SPATIAL ANALYSIS FOR ENVIRONMENTAL MAPPING OF ŠUMAVA NATIONAL PARK

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INTRODUCTION

The study area is Šumava National Park (ŠNP), the largest of the four national parks (68,064 hectares) located in the south-west of Czech Republic, on the border with Germany. Since 1990 it has been the protected Biospherical Reserve of UNESCO (Bilek et al. 1990). Being a unique mosaic of natural and secondary habitats of exceptional natural value of European-wide significance, the components of the ŠNP represent is the largest terrestrial significant part of the Natura 2000 network in Czech Republic and Germany. For instance, the fauna species of ŠNP include protected important examples, such as e.g. lynx, otter and peregrine (Bláha et al. 2013). The ŠNP is established as a special regime of environmental protection with unique biological communities that are the most precious objects of protection.

The area is represented by the vast wooded areas, mountain spruce and mixed forests of various ages, peat bogs, meadows biotops, moors and lakes. Altogether, they create a unique mosaic of biotopes, which encompass a variety of rare, endemic and endangered species, e.g. lynx, pearl mussel, owls, songbirds, etc (Jolecek et al. 1994; Semotanova 1998.). Geobotanically, the ŠNP belongs to the Bohemian Forest, which is split into two national parks, located in Czech Republic and in the adjacent Germany. It forms a unique protected forested area in Central Europe and one of the largest forested areas between the Atlantic Ocean and the Ural (Křenová and Hruska 2012). Geomorphologically, it covers Šumava plains, uplands Železnorudsko, Boubínská, Želnavskou, the Šumava mountains and Vltava furrow (Barešová & Hanusová 2010; Chabera 1998). However, some parts of the ŠNP experienced changes in the landscapes due to both natural climate changes and human impacts which is demonstrated in the undertaken modifications of the environmental zoning of the territory. Thus, since 1991 via 1995 and up to now, the zonation of ŠNP undergone changes, which resulted in the significant (almost double) decrease of Zone I (strictly conserved), slight increase of Zone II and increase of Zone III as well (Křenová and Hruska 2012). Some parts of ŠNP were previously deforested and used for agriculture since the last decades (mainly, from the middle of 20th century). Most of the fields and meadow areas have been abandoned. At the same time, many species are threatened by land-use changes (Bucharová et al. 2012). Other anthropogenic activities in Šumava area include treatments of mountain meadows and soils regularly practiced in the ŠNP: mowing, mulching and leaving fallow. The effects of such treatments includes significantly affected plant species diversity, shifts of dominance among certain species, decrease of the species richness (Maskova et al. 2009). Other triggers of ecosystems changes and ecological community dynamics include multi-year variation of climatic parameters and natural vegetation succession. For example, climate change increases the extinction probability of very small populations (Bucharová et al. 2012). As a result, the vegetation within the mountain ecosystems is gradually changing and degrading due both to anthropogenic effects and natural impacts. At the same time, the character of the rural landscape, strongly influenced by agricultural activity should be maintained in view of decreasing agricultural production. This question of environmentally sustainable management is highly important in the area of Šumava mountains (Cudlinová et al. 1999).

METHODS

The research aim was to analyse how the ecosystem landscapes located within the study area changed since 1991 until 2009 (18-year time span) using remote sensing data and GIS. The data include GIS layers in two forms: raster layers as Landsat TM images with 18-years interval (1991 and 2009), and vector thematic layers in ArcGIS shape-file format. The data were stored in a GIS project. Technically, the GIS project were generated in Quantum GIS (QGIS) software. Methodologically, the applied workflow used in this research included following steps: 1) Data capture, unpacking and storage. 2) Organizing GIS project. 3) Geo-referencing and re-projection. 4) Activating GDAL and GRASS remote sensing plugins. 5) Preliminary data processing. 6) Generating contour layers from DEM. 7) Colour composition from 3 Landsat TM bands. 8) Defining Region of Interest: raster mosaicing and clipping. 9) False colour composites (bands 4-3-2). 10)

Setting up parameters for classification. 11) Image classification using K-Means algorithm. 12) Pattern recognition. 13) Spatial analysis. The detailed illustrations of these steps are shown in the proposed presentation. The GIS analysis is used to test the importance of the natural and human-induced land used changes for survival of the important floristic locations in several case studies. Thus, landscape level predictors of commons (their location, size, borders) are evaluated using geospatial data: vector GIS layers and aerial images. The information received from these data includes digital model of the terrain (altitudes), vertical heterogeneity, slope, topographical related moisture index, heat load index and solar radiation index. The information on local geology and soil conditions (based on soil profiles), history of the colonization of the study area, and borders of land cadasters and private properties is taken from the auxiliary data. The land cover structure is calculated using Patch Analyst function embedded into the ArcGIS which is used to describe various aspects of landscape heterogeneity, habitat diversity and fragmentation.

RESULTS AND DISCUSSION

The outcomes are illustrated by two maps showing geographic distribution of land cover types within the study area in given time periods of 18-year time span. The results demonstrate visualization of the ecosystems in 1991 and 2009 showing dynamics of land cover types in the given time. The work demonstrated effective application of QGIS software combined with multi-source data (remote sensing and geoinformatics) for the purpose of environmental protection of precious areas of the Šumava National Park. The importance of the GIS and remote sensing (RS) data were successfully used for the environmental monitoring since 1970s (rapid development of Earth observation satellite systems and launch of the Landsat TM program). Therefore, the combination of remote sensing data and GIS tool for pattern recognition is proved to be effective tool for geo-botanical research, which is demonstrated in the current research.

CONCLUSIONS

The spatial analysis performed by means of QGIS in combination with remote sensing data (satellite images Landsat TM) for geobotanical studies. The spatio-temporal analysis was applied to raster images taken at 1991 and 2009. Built-in functions of the mathematical algorithms of QGIS enabled to process geospatial data and to derive information for geoecological modelling. The images classification was used to analyse changes in the ŠNP area that consist in different geobotanical land cover types. The results of spatial analysis demonstrated that structure, shape and configuration of landscapes in ŠNP changed since 1991.

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