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THE INFLUENCE OF NATURAL CONDITIONS ON CHANGES IN LANDSCAPE USE: A CASE STUDY OF THE LOWER PODOUBRAVÍ REGION (CZECH REPUBLIC)

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Abstract

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This study observes and evaluates the changes in landscape use during the last 230 years in an old farming land in Central Bohemia. As background materials, maps of the 1st, 2nd and 3rd military mapping from the 18th and 19th centuries were used. The study analyzes the influence of natural conditions on land use in detail. Changes are observed and evaluated in different natural units delimited by the main soil types, geobotanical units of potential vegetation, biogeographic units, catchment areas and geomorphological units. Special attention is given to land use changes in alluvial plains and flood areas. The studied territory, where fertile soils predominate, has experienced an intensification of land use, an increase in the percentage of arable land, and a loss of ponds and permanent grassland. During the observed period, most historical landscape structures were destroyed and the land-use has become homogenized. Differences ceased to exist between the use of alluvial plains and surrounding loess plateaus whereby the ecological stability of the landscape has decreased and the overall development from a landscape ecology perspective is considered negative. However, increasing afforestation of low fertile sand soils is one rational and ecologically positive feature of this development. Overall results here show a significant impact of natural conditions, particularly in soil fertility, on landscape use and on its historical changes.

Key words: land use, land use changes, rural landscape, natural conditions, Central Bohemia

Introduction

Observing changes in land use and in secondary landscape structure represents a very wide, but simultaneously extraordinarily topical and frequent issue in all branches of science dealing with landscape. In the Czech Republic, the number of studies dedicated to the changes in land use has significantly increased since 1990 (Lipský, 2010). One can also observe a similar increase of papers on this topic over the past two decades on a European and global scale (Aspinall, 2006).

Thanks to the Prague Albertov school founded by I. Bičík, the research of so-called historical land use has greatly expanded in the past 20 years in Czechia. The investigation of historical land use changes is based on the unique database of information on land use for all cadastral districts in 1845, 1900, 1948 and 1990 (Bičík, 1997; Bičík, Jeleček, 2003). In closer detail, old maps of the 1st, 2nd and 3rd military mapping are used, as well as stable cadastral maps and archival air photographs (Lipský, 2000; Demek et al., 2008). Similar surveys, which retrospectively follow changes in the use of cultural landscape, have also been carried out in other Central European countries (e.g. Gabrovec, Petek, 2003). Recent tendencies of changes are successfully observed by multitemporal satellite images, mainly with the help of the European database CORINE Land Cover and modern geoinformation technologies (e.g. EEA, 2006; Feranec et al., 2007).

Studies completed are mostly limited to the identification of changes in secondary landscape structure or they mainly utilized simple landscape metrics. Kolejka and Trnka (2008) point out that, although landscape is a comprehensively complicated system, most studies lack this comprehensive approach. Land use changes are mostly observed in defined territorial units, such as on the entirety of catchments, administrative districts or regions and disregarding their inner heterogeneity. However, Breuer et al. (2010) completed a thus far solitary study observing the developmental trends in the use of land in different types of natural landscape units.

Hypothesis and aim of the study

The aim of this study is to investigate land use in a specific area while simultaneously attempting to find dependences for the current and historical use of land in natural conditions. This is based on the generally valid statement that the use of land by man as a secondary landscape structure is significantly influenced by the primary landscape structure in its natural condition. Therefore, certain geo-ecological laws for landscape use exist (Brabec, Lipský, 2007). Although man is the main driving force in the cultural landscape through societal changes,, technology and economic relationships, the specific outcomes of these changes and their territorial differences are predominantly influenced by natural conditions (Lipský et al., 1999; Kabrda et al., 2006).

Natural landscape units have different potential and suitability for use and they can therefore be used in different ways. Their use changes in time and space and these changes differ everywhere. Therefore, the aim of this study was to establish:

1. how land use has changed in the studied territory due to natural conditions,
2. whether land use within natural entities homogenises or heterogenises,
3. whether the differences in usage among natural units are increasing or diminishing.

Methodology

Delimitation and characteristics of the interest area

The model area studied within the "Kačina" project was chosen for this work. It is comprised of 21 cadastral areas (14 administrative districts) with an overall area of over 113 km^2. It lies in Central Bohemia in the north-eastern part of the Kutná Hora region (Fig. 1), and geo-morphologically, this landscape is part of the Čáslavská kotlina basin. The flat relief of the basin is 200–239 m a. s. l. and it may reach a maximum of 300 m at the top edge of the fault-slope of the Železné hory Mts. A considerable part of the territory is formed by wide alluvial plains of lower streams of the Doubrava and Klejnárka rivers. Despite the simple geological and geomorphological structure, a mosaic of soil types has developed in the flat land. Depending on the substrate formed by loesses and loess loams, calcareous clays, fluvial sediments and blown sands, there are Chernozem, brown soils, Cambisols, Rendzinas and Fluvisols prevailing in the valley plains (Lipský, 2001). The soil mosaic closely corresponds to the distribution of potential natural vegetation, in which alluvial softwood and hardwood forests in the alluvial plains prevail. These consist primarily of elm-oak woodland, bird cherry-ash woodland and alder carr. Lime-oak woodland and oak-hornbeam woodland can be found on the low Kačina ridge. While pine-oak woodland on sandy substrate exists on the slopes of the Železné hory Mts there are also silver fir-oak and woodrush-oak woodland (Neuhäuslová et al., 1998). The area comprises 11 biochors of the second vegetation degree and two biochors of the third vegetation degree in the spur of the Železné hory Mts (Culek et al., 2005).

