LANDSCAPE CHANGES IN PROTECTED LANDSCAPE AREAS AND THEIR SURROUNDINGS

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Abstract

This paper focuses on landscape changes in selected Protected Landscape Areas (PLAs). We analyzed the period from the 1950s to 2020 using four time milestones (1950s, 1990, 2004, and 2020) within the selected PLAs and their 3 km buffers (both as a whole and within 1 km zones) to reveal differences in land-use change between these areas. Changes in arable land, permanent grassland, built-up areas, and buildable areas were evaluated. Across ten study areas—(1) Beskydy + Bílé Karpaty; (2) Blanský les + Šumava PLA and National park (NP); (3) Blaník; (4) Brdy; (5) Litovelské Pomoraví; (6) Moravský kras; (7) Poodří; (8) Pálava + Soutok; (9) Třeboňsko; and (10) Český les—arable land and built-up areas were significantly less represented within PLAs than in the surrounding buffers throughout the study period. In contrast, forest cover was more prevalent within PLAs. Moreover, buildable areas were more frequently located in the buffer zones, similarly to built-up areas, particularly within the closest 1 km buffer from the PLA boundaries. Although the trends in land-use change were similar across PLAs and buffers, the proportional shares differed significantly. The results indicate that landscape connectivity and ecological functioning beyond protected area boundaries may be threatened by differing land-use approaches.

Keywords: protected landscape areas, Czechia, surroundings, landscape changes

INTRODUCTION

In previous studies, we analyzed land cover changes and anthropogenic pressure within large-scale protected areas (e.g., Janík *et al.*, 2024a; Janík *et al.*, 2024b). On the one hand, relatively natural land cover types, such as forests and permanent grasslands, have increased; on the other hand, built-up areas have also expanded. Protected areas (PAs) are not isolated islands within the landscape, and understanding how changes differ between PAs and their surroundings is crucial for overall landscape functioning.

Additionally, such analyses can reveal the capacity of PAs to positively influence their surroundings (Mingarro, Lobo, 2023) and, conversely, indicate whether connectivity between protected and non-protected areas is maintained (Kubacka *et al.*, 2022). Moreover, studies of Natura 2000 sites across Europe show that fragmentation within PAs is significantly correlated with fragmentation in their surroundings (Lawrence *et al.*, 2021).

Therefore, in this paper, we present preliminary results on landscape changes from the 1950s to the present within selected protected landscape areas (PLAs) and their 3 km surroundings. We compare selected land cover categories, as well as built-up and buildable areas.

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MATERIALS AND METHODS

We analyzed selected features for ten study areas, defined as individual PLAs or groups of PLAs located less than 3 km apart. This approach was chosen because the analysis focuses on changes within the PLAs and their 3 km buffers (considered both as a whole and as 1 km zones: 0–1 km, 1–2 km, and 2–3 km). The selected areas are:

1) Beskydy + Bílé Karpaty;
2) Blanský les + Šumava PLA and National park (NP);
3) Blaník;
4) Brdy;
5) Litovelské Pomoraví;
6) Moravský kras;
7) Poodří;
8) Pálava + Soutok;
9) Třeboňsko; and
10) Český les.

Data on arable land, permanent grassland, and forest were manually derived from topographic maps and aerial imagery using ArcGIS 10.x (ESRI). Four time periods were analyzed:

1) The 1950s represent the beginning of modern nature conservation in Czechia, as well as major changes in landscape structure caused by agricultural collectivization. This dataset was based on 1 : 25,000 Czechoslovak military maps from 1952–1956 (General Staff of the Czechoslovak Army, 1952–1956).
2) The 1990 dataset reflects a milestone in political, economic, and social transformation, when the fall of communism led to a transition from a planned economy to democracy and capitalism. This dataset was based on 1 : 25,000 Czechoslovak military maps from 1988–1995 (General Staff of the Czechoslovak Army, 1988–1995).
3) The 2004 dataset represents EU accession and associated changes in agricultural policy and the transposition of EU legislation into national law. Land cover data were vectorized from a 1 : 10,000 base map (Czech Office for Surveying, Mapping and Cadastre, 2002–2006) and aerial imagery with a pixel size of 0.5 m (Czech Office for Surveying, Mapping and Cadastre, 2003–2005).
4) The contemporary dataset (2016–2020) is based on aerial imagery with a pixel size of 0.2 m (Czech Office for Surveying, Mapping and Cadastre, 2016–2020) and is supported by LPIS (Land Parcel Information System; Ministry of Agriculture, 2016–2020). Land use data were captured as polygons larger than 0.8 ha and wider than 40 m. This ensured a consistent level of generalization across sources of different spatial scales (1 : 10,000 to 1 : 25,000 topographic maps and aerial imagery with pixel sizes ranging from 0.5 m to 0.2 m). Given the varying level of detail among the input data, nine land cover categories were defined to ensure comparability (see Janík *et al.*, 2024a).

Polygon data for built-up areas were vectorized in greater detail than the land use categories, with a minimum mapping unit of 0.2 ha. These data were analyzed for four comparable time periods:

1) The 1960 dataset was derived from a 1 : 10,000 topographic map (Central Administration of Geodesy and Cartography, 1957–1971) and aerial imagery from the 1950s.
2) The 1990 dataset was vectorized from a 1 : 10,000 base map (Central Administration of Geodesy and Cartography, 1986–1995).
3) The 2004 dataset is based on a 1 : 10,000 base map (Czech Office for Surveying, Mapping and Cadastre, 2002–2006) and aerial imagery with a pixel size of 0.5 m (Czech Office for Surveying, Mapping and Cadastre, 2003–2005).
4) The 2016–2020 dataset represents the current situation and was obtained and refined from ZABAGED® and aerial imagery with a pixel size of 0.2 m (Czech Office for Surveying, Mapping and Cadastre, 2016–2020).

Buildable areas were extracted from current municipal spatial planning documents.

RESULTS

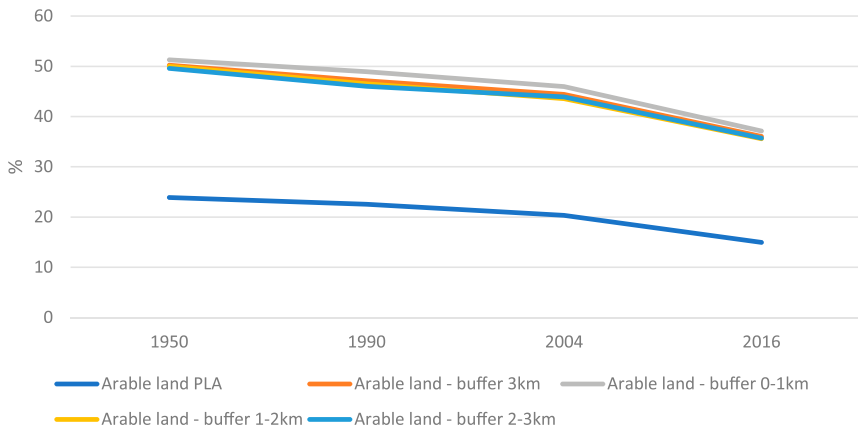
The results clearly show differences in land use between PLAs and their surrounding buffers during the study period, while trends in changes are similar across the entire study area. The average share of arable land is substantially lower within PLAs than in the surrounding areas, including both the entire buffer and the individual 1 km zones, with no significant differences among the buffer zones (Fig. 1). In contrast, forest is much more strongly represented within PLAs; its lowest share occurs within the first kilometer from the PLA boundary and increases with distance (Fig. 2).

Permanent grassland decreased in both PLAs and buffer zones between the 1950s and the 1990s, with a more pronounced decline in the buffer; subsequently, it increased again, more strongly in the buffer than within PLAs (Fig. 3). Built-up areas increased both within PLAs and in the buffer, but they are considerably more prevalent in the buffer, with the highest share occurring within the first kilometer from the PLA boundary (Fig. 4). This pattern is even more pronounced for buildable areas, which also reach their highest share within the first kilometer from the PLA boundary (Fig. 5).

