

HOW NATURAL AND CULTURAL ASPECTS INFLUENCE LAND COVER CHANGES IN THE CZECH REPUBLIC?

EVA BOUCNÍKOVÁ^{1,2}, TOMÁŠ KUČERA^{1,2}

¹ Institute of Systems Biology and Ecology, Academy of Sciences of Czech Republic, Na Sádkách 7, 370 05 České Budějovice, The Czech Republic, e-mail: evi@bf.jcu.cz, kucera@uek.cas.cz

² Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, 370 05 České Budějovice, The Czech Republic, e-mail: kucera@uek.cas.cz

Abstract

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Landscape development has been determined by environmental factors, economical development, and political decisions. Analyses of various landscape features and their historical and present changes need to be recognized to ensure future sustainable land use and landscape management. Our paper aims to introduce a landscape typology based on classification of landscapes and their changes over the last 15 years in the Czech Republic, after the Communism period. These landscape changes are connected with the restitution of private land ownership, changes in the Common Agriculture Policy (CAP), land abandonment and rural marginalisation. The results of CORINE land-cover and NATURA 2000 biotope analysis show

landscape changes between the years 1990 and 2000 on different spatial dimension and scale levels.

Key words: landscape, CORINE land-cover; land use

Introduction

Natural and cultural landscapes have changed their face in history over the whole Europe due to many aspects. Not only environmental factors determined landscapes, but also social transformations, political decisions and economic development left non-negligible marks. Trends differ between Western, Eastern (and Southern) Europe (Bastian and Steinhardt 2002). They also vary considerably between countries within a regional group, and between regions within a single country (Krönert et al. 1999). The European Environment report (European Environmental Agency 1995) distinguishes seven main factors that impact on landscapes: 1) intensification of agriculture, 2) overgrowth of agriculture lands, 3) urbanisation and development of infrastructure, 4) standardisation of building materials and designs, 5) tourism and recreation, 6) excavation of mineral resources, 7) disappearance of natural biotopes, habitats and ecosystems.

An eight impact factor can be added for the former communist countries, such as the Czech Republic, the so-called political breaks. Fanta et al. (2005) listed these political events in a project report that aimed to describe the roots of marginalisation and future landscape perspectives in a case study from a Czech border area (see Fig.1):

1 - The Munich Treaty of 1938: the areas of the earlier Czechoslovak Republic, along the borders with Austria, Germany, and Poland (the Sudetenland)

were inhabited mostly by a German population. These areas were annexed by Nazi Germany; and about 400 thousands Czech inhabitants were expelled from the area;

2 - The end of World War II – the Potsdam Treaty in 1945: the ethnic German population (nearly 3 million) was transferred from the Sudetenland area to post-war Germany; the open "niche" was colonized partly by the original Czech population and partly by Czech newcomers;

3 - The communist coup d'état in 1948 and the following collectivization of land in the 1950s: introduction of large-scale collective farming throughout the country, aimed at maximum production of agricultural commodities;

4 - Abolition of the communist regime in 1989: restitution of private land ownership in the 1990s; reintroduction of democracy and a market economy, including agricultural commodities; development of market-driven forms of land use;

5 - Accession of the Czech Republic to the EU in 2004: full association with the EU agricultural market; introduction of principles of the Common Agricultural Policy; searching for appropriate methods and forms of land use.

Even if the land-use changes over the last few decades were not fundamentally different from what happened historically, the scale of the changes over time and space, and their impact, was much greater than before. The land collectivization in the 1950's had mainly negative environmental, cultural-historical, and aesthetical consequences. The scale of agriculture enlargement (small private fields were joined into large collective ones), the turning of wetlands, meadows and hedgerows into arable land and the intensive use of chemicals led to a loss of landscape and biological diversity, while increasing water and soil pollution, soil erosion, ruderalisation, and the loss of cultural heritage (Boucníková et al., 2005).

Other land-use changes, related to the period after restitution of private land

ownership in the early 1990's, were already occurring before the negative impacts on the landscape from the last few decades were rehabilitated in the Czech Republic. Present changes are connected with land abandonment (Boucníková et al., 2005). In the Czech Republic, it is mainly a problem of "Less Favoured Areas" (LFA), where environmental and ecological conditions discourage agriculture.

Natural and cultural landscapes have to adapt to these changes and landscape planners, land users and researchers have to find strategies to develop and maintain multifunctional landscapes. Respecting the diversity and cultural-historical identity of landscapes is necessary to ensure a high quality of landscapes and their sustainable development. This may be reached by integrating ecological, economic and aesthetic-cultural approaches in land-use (Fanta, 2001a) (see Fig 2).

Landscape planning, focused on resource allocation, is an important tool for dealing with cultural landscapes. This links human attitudes and goals with a realistic analysis of landscape features, processes and systems (Cook, Van Lier, 1994). The aim of this paper is to provide a basic framework for landscape classification that might be useful for landscape planning.