The current cultural landscape is predominantly used for intensive farming with a prevalence of arable land (Table 1). However, this clearly differs from the rest of the Čáslavská kotlina basin by its special landscape character. It is characterised by a significantly more diverse landscape structure with a higher ratio of woodlands and line elements of scattered vegetation, particularly in the core part of the area in the broad surroundings of the Kačina and Žehušice castles. This secondary landscape structure, which is especially apparent in air and satellite photographs, is both a reflection of the above-mentioned mosaic of soils and a result of systematic, aesthetically motivated landscape formation in the 18th and 19th centuries. It is characteristic of this cultural landscape that most nature protected areas, centres of biodiversity and ecologically valuable areas are linked to historical landscape structures such as game-parks, pheasantries, ponds, quarries and alleys (Lipský, 2008). The former game-park around the Kačina castle with an area of 197 ha was declared a NATURA 2000 site (For additional information concerning the model area, please see the project website: www.projektkacina.estranky.cz).

Research methodology

Land use changes over the last 230 years were observed using the following material:
Maps of the 1st military mapping (1MM) from 1763–1783 in a scale of 1: 28 800;

T a b l e 1. Present landscape use of the model area, based on interpretation of the aerial orthophotomap from 2006.

Land use category	Area	
	absolute in ha	relative in %
Arable land	7551.0	66.69
Orchards and gardens	550.3	4.86
Permanent grasslands	573.0	5.06
Total agricultural land	8674.2	76.61
Forest	1914.6	16.91
Water bodies	93.9	0.83
Built-up areas	474.4	4.19
Others	165.3	1.46
Model area	11322.5	100.00

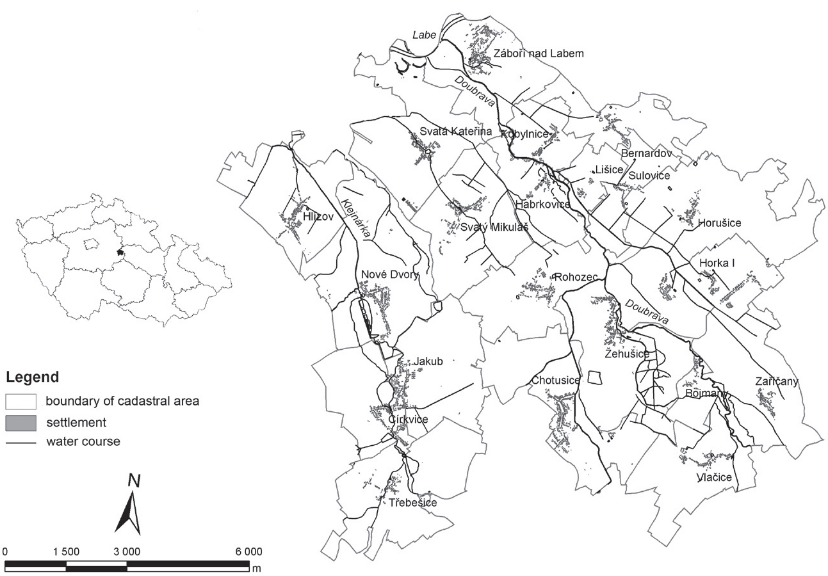

Fig. 1. Map of the model area.
Data source : www.projectkacina.estranky.cz

Maps of the 2nd military mapping (2MM) from 1819–1858 in a scale of 1: 28 800;
Maps of the 3rd military mapping (3MM) from 1874–1880 in a scale of 1: 25 000;
Orthophoto-air photographs from 2006.

To determine historical land use changes, an interpretation key with clearly defined categories was created and used (Skaloš, Bendíková, 2009). From thirty categories, seven comprehensive classes of land use were created: 1. arable land; 2. permanent grassland; 3. permanent farming cultures; 4. woods; 5. water bodies; 6. built-up areas; and 7. other areas.

Since the studied area has a flat nature with little altitudinal differences, it was considered pointless to analyze land use dependence on altitude and slope. Therefore, due to significant soil differences and the significant territorial representation of alluvial plains, including flood areas, land use dependence was based on the following four natural characteristics:

– soil types; with refererence to different soil fertility,
– geobotanical units of potential natural vegetation,
– biochors,
– bioregions.

Additionally, changes and differences in land use in alluvial plains, flood areas and individual catchment areas and in the geomorphological units were also observed.

Some of these characteristics are mutually fungible; e.g. the delimitation of the units of potential vegetation or biochors are primarily based on the soil conditions, although the soil, geobotanical and biogeographical units are not entirely identical. The potential natural vegetation of alluvial forests (according to Mikyška et al., 1972) cover 54% of the interest area but the bird cherry-ash woodland and alder carrs (according to Neuhäuslová et al., 1998) cover only 44%. Aggregated biochors of alluvial plains and damp depressions also cover 44% of the interest area and fluvisols together with gley soils cover 37%.

As a reference indicator for the ecological evaluation of landscape changes, a coefficient of ecological stability of landscape in its simplest S/L form (Míchal, 1992) was calculated for individual time horizons in individual territorial units delimited according to the natural characteristics of soil units, geobotanical units, biochors, bioregions, flood areas, catchment areas and geomorphological units. Since this calculation was based on the principle of permanence of vegetation structures in the landscape, permanent grasslands, orchards and gardens, woods and water elements were defined as ecologically stable areas (S), while areas of arable land, built-up and other areas, such as those mainly composed of roads, were defined as ecologically labile (L).

