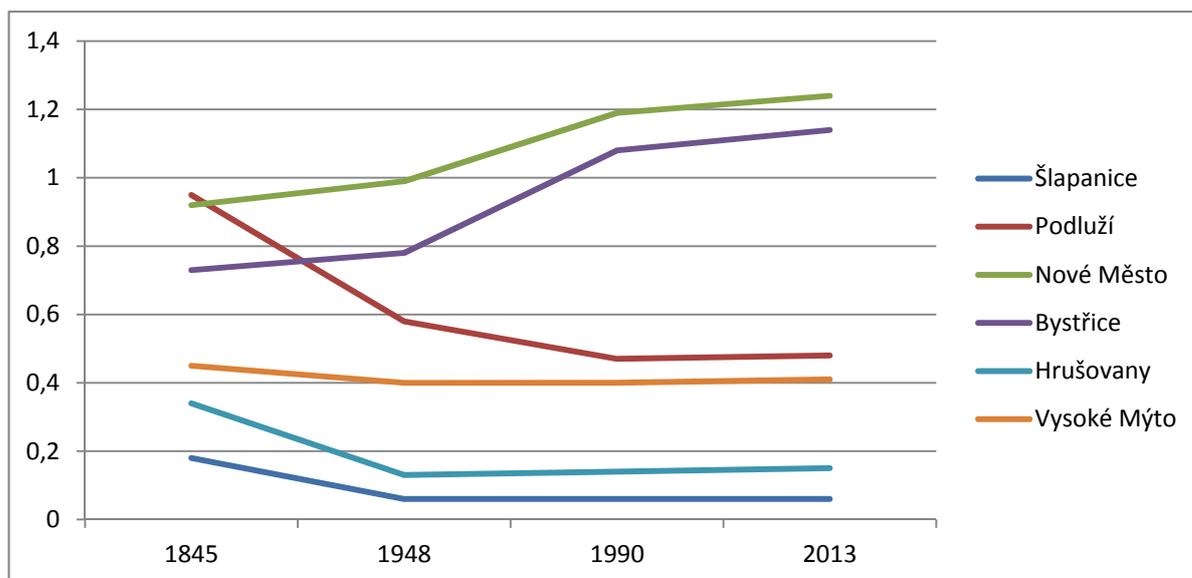


Fig 21. Development of the Coefficient of Ecological Stability 1845 - 2013. Source: Own calculations.

	Šlapanice	Podluží	Nové Město na Moravě	Bystřice n. P.	Hrušovany n. J.	Vysoké Mýto
Arable land 1845 - 1948	108	125	94	95	119	101
Arable land 1948 - 1990	88	93	80	76	91	93
Arable land 1990 - 2013	103	98	91	92	97	101
Forests 1845 - 1948	64	103	112	118	117	98
Forests 1948 - 1990	122	105	101	108	144	110
Forests 1990 - 2013	98	100	97	104	103	111
Meadows and pastures 1845 - 1948	26	49	91	82	24	88
Meadows and pastures 1948 - 1990	46	29	110	127	26	87
Meadows and pastures 1990 - 2013	108	105	95	106	146	97
Built-up and other areas 1845 - 1948	161	171	106	113	155	112
Built-up and other areas 1948 - 1990	249	208	245	298	204	192
Built-up and other areas 1990 - 2013	107	101	102	98	114	101

Tab 3. Development of selected types of land use in the period under investigation and selected case study microregions. Source: own calculations.

The values of the coefficient of ecological stability have mostly developed in relation to natural conditions. The ecological stability has improved in the mountain microregions during the whole period under the investigation. This improvement was most rapid during the communist period. The ecological stability in the lowland microregions fell in the pre-communist period and it is extremely low also after it. Podluží microregion seems to be a special case where the ecological stability absented until 1990. The Vysoké Mýto microregion has recorded almost unchangeable situation.

The area of arable land decreases in mountain microregions all the time since 1845 with the most rapid decrease during the communist period 1948 - 1990 (Fig. 21 and Tab. 3). Lowland microregions are characterized by decrease of an arable land during the communist period, a slight increase before and only small changes after it. Vysoké Mýto microregion exhibits stability of this indicator during the whole period.

Generally some afforestation occurs during the time. During the communist period the forest areas grew in all microregions. Noticeable decrease of the area of forests is true particularly in Šlapanice microregion where forests recede to both arable land and urban areas.