We analysed landscape and land cover changes that occurred in the Czech Republic over the last fifteen years. According to Solon (2003), the results of landscape diversity evaluation depends on: a) the kind of feature analysed, b) the kind of basic units, and c) the scale and spatial dimension of the analysis. In this study, evaluations focused on : 1) the dependency of landscape classification on social regionalisation (administrative districts) and 2) relationships between nature quality and landscape types. Also, an overview of land-cover changes in the last fifteen years is provided.

In the last century, the Czech Republic experienced some transformations of land use. Even if the total amount of agriculture land is decreasing from the 20th century

the percentage of arable land has differed (see Fig. 1) and from the fifties of last century, rural landscapes are characterised by enlarging land use scale.

Comparing the years 1950, 1980 and 2003, the total amount of agriculture land decreased from 4 679 000 ha in the year 1950 to 4 269 000 ha in the year 2003. But the percentage of arable land differed from 71.85% in the year 1950, to 75.31% in the year 1980, to 71.72% in the year 2003 (Czech Statistical Office 2005, http://www.czso.cz/csu/redakce.nsf/i/bilance_pudy). The new trend, occurring from the nineties of last century, is increasing amount of uncultivated agriculture land. No uncultivated agriculture land occurred in the year 1989, but it has increased up to 177 000 ha in the year 2003 (MZP, 2005).

Materials and methods

The assessment of natural and cultural landscapes and recent land-cover changes that have occurred since 1989, after restitution of private ownership, were described using CORINE land cover (CLC) data from the years 1990 and 2000 (The Czech Ministry of Environment 2004). The Czech national land cover database uses the European CLC database specifications set by the European Environment Agency (European Environment Agency 2002). A mapping scale is 1:100 000, with an accuracy of at least 100 m. The geometric reference for the CLC database has a minimum accuracy of 25 m.

The CLC nomenclature is hierarchical. For Europe, there are 5 classes at the first level, 15 classes at the second level, and 44 classes at the third level. For the Czech Republic, there are 5 classes distinguished at the first level, 13 classes at the second level, and 28 classes at the third level (see Table 1).

Determinations of natural, rural, and urban landscapes were done using the first level of the CORINE land cover nomenclature (Bossard et al., 2000) (see Table 1) for social, natural and independent regionalisation spatial dimensions. The social regionalisation was marked by administrative borders of districts, while by biogeographical regions for the natural regionalisation (Culek et al., 1996). We used a regular square grid, which divided the country into quadrangles of 10 longitudinal and 6 latitudinal minutes (approximately 133.5 sq km), for an independent spatial dimension.

The results of the landscape classification were compared with results from mapping of biotopes for NATURA 2000 (Agency for Nature Conservation and Landscape Protection, 2005). The scale of the NATURA 2000 mapping was 1:10 000 (Guth, Kucera, 2005). The degradation of biotopes was assumed as a combination of low values of representativity degree and conservation status (see Table 2).

Spatial data processing and analysis of land cover transformation was carried out using ArcView 3.1, ArcGIS 9, and FRAGSTASTS for ArcView.

Results

Results are presented in three sections: 1) dependency of landscape classification on social regionalisation (administrative districts), 2) dependency of nature quality on landscape types, and 3) land-cover changes.

Landscape classification on social and natural regionalisation, and a square grid

Landscapes were classified as rural, natural, rural – forestry, rural – urban, urban,

and balanced using the 1st level of the CORINE land cover nomenclature from the year 2000 (see Table 3). *Rural areas* were considered as space dominated by agricultural land, *urban areas* as space dominated by urban fabric, industrial and transport units, mine dump and construction sites, and artificial non-agricultural areas. Natural areas are those dominated by forests and semi-natural areas, wetlands and water bodies. In landscapes distinguished as *rural – forestry* or *rural – urban*, these classes are more or less equal. There was no distinct dominance of artificial areas, agriculture areas, forests and semi-natural areas, wetlands or water bodies in *balanced landscapes*. According to the regular grid regionalisation, rural areas accounted for 74% of the landscapes, 24% were natural areas, 1% rural-forestry areas and the remaining 1% of landscapes were divided into balanced and rural-urban areas. of the use of administrative borders produced 53 districts characterised as rural, 11 characterised as rural – forestry, 9 as natural, 3 balanced and only 1 defined as urban (see Fig. 3a).

The comparison of landscape types determined by CORINE land cover in administrative districts and the biotope NATURA 2000 mapping showed a very low number of natural biotopes in urban, balanced and rural landscapes. The abundance of natural biotopes increased in rural-forestry landscapes and was highest in natural landscapes (see Fig. 4).