The source data was processed in the GIS environment and consequently adjusted in Microsoft Office Excel (contingency table). The quantification of the representation of the individual categories of land use in the defined time horizons in individual categories of natural characteristics was performed using a contingency table.

Results

The development of the use of the cultural landscape of the "Kačina" project interest area (www.projektkacina.estranky.cz") is outlined in Table 2. This shows the dominant ratio of arable land, which consistently increased throughout the entire study period. The most significant increase in arable land took place in the 2nd half of the 19th century, when the highest percentage of overall agricultural land and the lowest percentage of woods occurred simultaneously. In the 20th century, the ratio of arable land slightly increased further, while the area of total agricultural land markedly decreased. Whereas, in the 19th century, the increase in arable land area was achieved at the cost of woods and ponds, in the 20th century shifts occurred within farming land mainly due to a transition from grasslands to arable lands. In the 2nd half of the 20th century, part of the arable land at the base and on the slopes of the Železné hory Mts was transferred into extensive orchards, and part of the grassland on dry sandy soils was afforested. The percentage of pond water areas experienced a significant decrease. These had previously occupied the largest area of up to 10% of the entire model area in the period before the 1st military mapping (Lipský, Kukla, 2009).

Development of landscape use dependent on soil conditions

In the region under review, the following main soil types are represented: alluvial and gley soil (37%), Chernozem (19%), brown soil (5%), Pararendzina (7%) and Cambisol (32%).

T a b l e 2. Percentage land use development in the model territory.

Land use category	Time horizon			
	1MM	2MM	3MM	2006
Arable land	53.5	57.0	65.7	66.7
Permanent Grasslands	17.8	16.8	13.8	5.1
Orchards and gardens	1.0	1.6	1.8	4.9
Total agricultural land	72.3	75.4	81.3	76.7
Forest	16.6	18.2	12.5	16.9
Water bodies	5.9	2.9	2.4	0.8
Built-up areas	1.7	2.0	2.5	4.2
Others	3.5	1.5	1.3	1.5

The largest proportion of arable land was found in Chernozem. Moreover, during the observed period of 230 years it increased from 72% to the present more than 82%. Similarly, high or even higher ploughing also took place in brown soil in the past, then it dropped slightly to a little less than 80% today.While the proportion of arable land is a little lower in Pararendzinas, there is a definite trend of intensification related to drainage in alluvial and gley soils (Fig. 2).

The lowest proportion of permanent grasslands existed in brown soil for the entire period, and this has kept declining continuously from 6.4% in the 18th century to the present 2.6%. Similarly a low and continuously declining proportion of permanent grasslands can also be seen in Chernozem, in Cambisol and in Pararendzinas. The highest proportion of permanent grasslands was logically found in alluvial and gley soils, but even here one can notice a reduction from 30% in the 18th century to 7.9% at present (Fig. 3). During the entire 19th century, the proportion of permanent grasslands consisting mainly of alluvial meadows

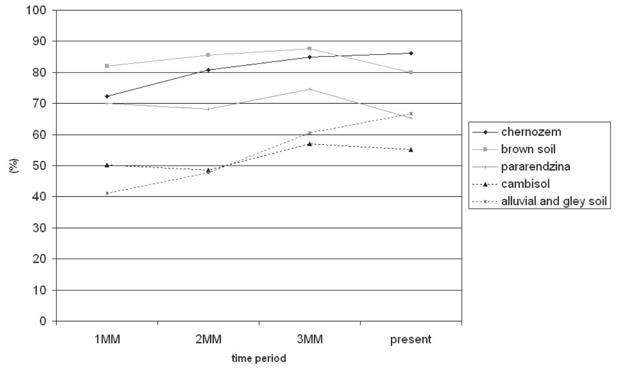

Fig. 2. Share of arable land (in percentages) depending on soil type.
1MM – 1st military mapping from 1763–1783, 2MM – 2nd military mapping from 1819–1858, 3MM – 3rd military mapping from 1874–1880, present – year 2006 (Figs 2–16)

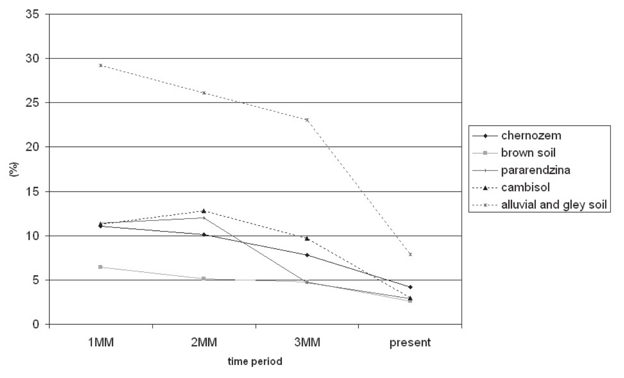

Fig. 3. Share of permanent grasslands (in percentages) depending on soil type.