The area of meadows and pastures decreased during the period between 1845 and 1948 in all the microregions probably in relation to the intensification of the agricultural production. The difference consists of an extremely rapid decrease of grasslands in lowland microregions and a slower decrease in mountain microregions and also in Vysoké Mýto microregion. During the communist period the decrease continued in lowland microregions whereas in the mountain microregions (Nové Město and Bystřice) the opposite tendency occurred. During the post-communist period, the increase of grasslands in a majority of areas has been probably driven by EU subsidies. It is true particularly in Hrušovany microregion where the fertile land is combined with the low population density.

It is clear that the built-up and other areas which mostly characterize urban land use have increased with time. During the communist period the urban areas more than doubled in the majority of cases. Recently, the area of urban use has slightly decreased in the Bystřice nad Pernštejnem microregion which could be a consequence of the uranium mining reduction.

4. General evaluation

Changes of the South-Moravian landscape were divided according to Vaishar et al. (2011) as follows:

- *Changes in agricultural use.* These changes manifest themselves mostly in a change of cultivated crops in fertile parts of Moravia. There were decreases in the sowing areas of winter wheat, an industrial sugar beet, silage maize, fodder crops and a rape. On the other hand, the sowing areas of spring barley, grain maize, forage crops and the area of vineyards have grown. The change of arable land for other agricultural use (pastures) come into account rather in mountain areas where also some ecological agriculture occurs.
- *Changes of agricultural use to other ways of land use.* Afforestation run in mountain areas where the natural conditions are not advantageous for intensive productive agriculture. On the other side, the arable land is not decreasing in fertile micro-regions. Urban ways of use (built-up areas, "other" areas, gardens) manifest in all territories with top in the suburban micro-regions. Energy production from renewable sources is a new feature in the Moravian rural landscape. Although the facilities (wind turbines, solar plants) do not take big areas, they are sometimes dominant and controversial elements in the landscape.
- *Changes emphasizing recreation landscape use.* The Moravian landscape starts to be commercialized for tourist purposes. It does not manifest in the land use so much but the tourist features (like pensions or bicycle trails) and tourist movement in the landscape is increasing. Especially, tourist activities are concentrated in some parts of the country like water reservoirs, Moravian karst, Lednice - Valtice area etc. Tourism impacts the landscape mainly during the summer season.

It can be stated that the macro-structural changes of the Moravian landscape depend on natural conditions and geographical position as regards to regional centres and transport routes. However, changes related to the landscape-microstructure and tertiary structure seem to be an important though they are less quantifiable in many cases. The frequency of occurrence of non-rural elements is increasing: non-rural buildings, communications, infrastructural facilities, wind turbines, solar plants, fences, tourism facilities etc. Some of the mentioned objects have a character of brownfields. Rural brownfields are usually smaller than the urban ones.

General trends of the communist period consisted of enlarging of plots (aimed at mass deployment of agricultural machines), plowing the bounds between fields, hydroameliorations (both drainage and irrigation) connected with straightening of flows and draining water into pipes. Transitions between different ways of land use are usually sharp.

Changes in the structure of cultivated plants modify rural scenery (colours) during the growing season. Fallow land is a rare feature. The demand for land is greater. A car as a part of its infrastructure followed by roads, parking, fuel stations and similar infrastructure started to be an inseparable part of rural life. All these changes impact on the perception of rural landscape.

The perception of the rural landscape is an important part of its tertiary structure where the landscape memory of residents mingles with the impressions of tourists. It is connected both with big historical events and memories of individuals. Perception of seniors can be different from the perceptions of children. Sometimes the tertiary landscape structure can be connected also to a surviving folklore.

5. Discussion and conclusions

Cloke (2013) defines four general conflicts concerning the contemporary rural landscape. They are: conflict with urban use, conflict with conservation and/or recreation, conflict with forestry and conflict over tenure.

Conflict of urban/rural use is apparent, especially in Šlapanice micro-region. However, it is present in all landscapes because urban elements penetrate to the landscape in the whole countryside. It is manifested both in the landscape macro and microstructure. The importance of urban features in the landscape consists more of the unfamiliarity or urban landscape elements than of the total area of built-up and other land use.