Dependence of nature quality on landscape types

Landscape quality was evaluated using the proportional abundance of natural biotopes in the regular square grid. For this study, we considered as natural biotopes all biotopes without biotopes that were mapped as habitats strongly influenced or created by man (Chytrý et al., 2001). More than 80% of natural biotopes is comprised

in 5.5% of the square grid, 5.3% of the areas has 60– 80% of natural biotopes, while 9.4% of the areas has 40– 60% of natural biotopes. Between 20–40% varies natural biotopes on 23.6% areas of the Czech Republic and less than 20% of natural biotopes occurs on 56.2% of the whole country. These last areas correspond with rural areas classified according to the CORINE land cover nomenclature (see Fig. 5a).

Although there are more than 40% of natural biotopes in many landscapes, most of these have been heavily impacted by humans. Biotope quality was expressed in the NATURA 2000 mapping by estimating their representativity degree and conservation status (Guth, Kucera, 2005). A total of 34% of all natural biotopes in the Czech Republic are considered as having low representativity and conservation status. Areas with possible high or low risk of negative impact on landscapes are distinguished in Fig. 5b. High risk areas are those with less than 40% of mapped natural biotopes, with more than 40% of these having low representativity and conservation status. In the Czech Republic, 278 squares in the regular grid (41%) (see Fig. **5b**) were distinguished as high risk. This means that there are 34 452 sq km of areas with natural biotopes with low representativity and conservation status. Landscape improvement should be concentrated on these areas.

Areas marked as low risk were those where natural biotypes comprised > 60% of the total grid area and less than 40% of these natural biotopes had low representativity and conservation status. These areas should be protected as reserves because the biotopes are only slightly negatively impacted.

Land use change over the last fifteen years

Different land use changes have occurred between the years 1990 and 2000 accompanied with land abandonment. This trend is clearly seen in land cover

changes, especially in changes of arable land, pastures, forests, and shrubs and/or herb vegetation (see Fig. 6). The ten largest changes in CORINE land cover are shown in Fig. 7. The most common change was in arable land (class 211 according to the CORINE nomenclature (Tab. 1) being turned into pasture (class 243)). These changes represent 3.5% (2821 ha) of the whole extent of the country and occurred mostly in border land areas, where the largest overall changes are apparent (see Fig. 8). Change in forest types, in which nearly 925 ha of transitional woodland shrubs turned into coniferous forest and 470 ha of coniferous forest became transitional woodland shrubs, was the second largest change over this time period.

Discussion

Landscapes are very complex phenomena that it is why it is not easy to describe and classify them. At present, the most common approach is to see landscapes from a holistic point of view (Naveh, 1998, 2001; Tress et al., 2001), as an integration of ecological, economic and aesthetic approaches (Fanta, 2001b). Cultural landscapes are seen as objects determined not only by physical conditions but also economic conditions, technical means, cultural and social aspects, demographic structure, cultural heritage, and planning and policy environment (Jongman, 2002). The economic value of cultural landscape can be considered very important, esp. in marginal areas (Cudlín et al., 2006).

The results of landscape evaluations depend on: a) the kind of features analysed, b) the kind of basic units, and c) the scale and spatial dimension of the analyses (Solon, 2003). All of these aspects are independent.

The analyses conducted in this paper showed that classifying landscapes depends on

the scale and spatial dimension chosen. In this case, the results confirmed the dependency of classified landscape types on social regional administrative districts. Slightly different landscape types were distinguished when using CORINE land cover with a regular square grid or biogeographical regions instead of CORINE land cover with administrative districts. Urban landscapes, which were overlooked when using the square grid or biogeographical regions, were distinguished with the spatial dimension of administrative districts. The dependence of landscape types on social regionalisation can be induced from this.

The strong cultural influence on landscapes is confirmed when comparing the spatial analysis of classified landscapes types to natural biotopes. It has been said that agriculture gives the face to rural landscapes. The changes in agriculture, which started in the 1950's, produced a steep increase in the percentage of arable land. Enlarging the land use scale mainly had an environmental impact, but also cultural-historical, and aesthetical impacts. This is seen by the low abundance of natural biotopes in rural landscapes and their strong degradation in many areas. These are areas considered to be high risk of negatively impacting landscapes. This poses the question whether natural systems and cultural landscapes can adapt. A strategy should be developed to maintain a multifunctional landscape that serves not only agriculture, forestry, transportation and urbanisation needs, but also the functioning of nature and supporting biodiversity (Jongman, 2002).

The present landscape trend in the Czech Republic is abandonment of arable land with an increasing amount of uncultivated arable land. This trend started to occur after abolition of the communist regime in 1989, followed by restitution of private land ownership in the 1990s. The development of land cover between 1990 and 2000 clearly shows the turning of arable land into pastures. The conversion of arable land into land principally occupied by agriculture with significant areas of natural

vegetation (Bossard, 2000) was also an important development. This occurred mainly in borderland areas that became, according to agriculture policy, “Less Favoured Areas (LFA)”, which are areas where environmental and ecological conditions discourage agriculture.

