TRANSFORMATION OF THE SLOVAK CULTURAL LANDSCAPE SINCE THE 18TH CENT. AND ITS RECENT TRENDS

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ABSTRACT

The paper is focused on a long-term development of the selected Slovak cultural landscape types (plains, basins, uplands, highlands, and mountains) in approx. 200 years, which shaped the main land use features as well as on the recent transformation trends. The land use development analyses showed that from a long term view perspective several distinct periods can be distinguished. Each of these periods was characteristic for certain land use changes depending both on the landscape character or the socioeconomic situation. The recent trends as land use intensification (intense agriculture, sub-urbanisation, industrial construction) or land use extensification (agricultural land overgrowing) are considered to be common for the entire Slovak territory. Special transformation trends reflect more local conditions, human needs and preferences (construction of water reservoirs, wind calamities or tourism resorts) and though they are spatially isolated and small they influence the majority of Slovak inhabitants.

Key words: cultural landscape, land use, transformation trends, Slovak Republic

INTRODUCTION

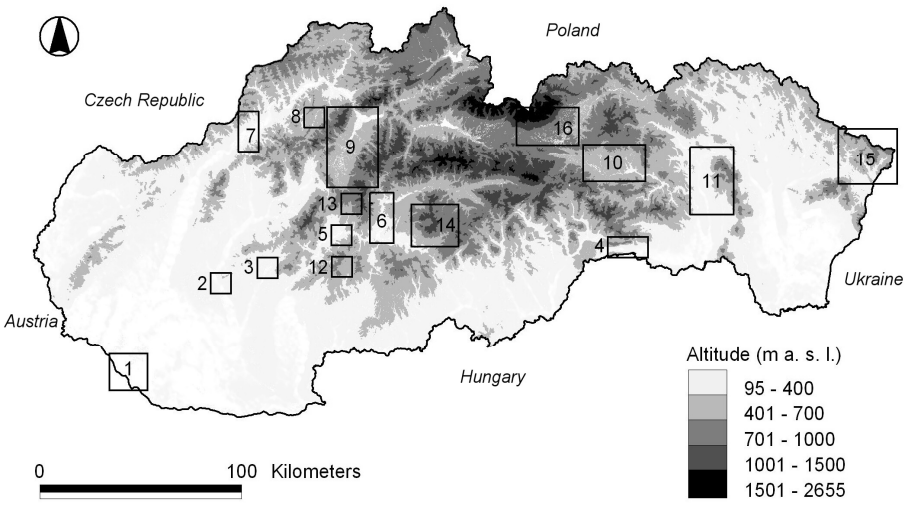
Modern approaches to land cover and land use changes focus on very recent time horizons using automated, semi-automated or manual interpretation of satellite images (EEA, 2007; Bontemps et al. 2009; Schneider et al. 2009) on various geographical coverage (from regional or continental to global). The main scope for such surveys is to provide the most updated information on spatial distribution of land related phenomena mainly for operational reasons and for future landscape forecasting. However cultural landscape development is a continuous long lasting process combining both natural conditions and human society needs. If we want to anticipate the future we have to know and understand the past. In the assessment of the cultural landscape development the complex mechanism that ruled the formation of the natural environment in remote geological eras can be skipped. The stabilisation of cultural, social and production relationships in our cultural landscape has been settled in the periods of several recent centuries. It was the transformation of feudal to the capitalist system in the 18th–19th centuries and from

the capitalist to socialist system and back to the free market democratic system in the 20th century that strongly changed the cultural landscape in Central Europe. Land use has undergone significant changes during that time. These changes were caused mostly by technological development, changed political and property situation. In the recent decades the main driving forces of land use change, especially in post-socialist countries, are the economic situation and social preferences. These drivers are often combined with unexpected natural disturbances that have occurred more frequently and strongly during last years.