Conflict of agricultural use with conservation and/or recreation does not seem to be crucial. Agriculture belongs to the Moravian landscape. It means that it is accepted both by the nature protection (in the form of ecological forms of agriculture) and by the tourism. The landscape protection partly manifests with decreasing areas of arable land in favour of forests, pastures and meadows in the landscape macrostructure. It occurs mainly in mountain micro-regions in our study. It is also connected to the mentioned conflict with forestry. What could be significant from the viewpoint of landscape is that both agricultural and forestry landscape use has a monocultural character of large fields covered by a single crop. Similarly in the case of forests, non-native spruce monocultures are different from the optimum landscape structure. These conflicts manifest themselves rather in land cover than in land use.

Conflicts in land tenure are a potential problem. Originally, land was cultivated by its owners. At the present time, land owners and land cultivators are very often different bodies. It becomes evident that there is a lower interest of cultivators in keeping the quality of agricultural soil which covers the largest portion of the Moravian landscape. Especially, when the owners of big agricultural enterprises settle in different regions, in cities or even abroad, the relation of the cultivators to the agricultural soil and the landscape is not a priority in comparison to direct economic benefits. Such situation leads also to an abandonment of non-used objects. There are thousands of rural brownfields (Klusáček et al., 2013): abandoned buildings of cooperatives and state farms, railway stations on abandoned railways, former garrisons of the Border Police, dilapidated buildings of sugar mills, distilleries and similar facilities of primary elaboration of agricultural products but also clerical and aristocratic buildings ruined by inadequate use during the communist period etc.

Hypothetically, the perception and relation of people to their landscape could be among important factors of the landscape changes. Some microregions were impacted by important migration movements: ethnically based population exchange after the WWII in the Hrušovany nad Jevišovkou microregion, immigration of miners in Bystřice nad Pernštejnem microregion and suburban migrants in the Šlapanice microregion. Most probably the relation of the immigrants to the landscape is less cordial. They do not understand the values of their “new” landscape. It is visible especially in the landscape details and in the microstructure.

Whereas the landscape macrostructure develops according to the rules of market economy, European subventions and demands of the landscape protection, the microstructure could be impacted by more specific instruments. The process of landscape consolidation plays its role. Besides the ownership clarification and digitization of land maps it is aimed at so called shared facilities, it means anti-erosion, anti-flood and ecological measures (Podhrázká et al., 2015).

Besides, the landscape detail could play an important role in the landscape perception and also in its attraction for tourists. The care for landscape detail is a matter of some cultural behaviour in a broad sense, the feeling of identity and togetherness of people. It seems that these characteristics develop in a rivalry between globalization and local identity.

Acknowledgement

The paper was elaborated within the project “Landscape memory as a rural heritage” Nr. TD020211 supported by the Technological Agency of the Czech Republic.

References

- [1] Antrop, M. (1997). The concept of traditional landscapes as a base for landscape evaluation and planning. The example of Flanders region. *Landscape and Urban Planning* 38(1-2), 105-117. DOI: 10.1016/S0169-2046(97)00027-3.
- [2] Antrop, M. (2005). Why landscapes of the past are important for the future. *Landscape and urban planning*, 70(1), 21-34. DOI: 10.1016/j.landurbplan.2003.10.002.
- [3] Bastian, O., Krönert, R. & Lipský, Z. (2006). Landscape diagnosis on different space and time scales a challenge for landscape planning. *Landscape Ecology* 21(3), 359-374. DOI: 10.1007/s10980-005-5224-1.
- [4] Bičík, I., Jeleček, L., Kabrda, J., Kupková, L., Lipský, Z., Mareš, P., Šefrna, L., Štych, P. & Winklerová, J. (2013). *Vývoj využití ploch v Česku*. Praha: Česká geografická společnost.
- [5] Blacksell, M. (2010). Agriculture and landscape in the 21st century Europe: the post-communist transition. *European Countryside* 2(1), 13-24. DOI: 10.2478/v10091-010-0002-8.
- [6] Brady, M., Kellermann, K., Sahrbacher, Ch. & Jelínek, L. (2009). Impacts of decoupled agricultural support on farm structure, biodiversity and landscape mosaic. Some EU results. *Journal of Agricultural Economics* 60(3), 563-585. DOI: 10.1111/j.1477-9552.2009.00216.x.
- [7] Brouwer, F. & Lowe, P. (2000): *CAP regimes and the European countryside: Prospects for integration between agricultural, regional and environmental policies*. Wallingford: CAB Publishing.
- [8] Brůna, V. & Křováková, K. (2005). Analýza změn krajinné struktury s využitím map Stablního katastru (pp. 27-34). In *Historické mapy. Zborník z vedeckej konferencie*. Bratislava: Kartografická spoločnosť Slovenskej republiky.
- [9] Brůna, V., Křováková, K. & Nedbal, V. (2005). Stablní katastr jako zdroj informací o krajině. *Historická geografie* 33, 397-409.