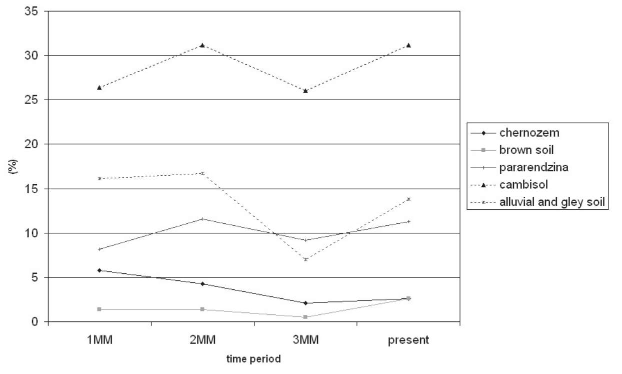

Fig. 4. Share of forests (in percentages) depending on soil type.

was maintained at over 20%. A dramatic decline was noticed only in the 20th century and this is closely linked to drainage of these soils.

Forest areas historically have their lowest occurrence in brown soil, where it remained at a negligible range for the whole study period. In Chernozem, the proportion of forest is also very low and it has been decreasing continuously from 5.8 to 2.6% at present. In Cambisols in the Železné vrchy Mts, the proportion of forest is the highest now of all time, with 26 to 31% (being the most at present). In alluvial and gley soils, the proportion of forest dropped between the 1st military mapping and the 3rd military mapping, and in the 20th century it increased again to its present value of 13.8% (Fig. 4).

Differences in landscape use according to geobotanical units of potential natural vegetation

According to the potential natural vegetation that is particularly dependent on soil conditions, the following basic units are represented: alluvial forests and alder carrs (54%), oak-hornbeam forests (34%), acidophilic oak forests (11.6%). Another two units only have a negligible representation: pine-oak forests and subxerophilous oak forests (Mikyška et al., 1972).

In the unit of alluvial forests and alder carrs one can notice significant intensification of exploitation in the past 230 years. The proportion of arable land kept increasing during the entire period under review, and it has practically doubled from 39% in the 1st military mapping to 68.3% at present (Fig. 5). The proportion of permanent grasslands has dropped accordingly from 27% to the present 6.9% with the main reduction ocurring as late as the 20th century (Fig. 6). Similarly, a proportion of forest has also declined. In this alluvial unit, fish pond water areas were previously significantly represented. However, their proportion was reduced from almost 10% in the 18th century to the present 1.3%. Even maps from the 1st military mapping do not show the maximum number of ponds since some large ponds were abolished before the mapping.

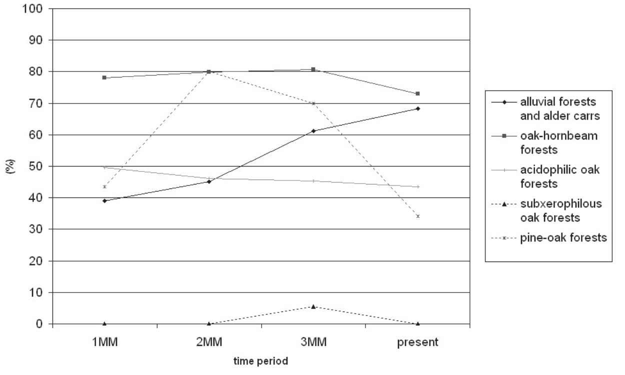

Fig. 5. Share of arable land (in percentages) in geobotanical units of natural potential vegetation.

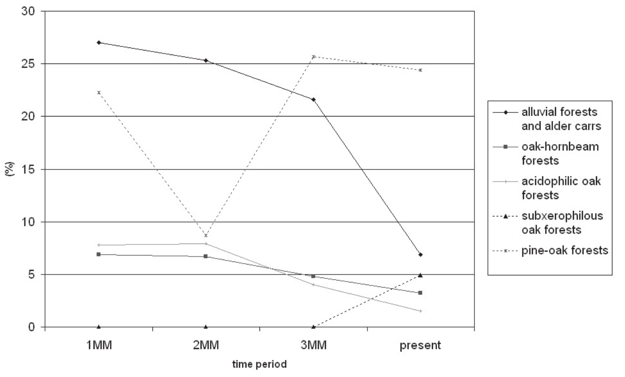

Fig. 6. Share of permanent grasslands (in percentages) in geobotanical units of natural potential vegetation.

In the oak-hornbeam grove unit, which corresponds to the "normal" trophic and hydric conditions and provides opportune conditions for agriculture, there is a much higher proportion of arable land. Throughout history, ploughing has ranged between 73 and 80.6%. However, this increased slightly in the 19th century, then slightly declined in the 20th century (Fig. 5). This was particularly caused by its conversion into intensive large-scale orchards during the last 40 years.

The proportion of arable land is much lower in the area of acidophilic oak forests. During the entire period under review it has consistently reduced to the present 43.5% (Fig. 5), while the share of permanent grasslands has dropped to a mere 1.5% today (Fig. 6). Meanwhile, the share of forests slowly increased from 36.5 to 47.6% at the expense of arable land (Fig. 7).

The proportion of the two remaining vegetation units is negligible and non-representative. In the subxerophilous oak forests area, forested land has dominated for the entire time period with a proportion of over 90%.