Preserved historical geographical data sources (e.g. historical maps) combined with modern methods and tools (GIS, remote sensing) enable to identify the cultural landscape development of a certain territory relatively precisely. This method has been widely applied in the recent landscape ecological and geographical research (e.g. Füleky and Major 1993; Skanes and Bunce 1997; Bürgi 1999; Cousin 2001; Petit and Lambin 2002; Bender et al. 2005). In the Central European landscape ecological school the research is based on the common scientific background and availability of historical maps (e.g. Kolejka 1987; Oťahel et al. 1993; Žigrai and Drgoňa 1995; Lipský et al. 1999; Olah and Žigrai, 2004; Olah et al., 2006; Petrovič, 2005; Hronček, 2008).

The paper presents the main transformation trends of the Slovak cultural landscape as identified within study areas representing various landscape types (Fig. 1). These study areas represent both the main natural landscape types in Slovakia (from plains to high mountains) and the selected specific land use types (in connection with mining activities, dispersed rural settlements etc.) or land use transformation examples (urbanisation, amelioration, land abandonment, wind calamity etc.).

Fig. 1 : Study areas in the Slovak Republic:
1 – Podunajská Rovina plain, 2 – Podunajská (Nitrianska) Pahorkatina hill land, 3 – Podunajská (Žitavská) Pahorkatina hill land, 4 – Turnianska Kotlina basin, 5 – Žiarska Kotlina basin, 6 – Zvolenská Kotlina basin, 7 – Ilavská Kotlina basin, 8 – Rajecká Kotlina basin, 9 – Turčianska Kotlina basin, 10 – Hornádska Kotlina basin, 11 – Košická Kotlina basin, 12 – Štiavnické Vrchy Mts., 13 – Kremnické Vrchy Mts., 14 – Poľana Mt., 15 – Bukovské Vrchy Mts., 16 – Hight Tatras Mts. and Popradská Kotlina basin



METHODS

In the research the following historical maps and aerial photographs from the Slovak territory were used: mining maps showing the mining surroundings of towns (1720-1750, with various large to medium scales), 1st Austrian Ordnance Maps (1772-1784, 1:28 800), stable cadastre maps from the 19th century (1866-1888, 1:2 880), 2nd Austrian Ordnance Maps (1822-1853, 1:28 800), 3rd Austrian Ordnance Maps (1888-1900, 1:25 000), Military Topographic Maps (1952-1956, 1:25 000 – 1:50 000) and aerial photographs (1949) and ortho-photo maps (2003). All historical maps used in this study were georeferenced in GIS (ArcView 3.2 or ArcGIS 9.2) using affine transformation into the S-42 (Pulkovo) or the S-JTSK (Křovák) coordinate systems. Although the cartographic accuracy of historical maps varied (e. g. the RMS error in the 1st Ordnance Survey maps was 100-300 m in mountain regions) they still serve as an important and unique data source. Since the identified land use forms from different sources varied the final land use were unified into wider comparable categories: forests, shrubs (area covered with a mix of grasslands, trees and shrubs), non forest woody vegetation (solitaires, lines of trees and/or shrubs in open landscape), grasslands, permanent crops (vineyards, orchards), fields, built-up areas (residential, industrial, recreational), water, wetlands, rocks and in special landscapes also subalpine and alpine vegetation. In order to measure (calculate) the intensity of land use change each land use form was assigned an coefficient of intensity. Land use intensity coefficients enable to classify land use categories accordingly to their prevailing natural to artificial character. They express natural value of land use categories regarding to ecosystem dominant (plant) species and their structure (Olah et al. 2006): 1 – autochthonous species and structure (forest, natural water body, rocks and debris, alpine and subalpine vegetation or other natural ecosystems) 2 – autochthonous species but altered structure or size (transitional woodland/shrub, non forest woody vegetation), 3 – allochthonous species but natural structure (grasslands), 4 – allochthonous species and altered structure (arable land, permanent crops), 5 – no vegetation or no natural species, introduced species (built-up areas, open quarries). The intensity of land use change occurring between the studied time horizons was calculated as follows:

$$I = i_{2\text{-}1} + i_{3\text{-}2} + \ldots i_{m\text{-}n},$$

where: I – intensity of land use change, $i_{2\text{-}1}$ – the 2nd subtracts the 1st time horizon land use intensity coefficient.

The land use change intensity can be distinguished in relative and absolute. Relative intensity of land use refers to overall direction of land use changes. Positive numbers express land use intensification and negative numbers refer to land use extensification. Absolute intensity of land use change expresses the total amount of changes in land use regardless to their direction. This expression is useful to emphasize the least stable land use spots in the landscape.

