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# Landscape changes of Prague outskirts from 1990 to 2012

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**Abstract**

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This paper follows up the landscape changes of Prague outskirts from 1990 to 2012 using the CORINE land cover data. It quantifies these changes by observing the acreage decrease and increase of individual types of land cover. The results confirm the frequently emerging trend in Europe, namely the increase of the urban area at the expense of arable land. Another significant change is the increase of pastures in the areas farther from the city. These changes are further analysed to find regularities relating to the relief, to the distance from the city and to the transport and settlement infrastructure. On the bases of the analyses there are defined the types of changes. The most significant change is a decrease of arable land at the expense of discontinuous urban fabric and pastures. The results show that there were changes made to the land cover on an area of 17,429 ha which is equivalent to 7.3% of the evaluated area.

**Keywords**: land-cover change; urban sprawl; CORINE; GIS

Landscape and land cover in Europe change due to population growth (Bilsborrow, Ogendo 1992), especially in the areas surrounding cities or other larger towns in the EU (EEA 2006). Rural landscape changes to urban landscape (Jenerette, Potere 2010; Vaz et al. 2014). Major driving forces of the changes of land cover are: urbanization, globalization and transport accessibility (Antrop 2004) handled through transport infrastructure which plays a significant role in the process of landscape urbanization (Lewis, Maund 1976; Antrop 2004; Vaz et al. 2012). Urbanization in the outskirts of cities, called suburbanization, often takes place in the area of fields and forests because the city inhabitants look for rural environment and the qualities such as the countryside. However, the suburbanization itself destroys these advantages through commercial development and transport development (Anderson, Bogart 2001). From the economic aspects, it is necessary to mention the influence of the lower costs of building plots in urban fringe thanks to which development expansion takes place in the form of leapfrogging, where developers skip over high value city-centre locations (Heim 2001). Urbanization and suburbanization, has an essential influence on agriculture whereby growth of artificial areas suppresses arable areas (EEA 2013).

Changes of land cover, such as the growth of human settlements and land use in the area of urban fringe is possible to identify with the help of the CORINE Land Cover (CLC) data (Vaz et. al. 2014). CORINE (Coordination of Information on the Environment) is, in the European context, the most widespread source of data used for combining of integrative landscape classifications and other thematic data (Büchner et al. 2010). CORINE is derived from landsat TM images that can refer to important problems with uncertainties (Regan et al. 2002). The advantage of CLC data is a transparent, well-founded spatial planning (Hewitt, Escobar 2011). Thanks to the use of the data such phenomena can be identified as extension of urbanized areas, structural changes in agricultural landscape (including changes between pastures and arable land as well as a changed and more complex cultivation pattern) but also changes in forestation (Feranec et al. 2007). In terms of systematic research it is important that CLC data are universally available and can be obtained for free and through the CORINE program, a united land resource management regula-

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tions for the whole Europe, initiated in 1985 (Briggs, Mounsey 1989). All of these data are broadly used in various projects and are of relevance to policies in land management (Feranec et al. 2007).

## MATERIAL AND METHODS

The principal questions of this paper aimed to be answered are: when and how the land cover changes and whereas the changes are located in connection with the distance from Prague, with relief, existing land use or the current transport infrastructure. Thus, the aim of this paper was to determine the pace and quantity of the changes of land use and to detect their spatial links within a given area. In spatial analysis CORINE Land Cover Changes (CLCC) data from 1990/2000, 2000/2006, 2006/2012 were compared. These data are useful only for a larger scale analysis. It is therefore an important tool to understand regional dynamic more efficiently (Vaz et al. 2014).

This paper is based on the assumption that landscape changes are related to biophysical system (Lambin, Meyfroidt 2010). These relations are possible to identify by overlaying of the individual landscape elements (Mcharg 1969). The analysis of the overlays was accomplished with the help of the Geographic Information System (GIS) to analyse the spatial information of land cover changes linked with other spatial data (relief, transport and settlement infrastructure, current land cover).