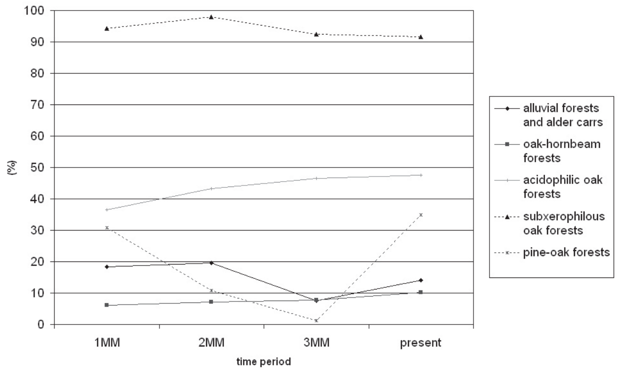

Fig. 7. Share of forests (in percentages) in geobotanical units of natural potential vegetation.

Changes in landscape use in inundated areas of alluvial plains

In the region under review, inundation areas are delimited with the streams of Doubrava and Klejnárka for Q_5, Q_{20} and Q_{100} (5-year, 20-year and 100-year floods). The so called active zone was further defined for local authorities, where stricter requirements for exploitation such as the prohibition of construction were applied. Changes in landscape use were analyzed in the inundation area Q_{100} and in the active zone.

The permanent growth of arable land is significant in the inundation area of the 100-year flood,: on the maps from the 1st military mapping, arable land once took up 27%, today it covers 71% of the area! To the contrary, the proportion of grassland, represented here by alluvial meadows, dropped from 31.5 to 8%! The most extensive liquidation of meadows took place as late as the 20th century. Additionally, the proportion of forests has decreased from 23 to today's 14%. The permanent reduction or even complete liquidation of water elements in the area is alarming, but characteristic, as their proportion has dropped from 13.2% to a mere 1.6%. The proportion of built-up areas has increased slightly from 1.4 to 2.3% (Fig. 8).

Thus the landscape of the inundation area of the 100-year flood, which corresponds approximately to the narrower delimitation of the alluvial plain, underwent a significant change. From the historical mosaic of alluvial meadows, small fields, alluvial forests, ponds and wetlands which were present in the 18th century, this has changed to an intensively exploited agricultural region of collective open fields. It has gone from a naturally poly-functional landscape to a mostly monofunctional production landscape. These changes have naturally had a negative effect on biodiversity, on environmental stability and on the landscape character of the alluvial region.

One can observe an even more considerable increase in arable land in the delimited active flood zone and an even larger reduction in the proportion of permanent grassland (Table 3). During the study period, the area of arable land increased 600%, while the proportion of permanent grassland (alluvial meadows) has decrease by almost 700%. Therefore, the land-

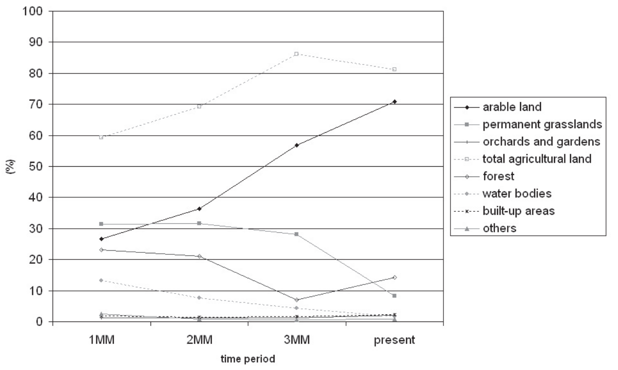

Fig. 8. Land use development in the inundated area of the 100-year flood.

scape matrix was changed completely in favour of arable land. Furthermore the proportion of forests has dropped slightly, although remaining above the average for the total region under review. The only positive things may be the active zone, where the built-up area has not extended and the area of forests has increased again since the end of the 19th century.

Changes in landscape use in individual biochores

There are 13 biochores in the region under review, but the proportion of some of them is very small and non-representative. To analyze the changes in landscape use, only a few representative biochores that are most typical for the region were chosen:
2 Nh – loam alluvia of the 2nd altitudinal vegetation zone (32% of the area),
2RE – plains on loess of the 2nd altitudinal vegetation zone (20.2%),
2RV – plains on blown sands of the 2nd altitudinal vegetation zone (7.7%),
2RB – plains on marls of the 2nd altitudinal vegetation zone (7.4%),

Table 3. Land use development in active flood zone (in %).

Land use category	Time horizont			
	1MM	2MM	3MM	2006
Arable land	10.9	35.6	45.4	65.8
Permanent grasslands	47.3	38.7	39.2	7.3
Orchards and gardens	1.5	2.4	2.0	2.3
Total agricultural land	59.7	76.7	86.6	75.4
Forest	21.0	15.8	7.8	18.4
Water bodies	12.0	5.0	3.3	4.1
Built-up areas	5.1	1.7	1.4	1.4
Others	2.1	0.8	0.9	0.7

2SQ – slopes on metamorphic rocks of the 2nd altitudinal vegetation zone (2.7%),
3BR – plains on acid granits of the 3rd altitudinal vegetation zone (the Železné hory Mts) (4.1%).

Development in the biochore of alluvia is practically the same as the one for Fluvisols, and for potential natural vegetation of alluvial forests and alder carrs and for inundated areas of 100-year floods. It is characterized by a complete change in landscape structure. Arable land has become the dominant landscape matrix, where its proportion today has more than doubled from 34 to 71% (Fig. 9). However, the proportion of permanent grassland has dropped from 36 to 8% (Fig. 10), together with the proportion of forests dropping slightly and pond water areas almost disappearing from the alluvial plains.

The biochore of the plain on loess is characterized by its dominant and highest proportion of arable land, which has ranged between 83 and 88% over the entire period (Fig. 9). The other categories of landscape use are only subsidiary here and of little significance.