Conclusions

From this study it can be seen that the political breaks and coherent land use changes have caused major changes to the land cover and quality of biotopes. Landscape classification and evaluation of the changes are difficult because they depend on the spatial dimension, the scale, the type of basic units, and the feature analysed. Six landscape types (rural, natural, rural – forestry, rural – urban, urban, and balanced) were recognised for a 1st level CORINE land cover hierarchy in the Czech Republic. A total of 74% of the landscapes in the Czech Republic belong to rural areas where natural biotopes have low abundance and are strongly degraded. Almost 24% belong to natural areas with a high proportion of natural and quality biotopes.

Translated by the authors

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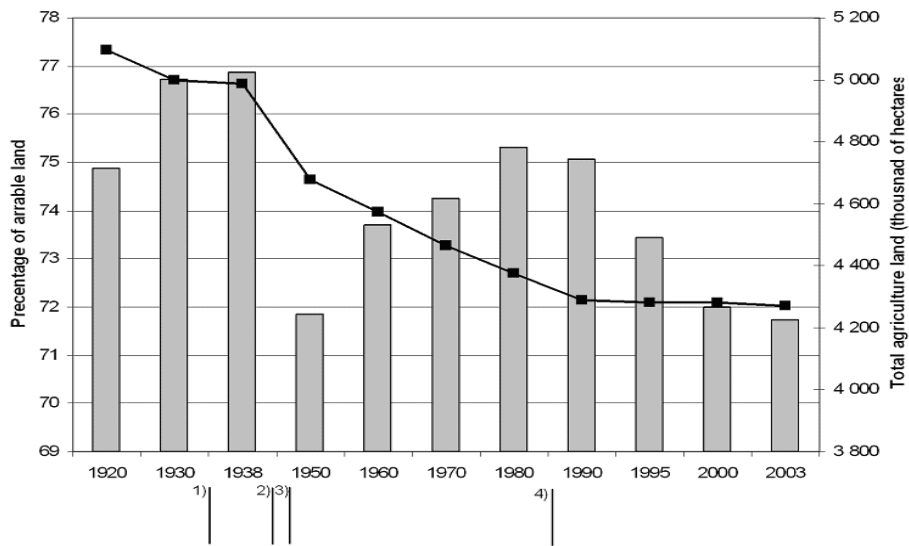
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Fig. 1. Land use changes and political breaks.



1 - The Munich Treaty in 1938, 2 - the end of the World War II, 3 - the collectivization of land in 1950s, 4 - restitution of private ownership of land.

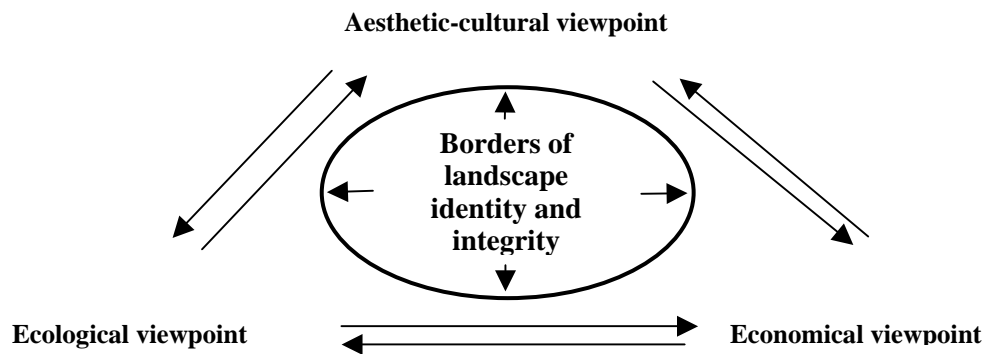


Fig. 2. Dealing with cultural landscape (Fanta, 2001b).

Table 1. The Czech National CORINE Land Cover Nomenclature (Bossard et al., 2000)

Level 1	Level2	Level 3	Area in 2000 [ha]	
1 Artificial areas	11 Urban fabric	111 Continuous urban fabric	1463.63	
		112 Discontinuous urban fabric	362585.3	
	12 Industrial, commercial and transport units	121 Industrial or commercial units	54773.08	
		122 Road and rail network and associated land	5272.703	
		123 Port areas	150.2605	
		124 Airports	5626.585	
	13 Mine, dump and construction sites	131 Mineral extraction sites	17102.38	
		132 Dump sites	13886.49	
		133 Construction sites	857.4813	
	14 Artificial non-agricultural vegetated sites	141 Green urban areas	6555.161	
		142 Sports and leisure facilities	12733.38	
	2 Agricultural areas	21 Arable land	211 Non-irrigated arable land	3262167
		22 Permanent crops	221 Vineyards	11942.15
			222 Fruit trees and berry plantations	32643.8
23 Pastures		231 Pastures	531704.8	
24 Heterogeneous agricultural areas		242 Complex cultivation patterns	42953.46	
		243 Land principally occupied by agriculture, with significant areas of natural vegetation	674769.4	
3 Forests and Semi-natural Areas	31 Forests	311 Broad-leaves forests	252740	
		312 Coniferous forests	1699292	
		313 Mixed forests	604224.3	
	32 Shrubs and/or herbaceous vegetation associations	321 Natural grasslands	39203.76	
		322 Moors and heathland	2738.861	
		324 Transitional woodland shrub	186969.5	
	33 Open spaces with little or no vegetation	332 Bare rock	209.86	
		(334 Burn areas) – only in the year 1990		
4 Wetlands	41 Inland wetlands	411 Inland marshes	5336.414	
		412 Peatbogs	3710.96	
5 Water bodies	51 Inland waters	511 Water courses	4300.56	
		512 Water bodies	50966.86	

Fig. 3. The differences in landscape classification using different spatial dimension:
A) the administrative districts; B) the biogeographical regions; C) the regular square grid.