- [10] Buhyoff, G. J., Miller, P. A., Hull, R. B. & Schlagel, D. H. (1995). Another look at expert visual assessment: validity and reliability. *AI Applications*, 9(1), 112-120.
- [11] Bukáček, R., Bukáčková, P., Culek, M., Matějka, P., Chroust, J., & Rusňák, J. (2008). *Strategie ochrany krajinného rázu kraje Vysočina*. Jihlava: Krajský úřad kraje Vysočina.
- [12] Bürgi, M., Hersperger, A. N. & Schneeberger, M. (2004). Driving forces of landscape change – current and new directions. *Landscape Ecology* 19(8), 857-868. DOI: 10.1007/s10980-004-0245-8.
- [13] Cloke, P. (2013): *Rural land-use planning in developed nations*. London: Unwin Hyman.
- [14] Crofts, R. S. & Cooke, R. U. (1974): *Landscape Evaluation: A comparison of techniques*. Occasional Papers, no 25, Department of Geography, University College London.
- [15] Daniel, T. C. & Vining, J. (1983). Methodological Issues in the Assessment of Landscape Quality (pp. 39-83). In Altman, I. & Wohwill, J., eds., *Behaviour and the Natural Environment* (eds.), Dordrecht: Plenum Press.
- [16] Demek, J., Havlíček, M., Mackovčín, P. & Stránská, T. (2007). *Journal of Landscape Ecology* 0(0), 32-53.
- [17] van Dijk, T. (2007). Complications for traditional land consolidation in Central Europe. *Geoforum* 38(3), 505-511. DOI: 10.1016/j.geoforum.2006.11.010.
- [18] Forman, R. T. T. & Godron, M. (1993): *Krajinná ekologie*, Praha: Academia.
- [19] Havlíček, M. & Dostál, I. (2010). Projevy suburbanizace ve využití krajiny v Jihomoravském kraji a v zázemí města Brna. *Acta Průhoniana* 94, 65-76.
- [20] Gulinck, H., Múgica, M., de Lucio, J. V. & Atauri, J. A. (2001). A framework for comparative landscape analysis and evaluation based on land cover data with an application in Madrid region (Spain). *Landscape and Urban Planning* 55(4), 257-270. DOI: 10.1016/S0169-2046(01)00159-1.
- [21] Jeleček, L. (2007). Environmentalizace vědy, geografie a historické geografie: environmentální dějiny a výzkum změn land use Česka v 19. a 20. století. *Klaudyán*, 4, 20-28.
- [22] Jones, M. (2003). The concept of cultural landscape: Discourse and narratives (pp. 21-51). In: Palang, H. & Fry, G., eds., *Landscape Interfaces. Cultural Heritage in Changing Landscapes*. Berlin: Springer. DOI: 10.1007/978-94-017-0189-1_3.
- [23] Klusáček, P., Krejčí, T., Martinát, S., Kunc, J., Oman, R. & Frantál, B. (2013). Regeneration of agricultural brownfields in the Czech Republic – case study of the South-Moravian region. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 61(2), 549-561. DOI: 10.11118/actaun201361020549.
- [24] Lausch, A., Blaschke, T., Haase, D., Herzog, F., Syrbee, R., Tischendorff, L. & Walz, U. (2015). Understanding and quantifying landscape structure – A review on relevant process characteristics, data models and landscape metrics. *Ecological Modelling* 295, 31-41. DOI: 10.1016/j.ecolmodel.2014.08.018.
- [25] Lindenmayer, D. B., & Fischer, J. (2013): *Habitat fragmentation and landscape change: an ecological and conservation synthesis*. Washington (D.C.): Island Press.
- [26] Lipský, Z. (1995). The changing face of the Czech rural landscape. *Landscape and Urban Planning* 31(1-3), 39-45. DOI: 10.1016/0169-2046(94)01034-6.
- [27] Lipský, Z. (1994). Změna struktury české venkovské krajiny. *Sborník České geografické společnosti*, 99(4), 248-260.
- [28] Lipský, Z. (2014). Historical development of the Czech rural landscape: Implications for present landscape planning. *Problemy ekologie krajiny* 36, 150-161.
- [29] Meyer, B. C. (1997): *Landschaftsstrukturen und Regulationsfunktionen in Intensivagrarschaften im Raum Leipzig-Halle. Regionalisierte Umweltqualitätsziele – Funktions-*

bewertungen - multikriterielle Landschaftsoptimierung unter Verwendung von GIS. Leipzig: Helmholtz-Umweltforschungszentrum.