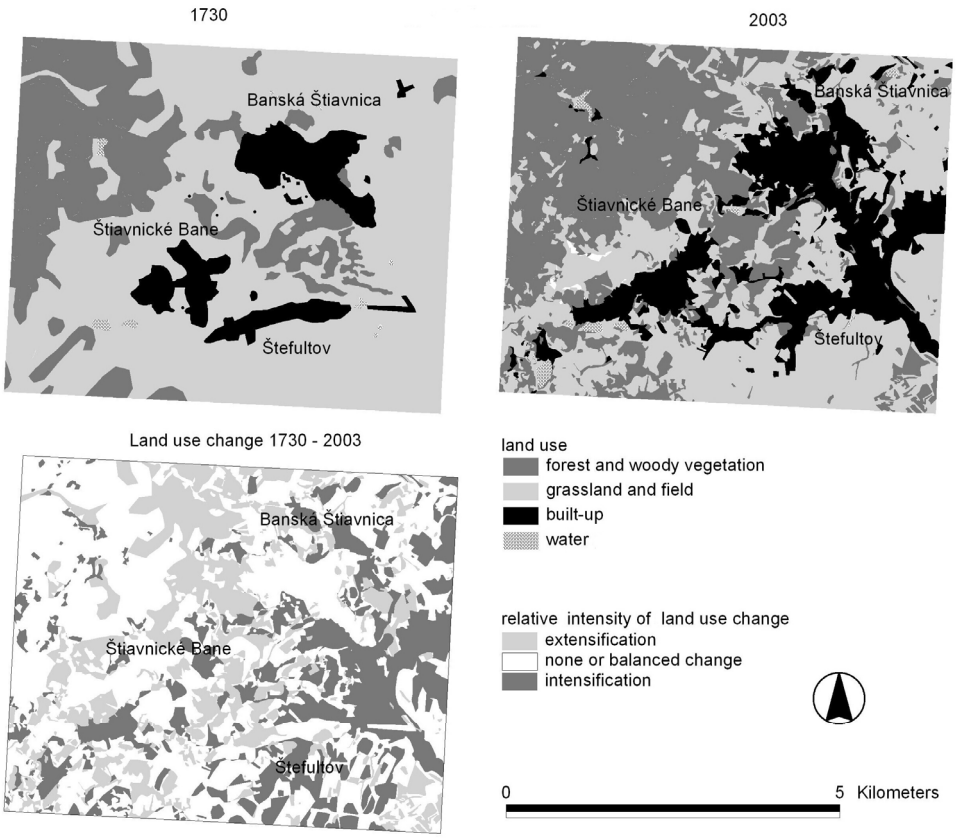
Transformation of the Slovak cultural landscape between the 18th and 20th century

The milestone of the Slovak cultural landscape formation is considered to be the Slavonic colonisation since the 6th century setting the basic distributions of settlements and agricultural land use mainly in lowlands and basins. Since the 11-13th century Christian monasteries, feudal castles with their tributary villages and merchant towns (especially free mining and royal towns) played a crucial role for the development of landscape. Later the Slovak territory also experienced 2 important non-Slavonic colonisations. The German colonisation began in the13th century in order to replace the inhabitants loss after the Tartar's invasion. The Wallachian colonisation took place in the period of the 15th-17th

century saturating the mountain and sub-mountain areas and introducing specific types of land use.

In the 18th century the cultural landscape of plains and basin valleys has already been stabilised for centuries. Relatively small towns and peasant villages, agricultural land and roads laid on the hilly parts of the landscape due to periodical floods occurring in the floodplain areas. The river and streams alluviums were left untouched (with the exception of the towns where the river banks were strengthened for safety reasons) or used as occasional pastures (Fig. 1 – study areas 1, 2, 3, 4). In the landscape of mining towns of central Slovakia this period already meant the decline of the medieval mining golden era (Fig. 1 – study areas 12 and 13, Fig. 2). The landscape was heavily deforested; its relief changed due to the surface mining, ore spoil dumps and the construction of mine and surface water management system. Sub-mountanous and mountanous landscapes faced the final phase of the late Wallachian (or mountain) colonisation leading to various kinds of dispersed rural settlement foundation such as Podpolianske lazy (Fig. 3), Myjavské kopanice, Novobanské štále or Oravské rale).