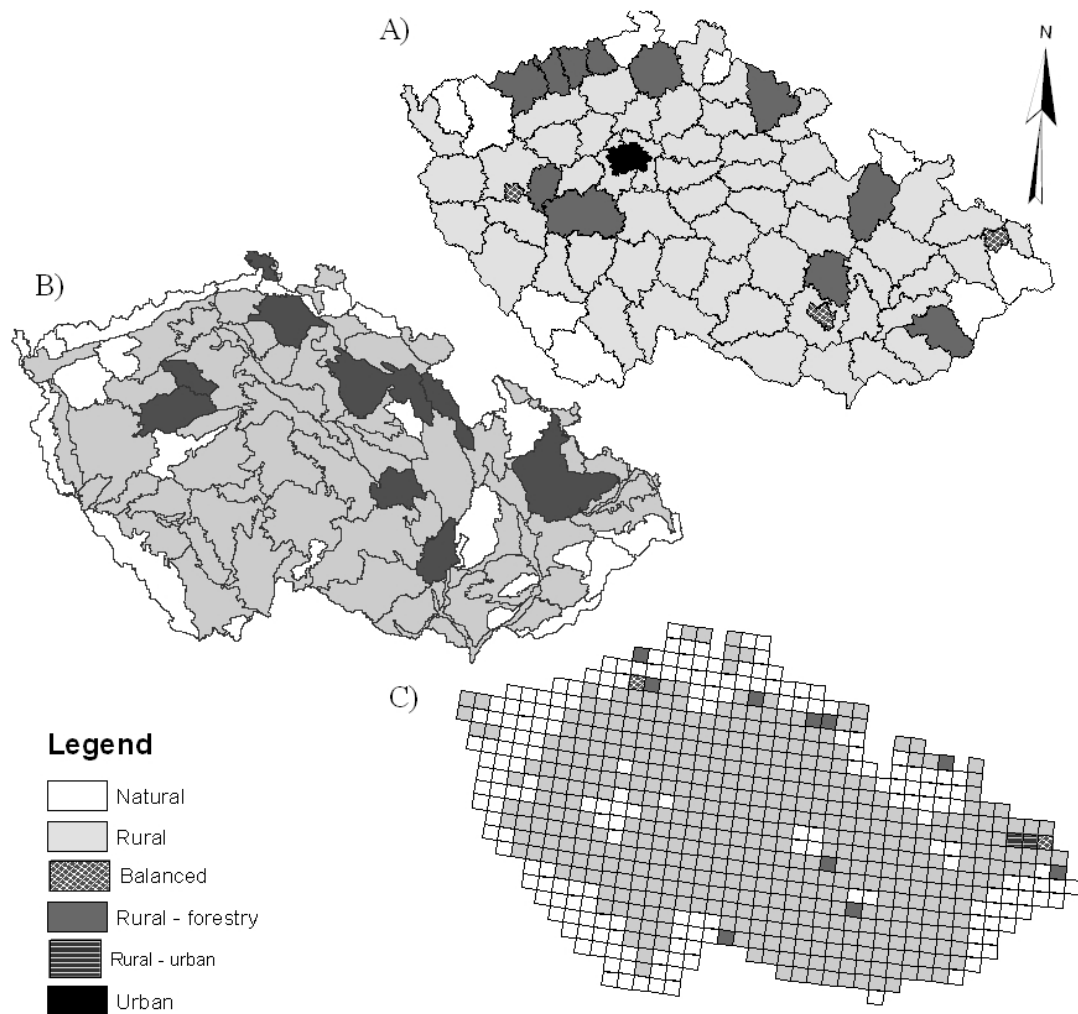


Fig. 4. Superficial abundance of natural biotopes in landscape types in administrative districts.

