# Land change modeler- a tool for prediction land changes in country (model area - cadastral area Báb)

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The characteristics of land cover have important impacts on climate, global biogeochemistry, and the abundance and composition of terrestrial species. The nature of the land surface - its roughness, albedo, and other properties affecting heat and water fluxes - modifies the basic patterns of ocean-driven atmospheric circulation and generate the regional and local intricacies of weather and climate. Different cover types have different ecosystem structures, community compositions, and biomass contents; they also take up and fix nutrients such as carbon and nitrogen at different rates, with important consequences for the distribution of these elements between soil, air, and water (Turner et al., 1993).

Land use reflects the importance of land as a key and finite resource for most human activities including agriculture, industry, forestry, energy production, settlement, recreation, and water catchment and storage. Land is a fundamental factor of production, and through much of the course of human history, it has been tightly coupled to economic growth (Richards, 1990). As a result, control over land and its use is often an object of intense human interactions. Human activities that make use of, and hence change or maintain, attributes of land cover are considered to be the proximate sources of change. They range from the initial conversion of natural forest into cropland to on-going grassland management (Schimel et al., 1991; Hobbs et al., 1991; Turner, 1989).

Global models of land-use and land-cover change are essential components of quantitative models of global environmental change (Muchová and Petrovič, 2010). Computer models permit the use of large quantities of social and environmental information needed for monitoring and projecting land transformations, linking data and theory through formal equations. They allow logical and internally consistent analysis of the relations between, and dynamics of, driving forces and land-cover change, providing the possibility of testing and calibrating these formulations through simulations of past and short-term future landuse/cover changes and comparison of the model results with observed changes. They allow us to examine the implications of current trends in driving forces and land transformations for future environmental changes, and can be used for sensitivity and policy "experiments" to examine the impacts of policy initiatives and economic and social reform pertinent to land use. Computer models, combined with Geographic Information Systems (GIS), provide the best possibility for integrating geographical and ecological units at various spatial scales of analysis. They also provide the potential to "fill in" holes where data are incomplete or unknown (Turner et al., 1993).

Computer model and geographic information system were used in the contribution for calculation land changes using ecological stability and for prediction of ecological changes in the year of 2025.

## Material and methods

Study area

The study focusses on one cadastral area in Slovakia: Báb with area of 2,009.09 ha (Fig. 1). Báb is located in Nitra region, Nitra district. Agricultural land covers 83.4% of Báb total area (arable land 76.4%), forests 6.9%, water bodies 2.2%, build-up areas 5.1% and other areas 2.5%. The territory belongs to a hilly area with the relief formed by medium to mildly steep slopes with significant manifestations of water erosion and floods. Báb belongs to a dry and warm climatic area with frequent droughts. It is a typical land of intensive agricultural use with top-quality soils and area with very low ecological stability.

Data acquisition

Transformed vector data to raster of ecological stability was used to obtain graphical information on ecological stability for study area. Raster grid was created from vector with size of 2 meters.

