

Changes of the forest spatial pattern in the northern Carpathians in the 20th century

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In the northern Carpathians, as in many European mountains, forest area has been increasing throughout the 20th century, especially after the World War II. Main causes of the forest expansion in the northern Carpathians were post-war re-settlement actions or social and economical changes affecting rural areas in the region, like industrialization programme in the communist countries, slow decline of the importance of agriculture and the decrease of population active in agriculture (Kozak et al., 2007).

Changes in forest cover impact and modify forest spatial pattern, in particular forest fragmentation. The latter has several effects on biodiversity (Kupfer, 2006): sample effects (habitat loss), area effects (reduction of forest area and number of patches), isolation effects (distance and connectivity of forest patches) and edge effects (creation of forest edges). The aim of this study was to quantify changes of forest spatial pattern between 1930s and the end of the 20th century in the northern Carpathians at a fine scale (28.5 m spatial resolution). Possible implications for biodiversity in the region were discussed.

The study was carried out in seven case study areas, approximately 1000 km² each, sampled along the main Carpathian ridge from west to east, in Poland, Czech Republic, Slovakia and Ukraine. Binary raster forest maps with two classes (forest and non-forest) were used. The maps were derived from Polish topographical maps for the 1930s, and from Landsat imagery for the end of the 20th century (Kozak et al., 2007). Forest spatial pattern was quantified for the beginning and the end of the studied period using three indices (see also Estreguil et al., 2007; Estreguil et al., in prep.; Vogt et al., 2007 for a discussion of forest spatial pattern classes nomenclature):

[1] ratio of “non-core” forest area to “core” forest area (NCC), to assess “core” forest dominance and frequency of edge effects; “core” forest is any forest located further than a specified distance from the forest boundary (in this study 57 m, that is 2 pixels), and “non-core” forest is all other forest where edge effects occur; increase of NCC is related to the increase of forest fragmentation;

[2] number of small forest patches in the non-forested area (FP), to address external forest fragmentation; “small” refers to any patch in which “core” is absent;

[3] number of small non-forest patches in the forested area (NFP), to address forest perforation (internal fragmentation); “small” is defined as in [2].

Forest cover changes between 1930s and the end of the 20th century induced significant changes of the forest spatial pattern in the studied area. NCC decreased clearly in most case study areas (fig. 1), except where forest cover was relatively high already in the 1930s and stable in the studied period (case study areas 6&7, fig. 1). FP and NFP were frequently increasing (fig. 2, case study areas 2&6) except case study areas where significant forest cover increase in the 20th century was noted (case study area 4, fig. 2).

In areas where forest expansion was relatively slow, NCC, FP and NFP proved a relatively stable or increasing forest fragmentation. In at least two case study areas (3&4, fig. 1) the rate of change of NCC and related reduction of FP and NFP (fig. 2) prove a significant decrease of forest fragmentation (both external and internal) in several Carpathian regions in the 20th century. In particular, small-size land cover patches (forest or non-forest) were disappearing there from the landscape. This change was most pronounced in areas of significant forest expansion related to the post-war forced re-settlement and depopulation (Kozak et al., 2007).

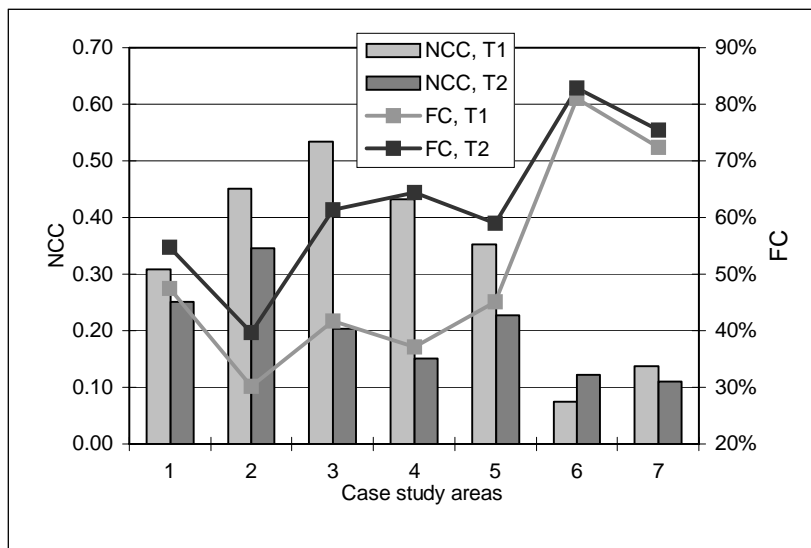


Figure 1: Forest non-core to core ratio (NCC) and forest cover (FC) in the 1930s (T1) and at the end of the 20th century (T2) in case study areas

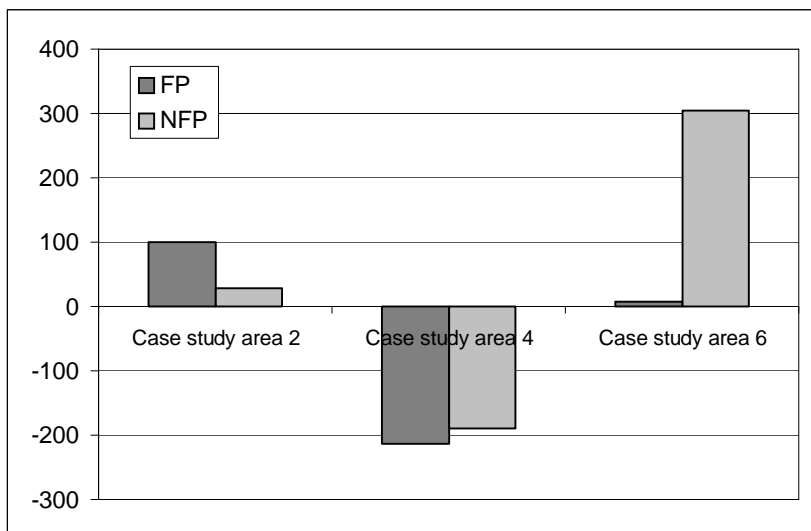


Figure 2: Changes in numbers of forest patches (FP) and non-forest patches (NFP) between the 1930s and the end of the 20th century, for three case study areas

As a consequence, a decrease of heterogeneity of forested landscapes throughout the 20th century in several regions of the northern Carpathians can be concluded. Due to the transformation of rural areas and high rates of recent land abandonment in the region (Kuemmerle et al., submitted) forest cover will likely increase in near future. The continuing trend of forest cover increase may thus result in higher naturalness in the region, favouring in particular interior forest species, e.g. large mammals. However, a potential negative consequence of land abandonment and forest expansion in the region is a loss of cultural landscapes and threats for biodiversity related to mosaic-type land use patterns.

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