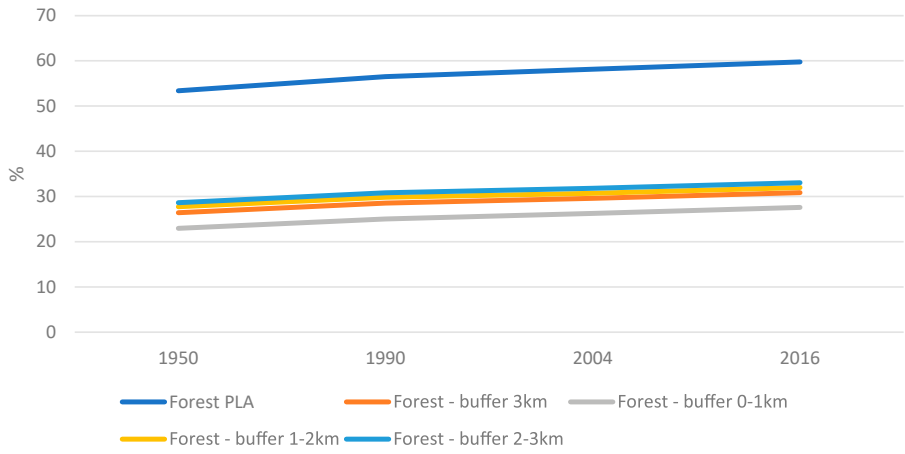
Differences are also evident among individual PLAs. For example, Blaník PLA shows a similar land use structure and development trends to its surroundings. In contrast, Brdy and Český les PLAs differ markedly from their buffers, as they represent relatively stable, forest-dominated areas surrounded by landscapes that have undergone more intensive agricultural and residential change. Even buildable areas, which may be used for future development, are much more prominent in the buffer zones.

DISCUSSION

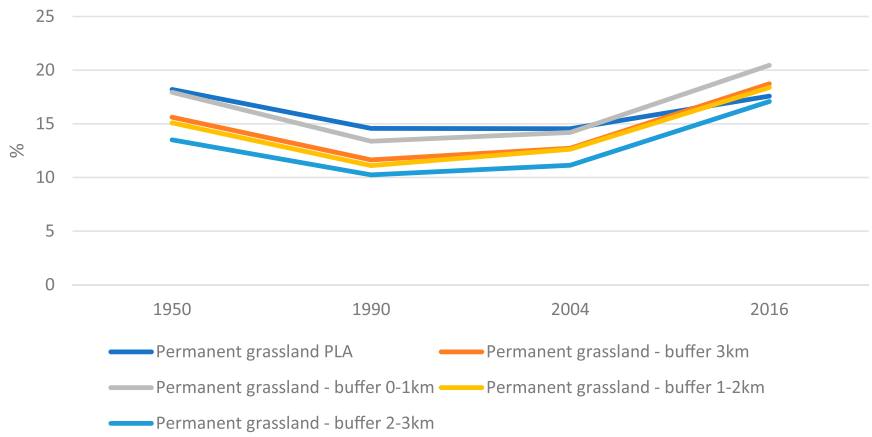
Our preliminary findings can be discussed in relation to earlier studies that also examined landscape change in PAs together with their surrounding buffer zones, including analyses of European NPs (Kubacka *et al.*, 2022; Mingarro, Lobo, 2023). At this stage, the results are based on descriptive assessment only, as the dataset is still being completed for all large-scale protected areas. Once the full dataset is compiled, we plan to apply additional landscape metrics and statistical methods to evaluate the spatial patterns and drivers of landscape change in greater detail. Nevertheless, the current results already indicate several important trends. Similar to Kubacka *et al.* (2022), the zone within 1 km of PLAs boundaries appears to be the most affected by artificial and built-up land cover. However, this effect varies considerably among individual protected landscape areas, and in some cases the contrast in land