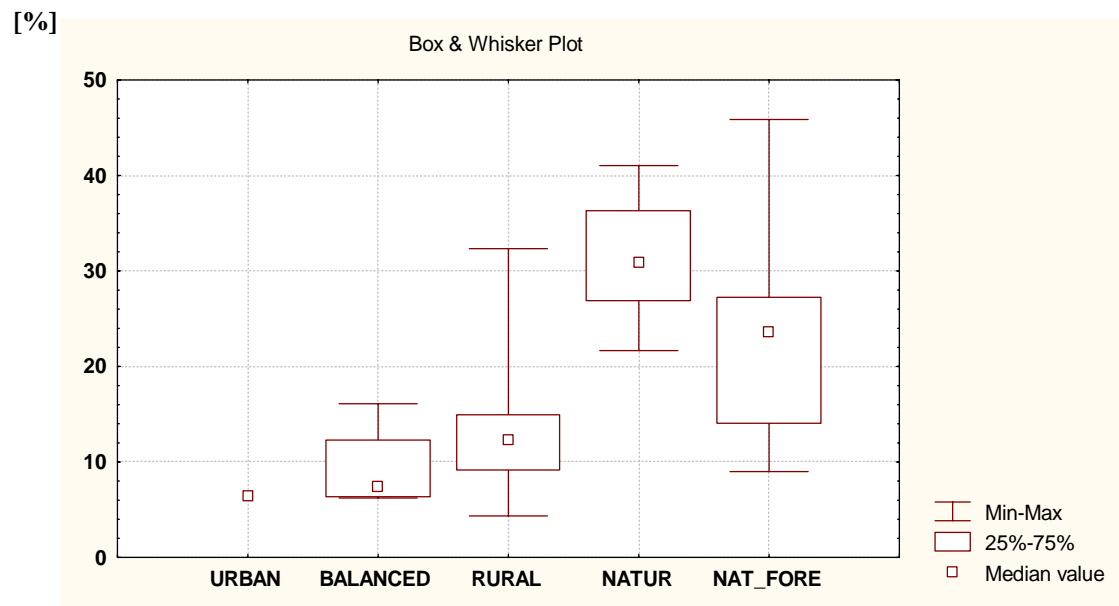


Fig. 5. Spatial distribution of areas with different coincidence of natural biotopes on the grid level: 5a) Natural biotopes in landscape types; 5b) Natural biotopes and their degradation. (Degradation is expressed as a proportion of area covered by biotopes with low representativity and conservation status).

Fig. 5a.

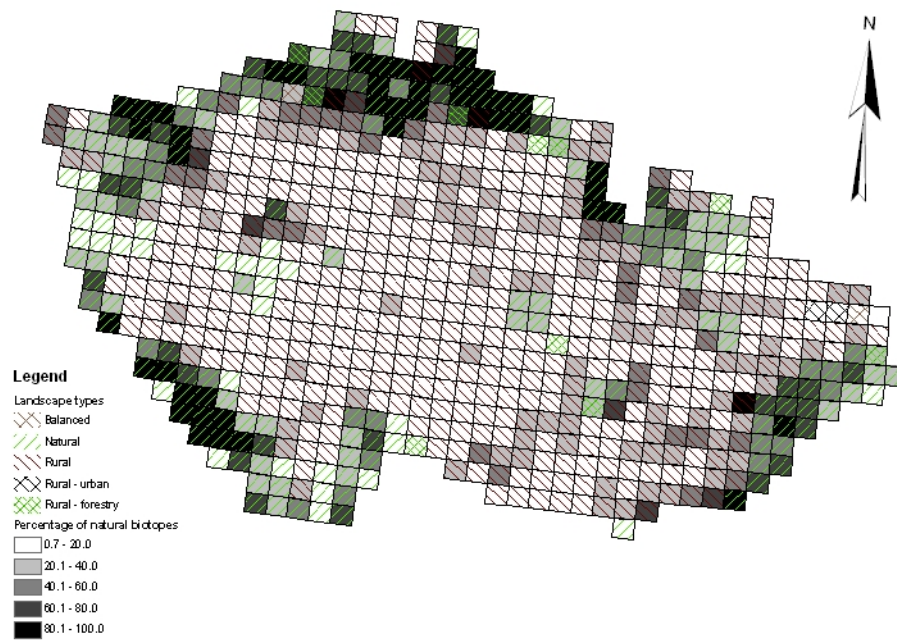


Fig. 5b.