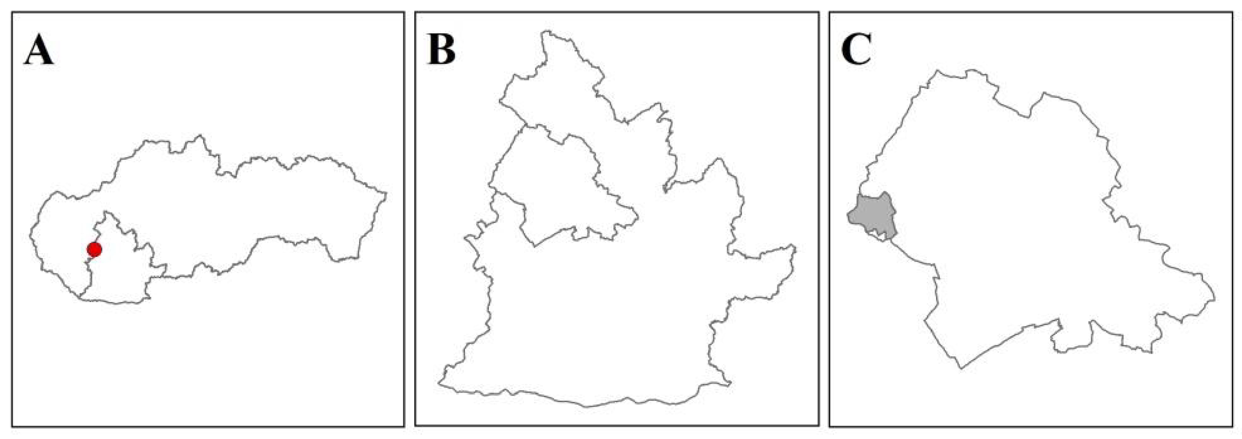


**Figure 1. Báb location in A) Slovakia and region, B) region and district, C) district and cadastral area**

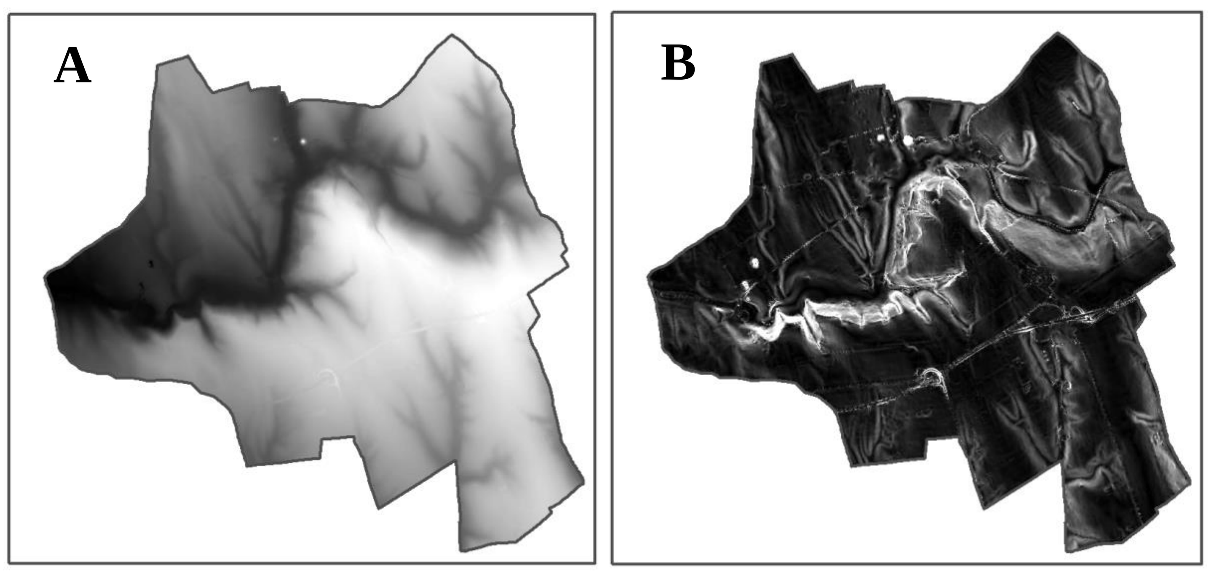


**Figure 2. A) digital elevation model, B) slope of the territory calculated from elevation model**

Vector data was prepared in previous research for two time horizons A) distant past land use from the year of 1860, B) present land use from the year of 2000 (Fig. 3a, 3b). In previous research was also prepared digital elevation model of the territory and slope of the territory calculated from elevation model (Fig. 2).

Land change modelling

The Land Change Modeler (LCM) software package was used for modelling of changes of ecological stability to derive the predicted future map in this contribution. LCM is a software extension for ArcGIS oriented to the pressing problem of accelerated land conversion and the very specific needs of biodiversity conservation. Tools for the assessment and prediction of land cover change and its implications are sequentially organized around major task areas--change analysis, change prediction, impact assessment for habitat and biodiversity, and planning interventions (Clark Labs, 2018).

## Results and discussion

In stage one, two land cover maps, with information about ecological stability, of different dates were specified (Fig. 4a and 4b). Area of gains and losses, net change, persistence and specific transitions both in map and graphical form were reviewed and evaluated in LCM. Using past land transition information and incorporating environmental variable maps, LCM created a GIS data layer expression of transition potential - the likelihood that a land use will transition in the future. Each transition is modelled with resulting in a potential map for each transition - an expression of time-specific potential for change. The environmental static variables as digital elevation model and slope of the territory were used in LCM. Variables can be tested to confirm whether or not they hold explanatory power for the transition. A soft prediction output was also provided which a continuous map of vulnerability to change for the selected set of transitions. The main stage involved modelling the potential change using maps of year 1860 and year 2000 to generate simulations of the ecological stability elements in the year 2025 (Fig. 3c).