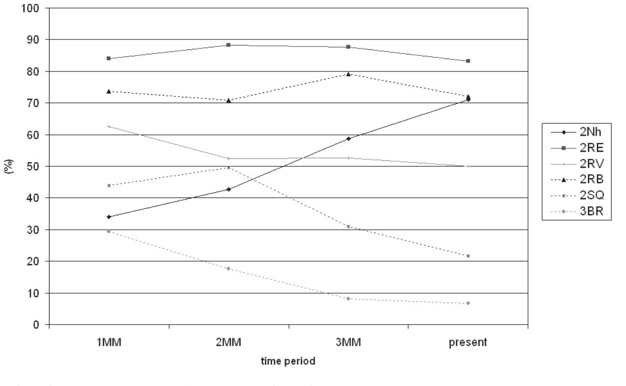

Fig. 9. Share of arable land (in percentages) in main biochores.

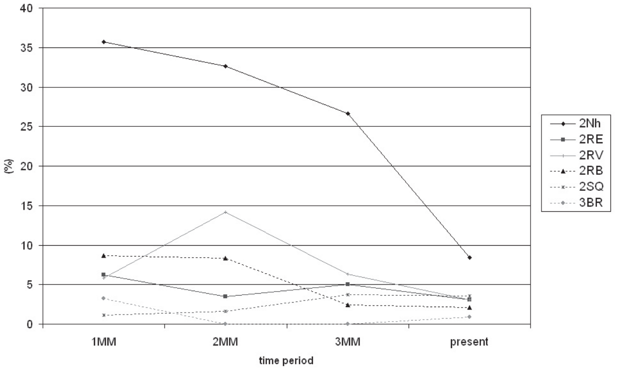

Fig. 10. Share of permanent grasslands (in percentages) in main biochores.

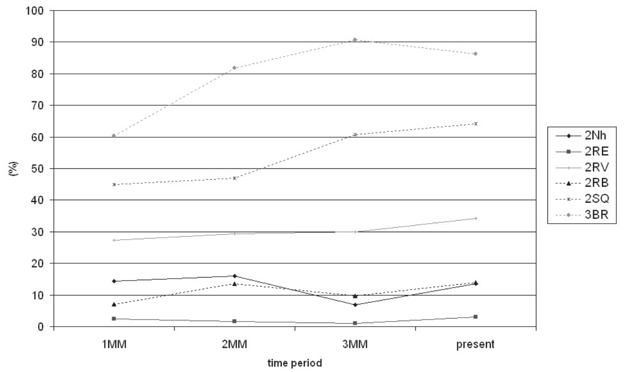

Fig. 11. Share of forests (in percentages) in main biochores.

The development and structure of landscape use in the biochore of plains on blown sands is quite different. Arable land, however, also has the highest proportion here, although its percentage has dropped from 62.5 to 50% (Fig. 9). The second most important category of landscape use is forest, whose proportion rose from 27 to 34% (Fig. 11). In this biochore, there was a significant increase in the proportion of built-up areas from 0.06 to 6%, which can be considered as rational development.

The biochore of plains on marls is also characterized by its dominant use as arable land, with its proportion not changing significantly during the period under review, ranging between 70 and 80%. The proportion of forests in the biochore has increased from 7 to 13.5%, while the proportion of permanent grassland decreased significantly from 9 to 2%.

On the slope of the Železné hory Mts (biochore 2SQ), the proportion of forest has increased significantly from 45 to 64% today (Fig. 11). Therefore, the forest has became the dominant landscape element on its fault-slope and also a significant view landmark, while 230 years ago it shared dominance with arable land. However, the proportion of arable land has been falling for the whole period of time and it has decreased to a half of its former 44% to 22%. The proportion of orchards and gardens has risen from 0 to 7.2% while the other categories are negligible here.

Finally, on the Železné hory Mts plateau (biochore 3 BR), the forest has prevailed during the whole period under review. Its proportion has risen significantly during the 100 years between the 1st and the 3rd military mappings from 60 to 91%, and it currently covers 86%. Meanwhile, arable land has almost disappeared here and a new element occurring as late as the 20th century is the orchard.

Differences in landscape use in individual bioregions

Bioregions as individual biogeographical units (Culek et al., 1996) correspond approximately to the main geomorphologic units. Three bioregions are represented in the region under review, but their territorial representation is very unbalanced. The Polabský bioregion is dominant, constituting 82.7% of the territory, while the Českobrodský bioregion stretching towards the south-eastern edge has 10.4% and the Železnohorský bioregion towards the north-eastern edge of the region accounts for 6.8%.

Arable land dominates in the Polabský bioregion, which best represents the entire model region, with its proportion continuing to increase from 51 to 69% during the period under review (Fig. 12). The proportion of permanent grassland dropped accordingly from 21 to 5% while the biggest decline occurred as late as the 20th century. Also in the 20th century, the proportion of orchards and gardens increased more significantly and water areas dropped from 7% on the 1st military maps to 1% today (Fig. 13).