- [30] Míchal, I. (1982). Principy krajinařského hodnocení území. *Architektúra a urbanizmus* 16, 65-87.
- [31] Míchal, I. et al. (1999). Hodnocení krajinného rázu a jeho uplatňování ve veřejné správě, metodické doporučení AOPK (pp. 111-116). In Vorel, I., Sklenička, P., eds., *Péče o krajinný ráz – cíle a metody*. Praha: ČVUT.
- [32] Nassauer, J. I. (1995). Culture and changing landscape structure. *Landscape Ecology* 10(4), 229-237. DOI: 10.1007/BF00129257.
- [33] Podhrázká, J., Vaishar, A., Toman, F., Knotek, J., Ševelová, M., Stonawská, K. & Vasyľchenko, A. (2015). Land consolidation in the Czech Republic. Perception versus reality. *European Countryside* (in print).
- [34] Punch, K. F. (2008): *Základy kvantitativního šetření (Basis of quantitative investigation)*. Praha: Portál.
- [35] Olwig, K. R. (2007). The practice of landscape „Conventions“ and the just landscape: The case of European Landscape Convention. *Landscape Research* 32(5), 579-594. DOI: 10.1080/01426390701552738.
- [36] Semotanová, E. (2002). Studium krajiny a srovnávací kartografické prameny (pp. 63-70). In Němec, J., ed., *Krajina 2002. Od poznání k integraci*. Praha: Ministry of Environment.
- [37] Skaloš, J., Weber, M., Lipský, Z., Trpáková, I., Šantrůčková, M., Uhlířová, L. & Kukla, P. (2011). Using old military survey maps and ortograph maps to analyze long-term land cover changes – case study (Czech Republic). *Applied Geography* 31(2), 426-438. DOI: 10.1016/j.apgeog.2010.10.004.
- [38] Skaloš, J. & Engstová, B. (2010). Methodology for mapping non-forest wood elements using historic cadastral maps and aerial photographs as a basis for management. *Journal of Environmental Management*, 91(4), 831-843. DOI: 10.1016/j.jenvman.2009.10.013.
- [39] Sklenička, P (2003): *Základy krajinného plánování*. Praha: Naděžda Skleničková.
- [40] Sklenička, P. (2006). Applying evaluation criteria for the land consolidation effect to three contrasting study areas in the Czech Republic. *Land Use Policy* 23(4), 502-510. DOI: 10.1016/j.landusepol.2005.03.001.
- [41] Skokanová, H. & Eremiášová, R. (2012). Changes in the secondary landscape structure and their connection with ecological stability: the cases of two model areas in the Czech Republic. *Ekológia Bratislava* 31(1), 33-45. DOI: 10.4149/ekol_2012_01_33.
- [42] Swanwick, C. et al. (2013): *Guidelines for Landscape and Visual Impact Assessment*. 3rd Edition. London: Routledge.
- [43] Taylor, K. & Lennon, J. (2012): *Managing cultural landscapes*. London: Routledge.
- [44] Těšitel, J., Kolbmüller, B. & Stöglehner, G. (2014): *Vital landscapes*. České Budějovice: NEBE.
- [45] Vaishar, A., Jakešová, L. & Náplavová, M. (2011). Current problems in the South-Moravian rural landscape. *European Countryside* 3(4), 265-281. DOI: 10.2478/v10091-012-0008-5.
- [46] Vos, W. & Meekes, H. (1999). Trends in European cultural landscape development: perspectives for a sustainable future. *Landscape and Urban Planning* 46(1-3), 3-14. DOI: 10.1016/S0169-2046(99)00043-2.
- [47] Vorel, I., Bukáček, R., Matějka, P., Culek, M. & Sklenička, P. (2004): *Posouzení vlivu navrhované stavby, činnosti nebo změny využití území na krajinný ráz – metodický postup*. Praha: Czech University of Technology.
- [48] Walz, U. (2001): *Charakterisierung der Landschaftsstruktur mit Methoden der Satelliten-Fernerkundung und Geoinformatik*. Dresden: Institut für ökologische Raumentwicklung e.V.

[49] Zonneveld, I. S. (1995): *Land Ecology*. Amsterdam: SPB Academic Publishing.