CORINE Land Cover Changes (CLCC) data were compared by biochores. Biochore is defined as a climatic boundary marked by a change in vegetation type. A biochore type consists of a code providing information about a vegetative stage, about georelief and about soil substrate (Culek et. al. 2003). For this paper, the information about georelief type was used. Georelief of a biochore is defined as a georelief type (for example upland, highlands) which is delimited by geomorphological shapes (for example ridge, valley, hill) and eventually basic genetically homogenous surface areas (slope) (Culek et. al. 2003). For a better further interpretation of the resultant maps and data comparison with the transport and settlement infrastructure data a geographic database of the Czech Republic (ZABAGED®) was used particularly the data of significant objects, roads and buildings. As a result, overlay maps and corresponding graphs were generated.

The defined area was taken over from the project "Green belts, the creation of conditions for the formation of areas of publically accessible greenery, analytical phase" (U24 2009) (Fig 1). In terms of geomorphology there are several types of georelief in this area, namely: the floodplain of the river Vltava and the valley of the side tributaries flowing into it, slashed plateaus and plains surrounding the city, uplands, highlands and slopes in the southern part of the area, sporadically also ridges.

## RESULTS

The evaluation was accomplished on the basis of CORINE data, available for the whole Europe and the relief data according to the type of biochore available for the Czech Republic.

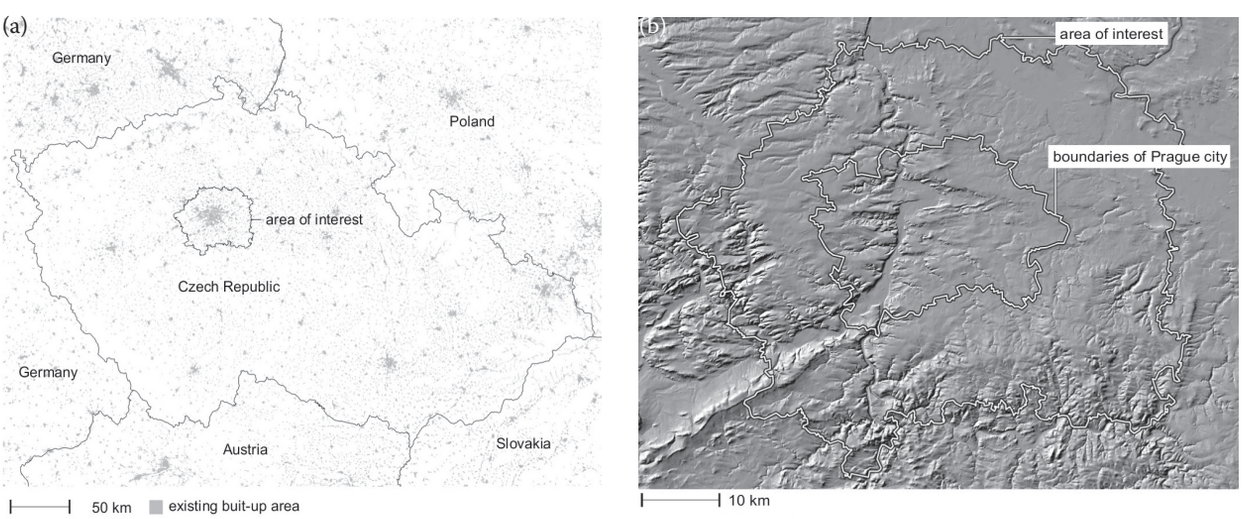


Fig. 1. Area of interest (a) and relief of the area of interest (b)