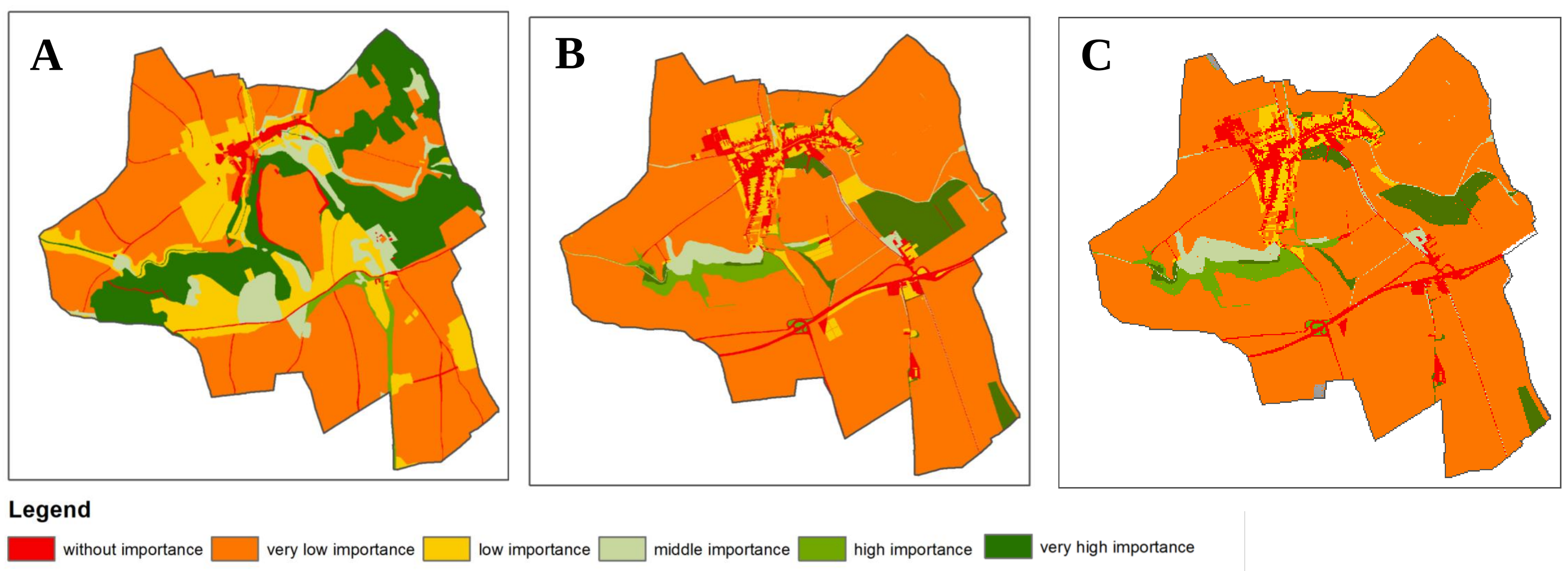


**Figure 3. Ecological stability for A) a year of 1860, B) a year of 2000, C) and prediction for a year of 2025**

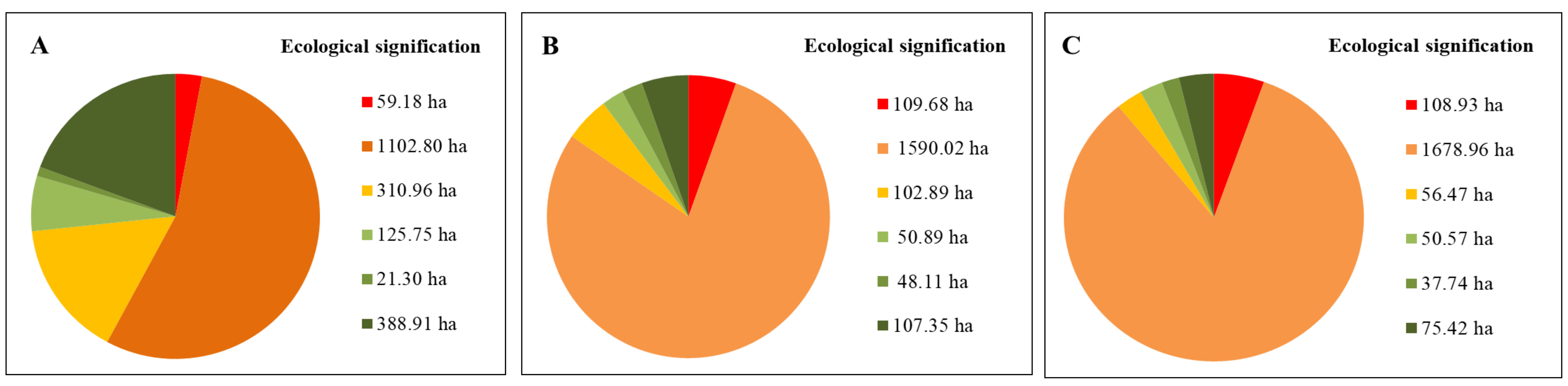


**Figure 4. Ecological signification of land use elements for A) a year of 1860, B) a year of 2000, C) and prediction for a year of 2025**

As we can see on the figure 3c and 4c, negative trend in landscape is confirmed. Elements of landscape which are included in the 5th degree of ecological stability, recorded the largest decline in simulated year of 2025. Elements included to this degree are the most important elements in country from ecological point of view, e.g. forests, water courses and areas, grass-herbal communities, etc. This simulation was conducted as initial work with LCM. To the future, we need to work with more variables; static or dynamic, we need to verify simulated data and need to use more stages for maps predictions.

## Conclusion

This study sought to simulate rapid agricultural expansion and decrescent green space using an integrated LCM. Overall, the result from this study suggests that the current trend in landscape has negative implications on green space structure in cadastral area Báb, Nitra region. Notably, the spatial effect of agricultural activities on rapid decrease of green are influenced by the historical spatial changes, implementation of the previous master planning efforts and uncontrolled agricultural policies. An integrated LCM model and spatial metrics might be an efficient model for simulating decrease of green. The models allow for a set of diagnostic tools to assess failure and successes in agricultural strategies. An analysis of future land use changes in the longer term is recommended to compare potential green space changes influenced by rapid agricultural expansion beyond the year 2025.

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