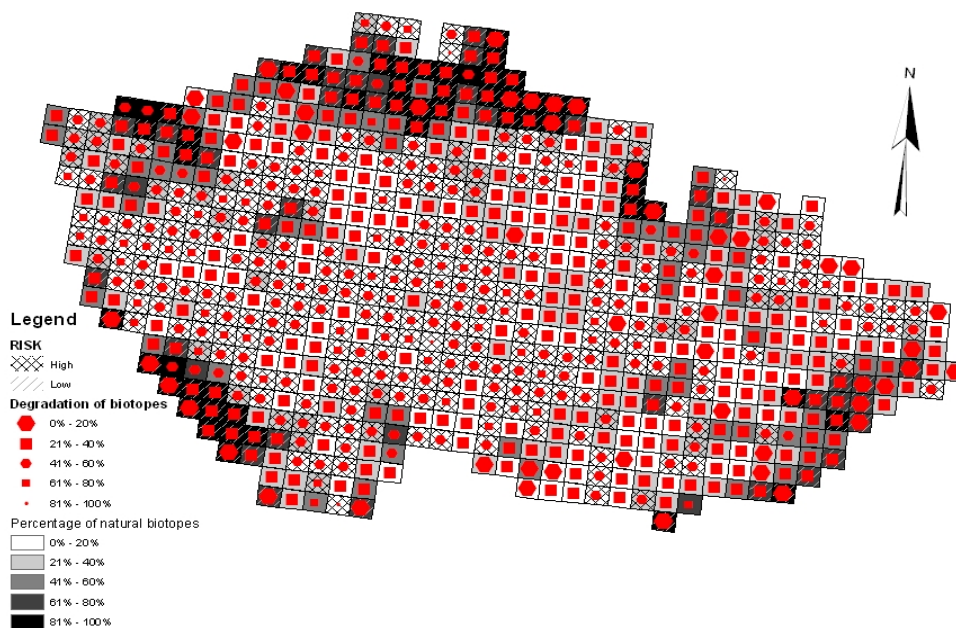


Fig. 6. Changes of the 2nd level of CORINE land cover nomenclature between the years 1990 and 2000 (see Table 1).

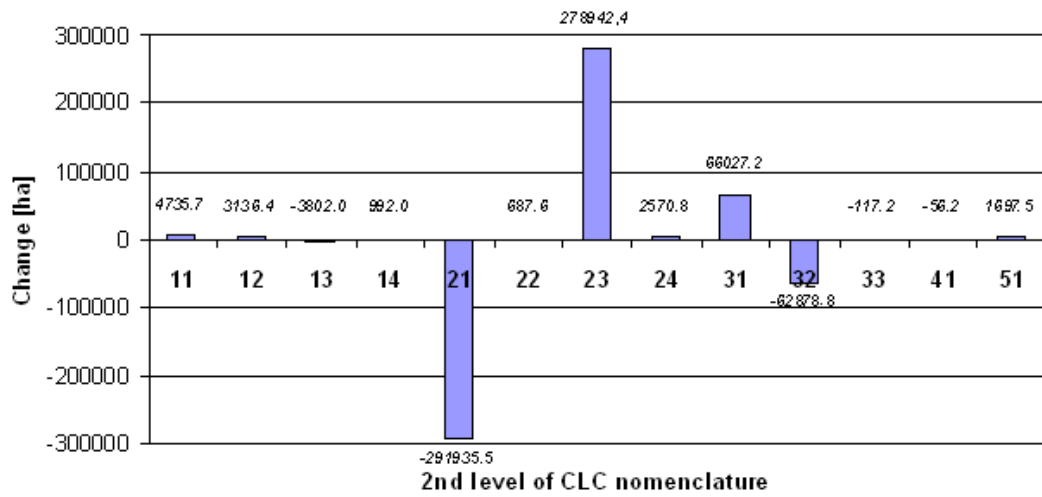


Fig. 7. The ten most common directions of changes of 3rd level of CORINE land cover nomenclature from the year 1990 to 2000 (see Table 1).

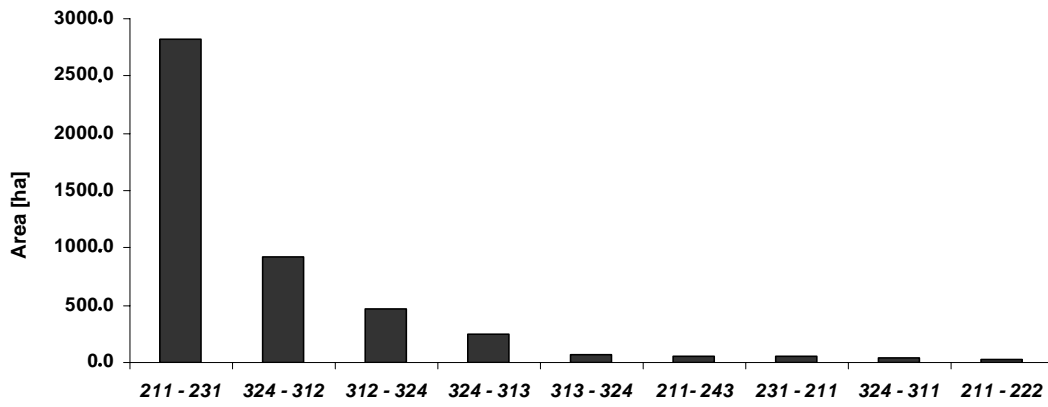


Fig. 8. Distribution of prevailing land cover changes and percentage of changes that occur in 8a) districts and 8b) square grid (Those squares where changes are over 10% are depicted).

Fig. 8a.