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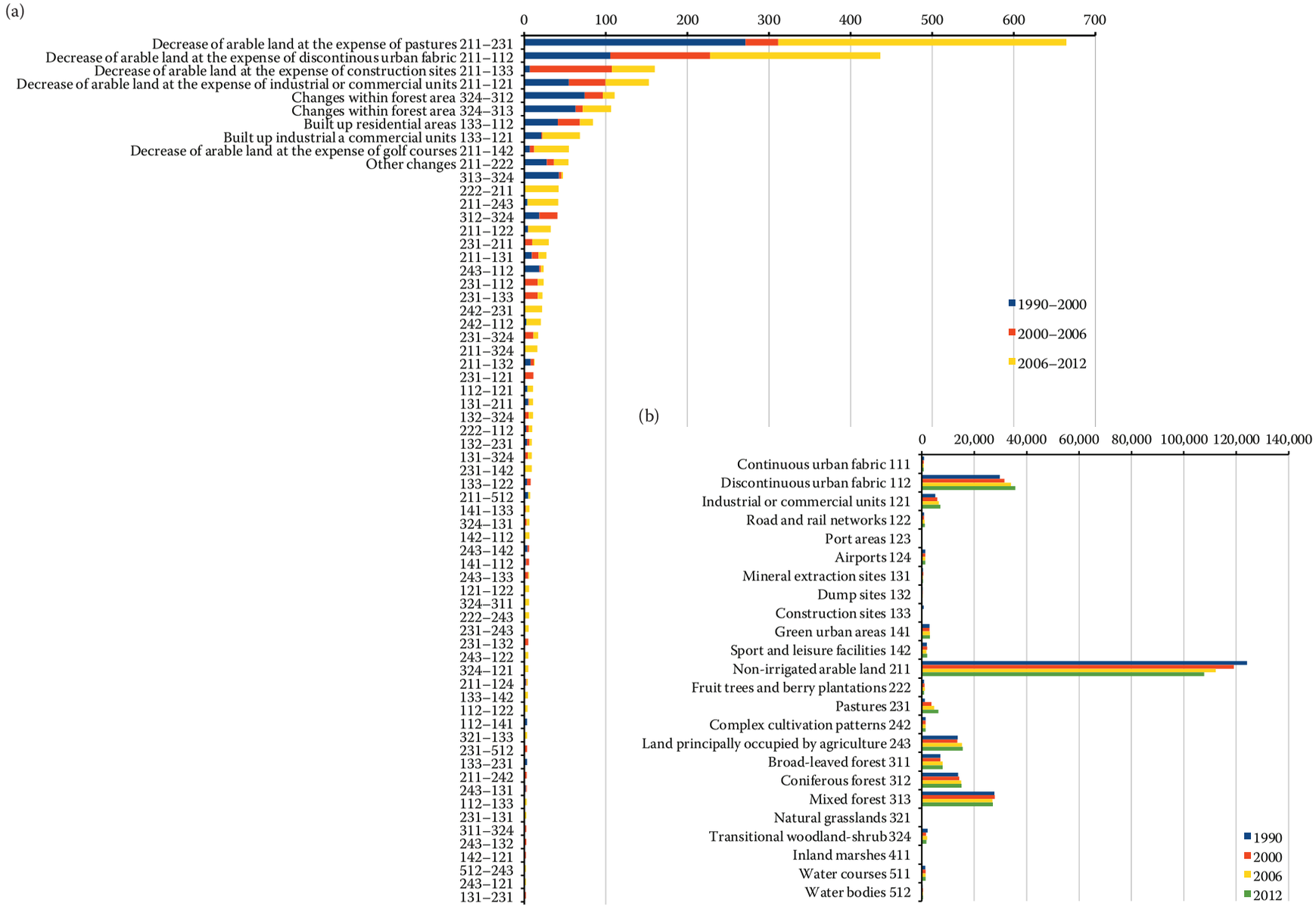


Fig. 2. Dominant changes of land cover from 1990 to 2012 according to CLCC (ha/year) (a) and state of land cover from 1990 to 2012 according to CLC (ha) (b)

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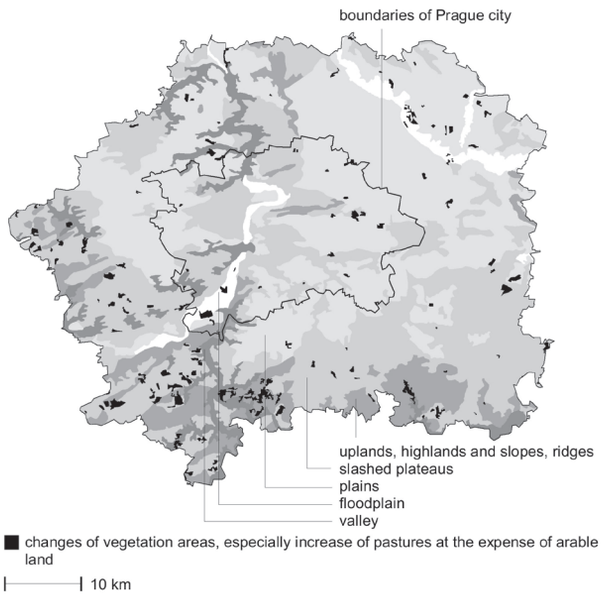