In the Českobrodský bioregion, agriculture on arable land dominates with over 80% over this period, while the percentage of forests and water areas is very low. However, the proportion of arable land has dropped slightly from 88 to 81% (Fig. 12) and the share of

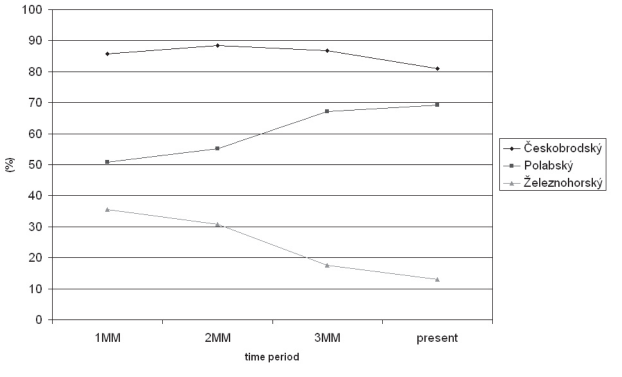

Fig. 12. Share of arable land (in percentages) in biogeographical regions.

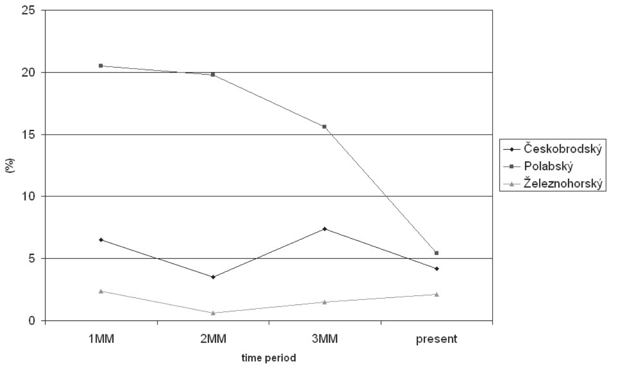

Fig. 13. Share of permanent grasslands (in percentages) in biogeographical regions.

forests has risen slightly, with its lowest value of 0.04% at the end of the 19th century (Fig. 14). Additionally, the proportion of orchards and gardens has increased from 0.06 to 4.9%.

In the peripheral Železné hory Mts bioregion, forests have dominated during the whole period under review. Their proportion increased significantly as early as the 19th century from 54 to 78% (Fig. 14). The category of arable land gradually declined here, from the previous 36 to 13% today. The share of permanent grasslands is negligible, ranging between 1 and 2%. The proportion of orchards, which was negligible in the past, increased during the 20th century to 5% today.

Discussion of outcomes

The outcomes confirm the trend of prevailing intensification in the exploitation of agricultural land. This is apparent in the increasing area of arable land and the significant reduction in grassland area. Differences increased towards polarization, predisposed significantly to the different natural conditions between the Železné hory Mts and the Čáslavská kotlina basin. Extensification of landscape use is apparent in the Železné hory Mts despite its low altitude above sea level, and this has been expressed by ceasing agricultural cultivation and forest planting. On the contrary, in the Čáslavská kotlina basin, intensification of landscape use has occurred during the whole period, where this is characterized by a high degree of ploughing and a reduction in all the other categories, particularly those of permanent grasslands and water areas. From a merely economic viewpoint, this development is rational and it corresponds with the natural conditions. Nevertheless, a reduction in permanent grasslands in all natural units is alarming. From an environmental viewpoint, the general development is very negative, excluding the Železné hory Mts part of the region. This is also apparent in the continuous decline in the values of the coefficient of ecological stability, even though this characteristic is very simplified and it is used for reference purposes only (Fig. 15).

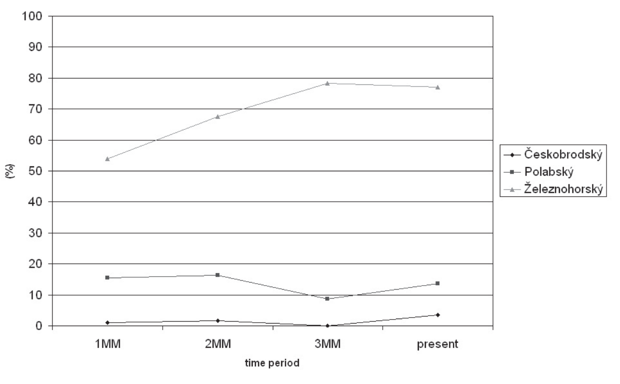

Fig. 14. Share of forests (in percentages) in biogeographical regions.

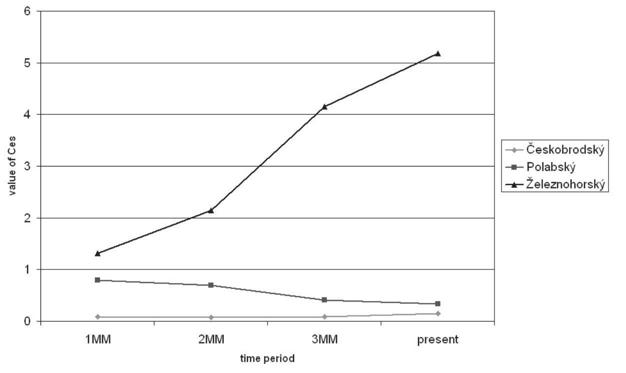

Fig. 15. Development of the value of the coefficient of ecological stability of the landscape in biogeographical regions.
Source of data: personal measurements and calculations

Monitoring the development of landscape use consistent with its natural characteristics has convincingly confirmed the intensive exploitation of the most fertile soils of Chernozem, brown soil and pararendzina during the entire period under review. A significant increase in the intensity of landscape use on fertile Fluvisols in alluvial plains following artificial draining was also observed. The effect of various soil characteristics on exploitation can be synthesized in the decisive soil fertility factor (Brabec, Lipský, 2007).