Fig. 2: Land use changes of the Banská Štiavnica's mining landscape in the Štiavnické Vrchy Mts. (study area 12)



Although the 19th century was the period of significant social, national and economic changes in the Austria-Hungarian Empire the historical maps from the middle of the century showed that the land use was very similar compared to the previous century. Urbanised areas slightly increased mainly in large towns and a new way of transport emerged – railways (e.g. Košicko-bohumínska railway). The mining towns' land use divided into two directions. The higher situated parts became forests again and the lower parts were urbanised mainly as new industrial or residential areas (Fig. 2). The land use of rural areas seemed to stay almost unchanged in all studied areas.

Fig. 3: Traditional settlements called 'lazy' and land use in the Podpoľanie region (study area 14)

The first half of the 20th century represented a relative stagnation of the land use development due to WW I, the global economic crisis in 1930s and WW II. However the urbanised areas have increased and even new towns, interconnected with a new industrial development, were founded (Baťovany – now Partizánske and Svit, Fig. 4, year 1988).

Since the 1950s cultural landscape has been characterized by a giant industrial and residential urbanisation (newly founded towns such as Žiar nad Hronom – Fig. 5, 6 or Nová Dubnica – Fig. 1 study area 7,) and an agricultural lands intensification especially in the plains and alluvial valleys. The exponential population growth was followed by a massive urbanisation, when smaller to medium towns increased their areas 2-3 times (Fig. 1, in the study areas: 3 – Zlaté Moravce, 7 – Dubnica nad Váhom, 8 – Rajec, 9 – Martin, 10 – Spišská Nová Ves), large cities even 4 times in the period of 1900-2000 (Fig. 1, in the study areas: 2 – Nitra, 6 – Zvolen and Banská Bystrica, 16 – Poprad, 11 – Prešov). The formerly naturally limited (wetlands) or barren areas have been ameliorated (rivers banks strengthening, drainage and irrigation mainly in the Podunajská Nížina and the Východoslovenská Nížina plains and alluvial valleys) to provide enough space for either a construction of a new urbanisation areas or transportation corridors or for collectivised intensive agriculture.

Fig. 4: Examples of deforestation in 1822 and urbanisation until 1988 and land use changes during the whole period under consideration 1772-2003 and the 2004 wind calamity area in the High Tatras National Park area (study area 16)