Fig. 3. Changes of vegetation areas, especially increase of pastures at the expense of arable land

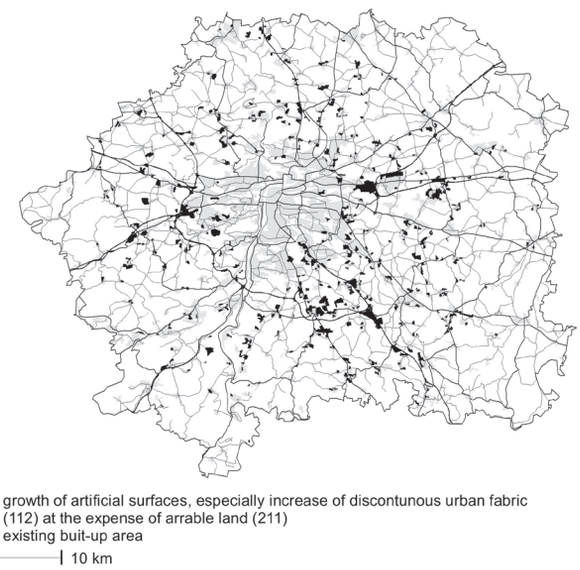


Fig. 5. Increase of artificial land relating to transport and settlement infrastructure from 1990 to 2012

The most significant changes and their acreage during the individual years are captured in the chart (Fig. 2a). Within the changes of land cover the decrease of arable land (211) expressly dominates (Fig. 2). The decrease of arable land is caused by its conversion to artificial land situated on the plateaus close to the city. Further, it is caused by the conversion of arable land to pastures in the more distant areas from the city situated on the more complex shapes of the relief. The following detected changes are not so distinctive as far as the size is concerned. A decrease of arable land at the expense of sport and leisure activities (211–142) can be also mentioned, which increased broadly during 2006–2012. In CORINE nomenclature it means sports grounds, leisure parks, golf courses, racecourses etc. (EEA 1995). In the case of study area there are mainly golf courses. To simplify the map reading, all the changes on the map were divided to reversible

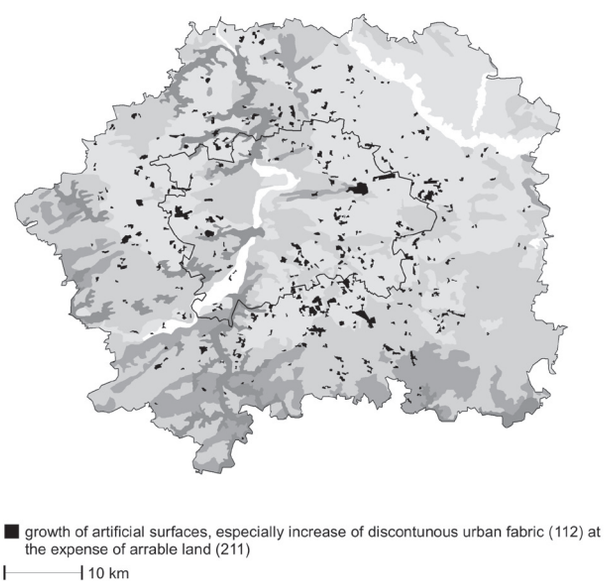


Fig. 4. Growth of artificial surfaces, especially increase of discontinuous urban fabric (112) and the expense of arable land (211)