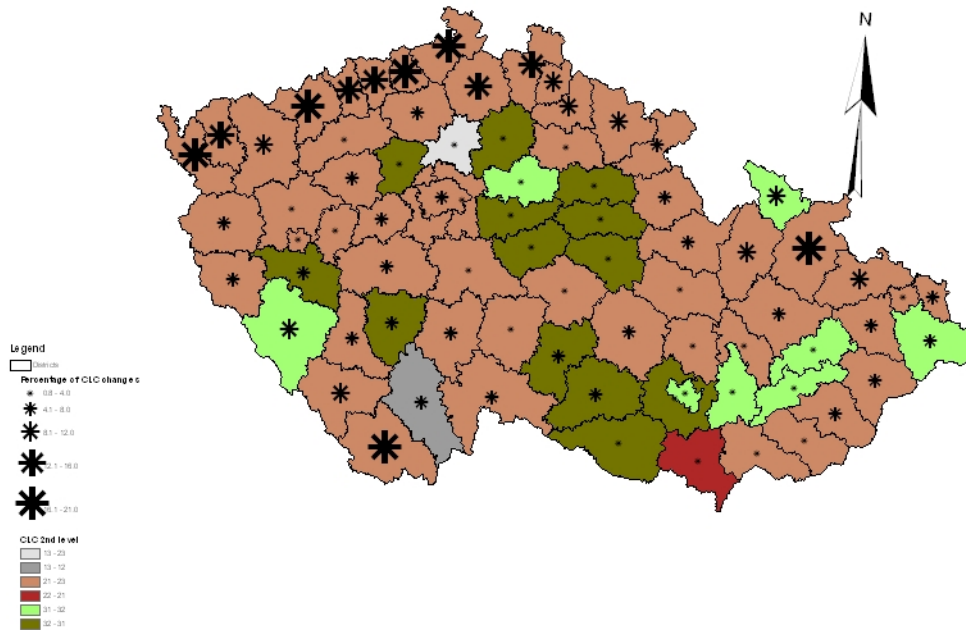


Fig. 8b.

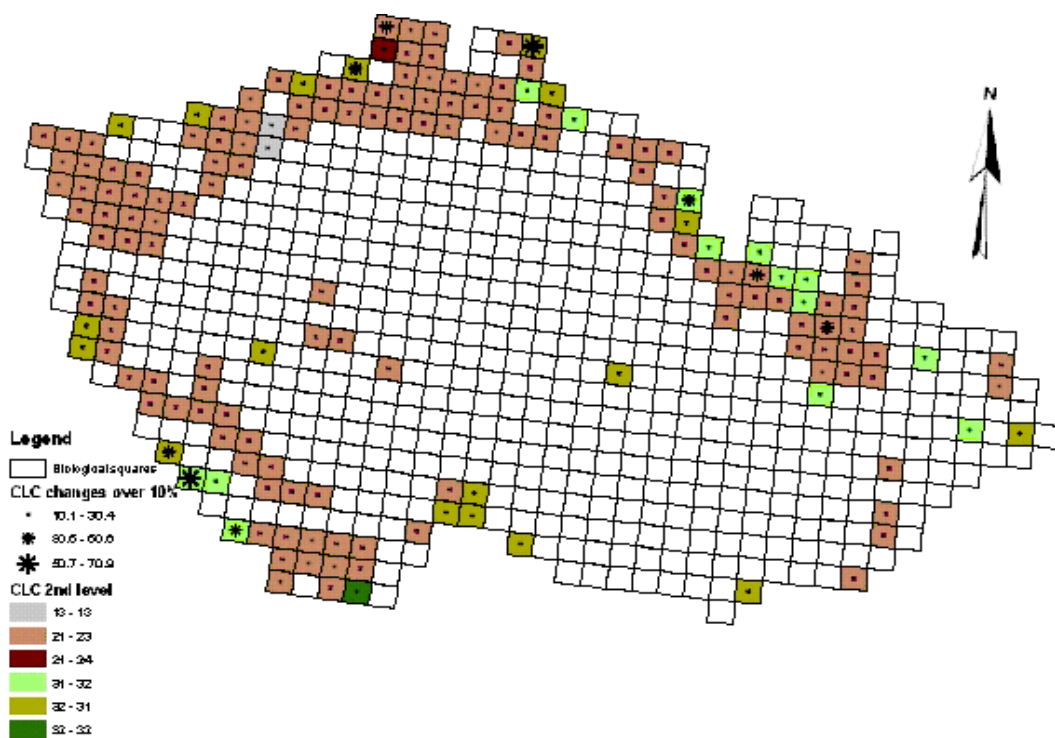


Table 2. Values of low representativity and conservation status

	Representativity degree				
Conservation status		A	B	C	D
	A				x
	B			x	x
	C			x	x

T a b l e 3. Extent of landscape types according to different spatial resolutions. [sq km]

	Urban	Rural	Natural	Rural - forestry	Rural - urban	Balanced
Administrative districts	496.0	57963.5	9826.1	10058.6	-	570.0
Biogeographical regions	-	54039.0	15054.3	9721.6	-	-
Regular square grid	-	58476.3	18973	955.3	266.6	196.9