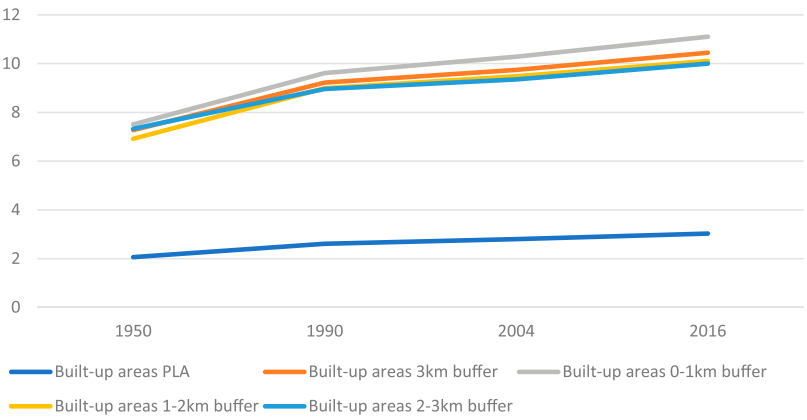
1: *Average share of arable land within PLAs and their buffer zones during the study period*



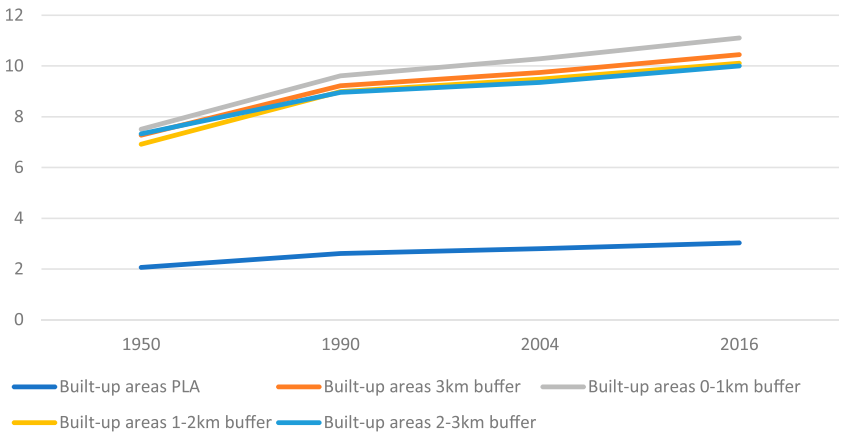
2: *Average share of forest within PLAs and their buffer zones during the study period*



3: *Average share of permanent grassland within PLAs and their buffer zones during the study period*



4: *Average share of built-up areas within PLAs and their buffer zones during the study period*



5: *Average share of buildable areas within PLAs and their buffer zones during the study period*

cover across protected area boundaries is very pronounced. Unlike the pattern described for European NPs, our results do not suggest that protected areas in Czechia effectively buffer their immediate surroundings from land cover changes driven by human activities (Mingarro, Lobo, 2023). In this respect, the observed pattern also differs from that reported for Natura 2000 sites, where fragmentation within protected sites was found to be more closely related to fragmentation in surrounding landscapes (Lawrence *et al*., 2021). Instead, our study areas show a relatively strong contrast between PAs and their buffers. Such sharp boundary effects have also been reported from protected areas in Africa, where rapid growth of urbanization and agriculture has intensified human pressure near PAs borders (Bailey *et al*., 2016). In the case of Czech protected landscape areas, although anthropogenic pressure has increased within the protected areas themselves, it remains substantially higher in their surroundings (Janík *et al*., 2024b).

CONCLUSION

Preliminary results show similar trends but different proportions of key land-use categories and varying potential for further development of built-up areas within PLAs and their buffer zones. This highlights the need to integrate landscape planning both within and outside PLAs to ensure the ecological functioning of valuable core areas and to maintain connectivity beyond PLA boundaries (and between them).

In future work, we aim to complete the dataset for all large-scale protected areas in Czechia and to analyze them comprehensively, also taking into account the year of their designation.

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