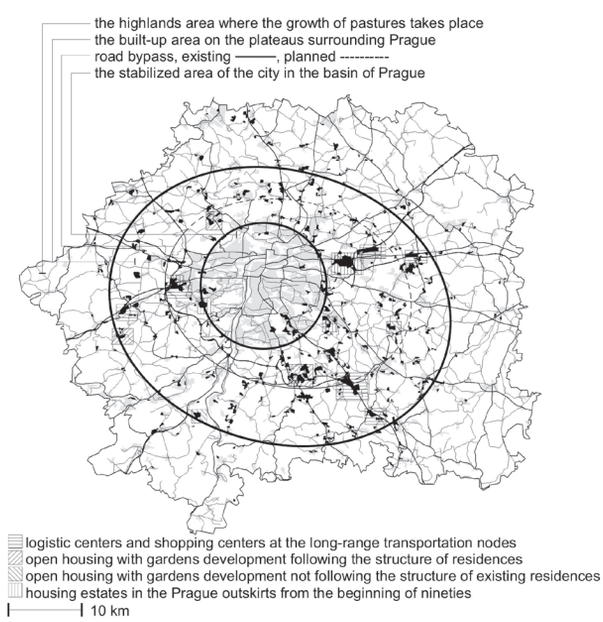


Fig. 6. Types of urban changes and zones of change

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and irreversible (Figs 3–6). The reversible changes are the changes within the vegetation areas. The irreversible changes dwell in the conversion of vegetation areas to artificial surfaces. The results showed that the conversion speed of the arable land to artificial land increased. While during 1990–2000 discontinuous urban fabric (112) increased at the expense of arable land (211) about 105 ha a year, during 2000–2006 it was 122 ha a year and during 2006–2012 it was 209 ha a year (Fig. 2a). From 1990 to 2000 the acreage of the artificial land was distinctly influenced by the final stage of the housing estates at the edge of the city on the urban fringe. Within artificial land two classes dominate, namely discontinuous urban fabric (112), which means units consisting of block of flats, individual houses, gardens, streets and parks, and industrial or commercial units (121), and eventually the third class – construction sites (133). In terms of spatial context it is possible to trace by the newly originating artificial land: the relationship to the city, the relationship to urban structure of the surrounding municipalities and the relationship to transport infrastructure. In this respect and within the observed area and given period, the following types of newly developing areas were determined: housing estates in the Prague outskirts from the beginning of ninety-nineties, open housing with gardens development following the structure of residences surrounding Prague, open housing with gardens development not following the structure of existing residences, logistic centres and shopping centres at the long-range transportation nodes (Fig. 6). Further, the study searched for a relationship of land cover to the distance from the city, to the transport and settlement infrastructure and to relief within the observed area. Results show that the increase of pastures occurred in the peripheral parts of the observed area where the relief is more complex. However, there was a significant increase of artificial land on the plateaus surrounding the city. On these plateaus, there was a relatively dense settlement and transport infrastructure. Therefore, it is obvious that the proximity of the city and the dense transport and settlement infrastructure on a flat terrain generate suitable conditions for an easy urban development at the expense of arable land and agriculture.

## DISCUSSION

The results show that within the studied area there is a similar trend to that observed elsewhere in Europe. This trend includes the decline of agricultural activity, increase in urban sprawl, increase in the development of roads and the pressure from leisure activities (Feranec et al. 2000; Jongman 2002; Van Eetvelde, Antrop 2004). The results confirm also the trend of the increase of pastures in the Czech Republic. This growth of pasture areas is specific to the area with a relief of higher altitude in the observed area (EEA 2013). The growth of pasture could be explained by the political situation after 1989, the grant policy and poor resolution of the CLCC data. After 1989, the land was returned to the original owners. Some land was left uncultivated and therefore was changed by succession to the spontaneous vegetation (Pavlů, Hejcman 2003). Also grants for pasture renovation have a large impact on the grassland area (Mládek et al. 2006). CLCC data generate some inaccuracies, because it is not able to distinguish between arable and pasture land. Therefore it is highly important to use integrating multitemporal satellite data (Banko et al. 2004).

On the basis of the submitted results it is possible to define zone changes and to trace how they develop. Three essential zones can be determined in the observed area, namely: the stabilized area of the city in the basin of Prague, the developed area on the plateaus surrounding Prague and the highlands area where the growth of pastures takes place (Fig. 6). The summary of the given zones and their relationships can be described as a dynamic pattern of landscape changes of a given area. Regarding the large range of the developed areas on the plateaus surrounding the city, it can be concluded that in this very area, and primarily at places of its contact with the city, the land cover changes the most. Especially this kind of flat landscape requires consistent planning tools (Munroe et al. 2005).

CLCC data were used, because they are easily accessible and it is in one form for the whole Europe. It shows the land use from 1990 until 2012. However, it is essential to realize the weakness of CLCC data, which is the low resolution. It is necessary to constantly remember these weaknesses while interpreting the results of analyses.

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