The natural development of the wide alluvium on the lower course of Doubrava was changed by regulating the Doubrava river, by systematic drainage and by ploughing bottom lands. Today its greater part represents fossil alluvium in terms of natural development processes where natural pedogenesis of Fluvisols does not happen. Therefore, a strong homogenization of landscape structure has occurred in the Čáslavská kotlina basin, which is mostly covered with arable land. The specifics of landscape use in the bottom lands, which have almost disappeared (Lipský, 2008), were characterized by varied historical landscape structure in the 18th and the 19th centuries. The fine mosaic composed of arable land, and numerous ponds, wetlands, alluvial meadows and alluvial forests with alder groves, was replaced by a dull countryside of extensive fields, thereby matching the neighbouring loess plains (Lipský, 1995).

The similar development of exploiting bottom lands towards intensification is confirmed by data from works by Buček (2010), Kiliánová (2001), Jurnečková, Kolejka (1999), Demek et al. (2008) and Šulcová (2006) regarding the fluvial plains of the Morava, lower Svratka, lower Jihlava and the middle Elbe rivers in Czechia (Table 4). The area of arable land has increased significantly to become the largest in the reviewed region of the lower Doubrava and Klejnárka, while the area of grasslands has drastically declined everywhere, and it is now smallest in South Moravia.

T a b l e 4. Changes in the proportion of arable land, permanent grasslands and forest in alluvial plains of selected rivers in Czechia since the 1st half of the 19th century to the present (in percentages).

Region (alluvial plain of the river)	Arable land		Permanent grasslands		Forest	
	2MM	present	2MM	present	2MM	present
Lower Doubrava and Lower Klejnárka	42.8	71.0	32.6	8.4	16.0	13.5
Morava[1]	21.5	51.8	47.5	8.3	27.9	25.5
Svratka below Brno[2]	24.8	66.5	33.1	1.2	x	x
Lower Svratka and Lower Jihlava[3]	14.9	55.0	43.8	2.5	37.3	24.8
Middle Labe (in the district Nymburk)[4]	x	x	x	x	30.7	29.0

Source of data: [1]Kilianová (2001), [2]Jurnečková, Kolejka (1999), [3]Demek et al. (2008), [4]Šulcová (2006)

T a b l e 5. Development of the value of the coefficient of ecological stability of the landscape in inundated area of the 100-year flood (Q_{100}) and in the active flood zone.

Area	Time horizont			
	1MM	2MM	3MM	present
Inundated area of Q_{100}	2.22	1.60	0.69	0.35
Active flood zone	4.51	1.62	1.10	0.47
Whole model territory	0.70	0.65	0.44	0.38

Development in riverine landscapes with accompanying liquidation of water areas, wetlands, forests and grasslands, and their replacement by arable land is very negative in terms of flood protection, water retention and its accumulation in the landscape and also environmental stability. Negative developments in the inundation area of the 100-year flood and in the active inundation zone are also confirmed by the data in Table 5. The value of the coefficient declined in the inundation area by more than 600% and by almost 1000% in the active zone, and this value is even lower today than in the whole region under review (Fig. 16).

Unlike the levelling exploitation of landscape in fluvial plains, differences in the exploitation between fertile and infertile lands has increased in the region under review. This applies not only to the comparison of the Čáslavská kotlina basin and the Železné hory Mts, but also within the basin. The proportion of arable lands decreased on sandy soils with low fertility and the proportion of forest increased, while this trend was the opposite on rich soils. This development is economically logical and rational, and it confirms conclusions in the work by Breuer et al. (2010) concerning the apparent influence of natural conditions and the general tendency to economically effective exploitation.

An interesting, more complex development is noticeable in the historically composed countryside around the Kačina castle. The systematic, aesthetically motivated landscape formation by man acted against the prevailing trend of deforesting fertile lands. Although arable land also prevails here, and the proportion of grasslands has declined significantly

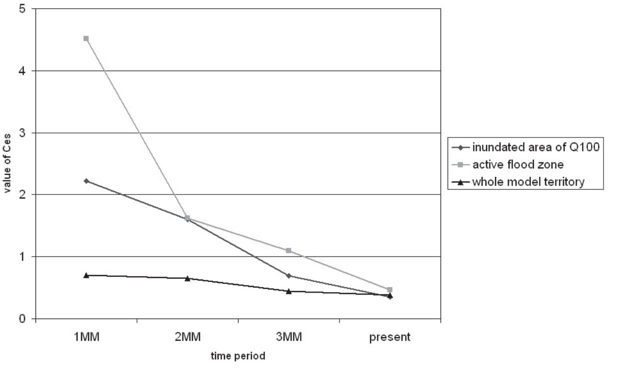

Fig. 16. Development of the value of the coefficient of ecological stability of the landscape in inundated area of the 100-year flood and in active flood zone.

as elsewhere, the proportion of forest has simultaneously increased. This was caused by the generous landscape formation of the Kačina region from the end of the 18th century which extended the forest growth and prevented planar drainage of alluvial lands in the Kačinská Game Preserve. Thanks to this historic development, the Kačinská Game Preserve and the Žehušická Game Preserve represent important islands of increased biodiversity in the region. This successfully provides intensive agriculture and an environmentally stabilizing core within the entire Čáslavská kotlina basin. This has now developed into an important functional biocentre, the NATURA 2000 site, and it is the gene base for three forest tree species.

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