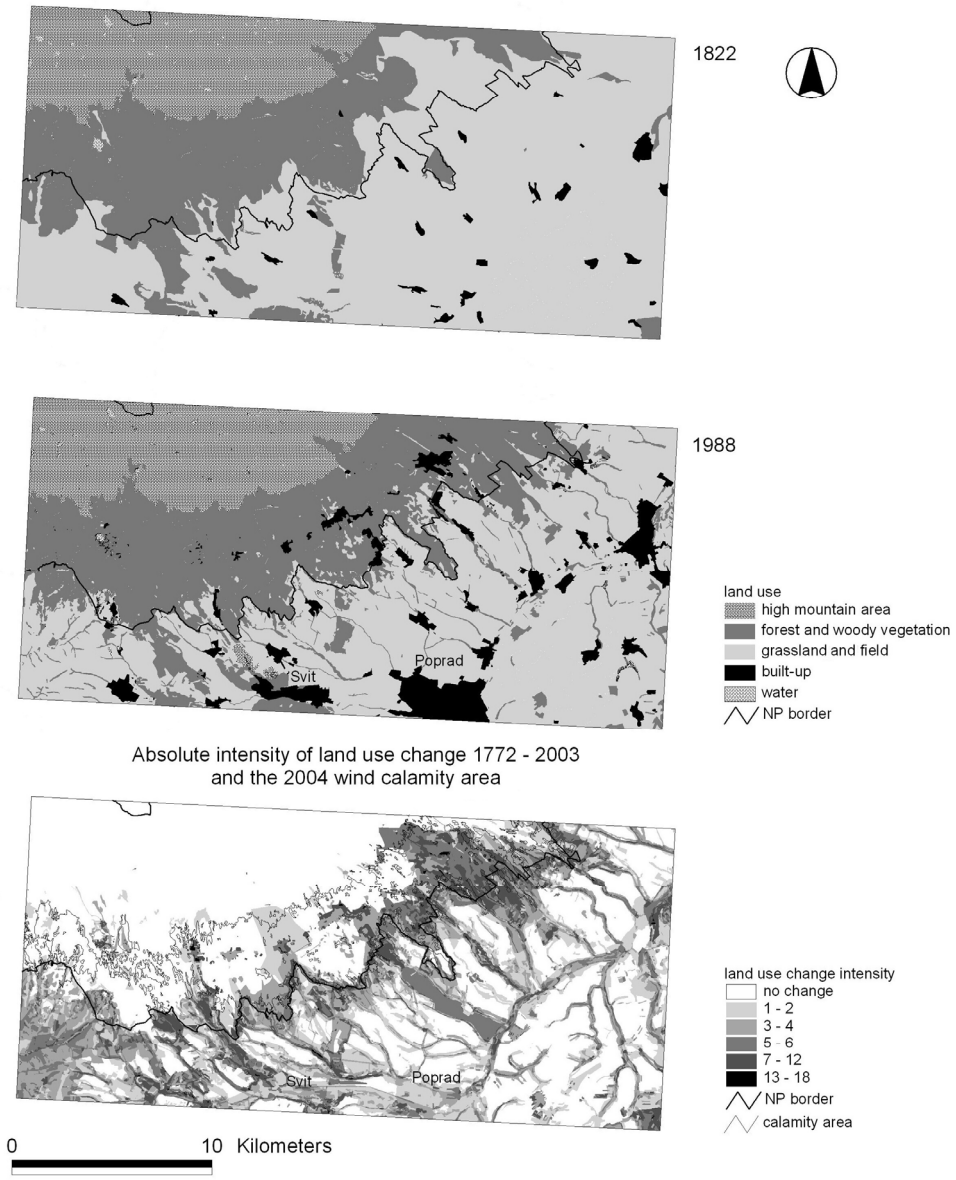


Fig. 5: Socialist urbanisation and industrialisation of the Žiar nad Hronom cadastre in the Žiarska Kotlina basin (study area 5)

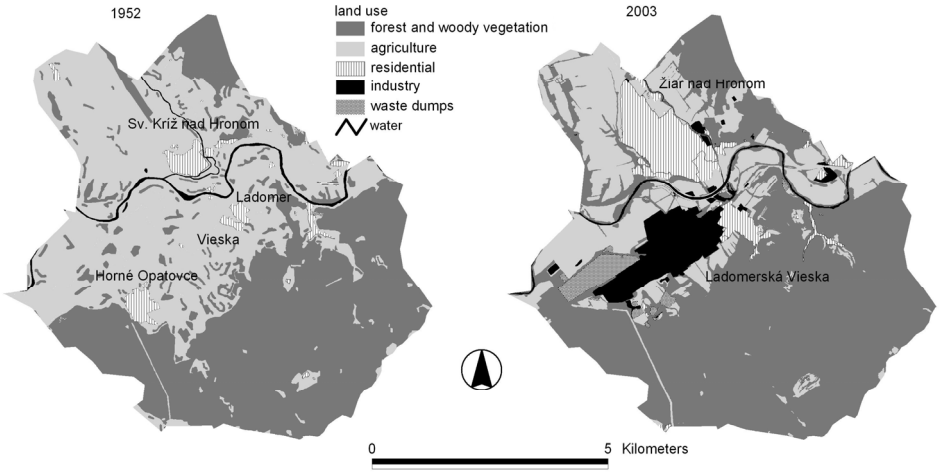


Fig. 6: Aluminium plant and the waste dump in Žiar nad Hronom in the Žiarska Kotlina basin (study area 5)

Fig. 7: Examples of the Turnianska Kotlina basin before wetlands amelioration (1853) and after it (2003) with increased urbanisation, and the land use stable areas for the whole studied period of 1784 – 2003 (study area 4)

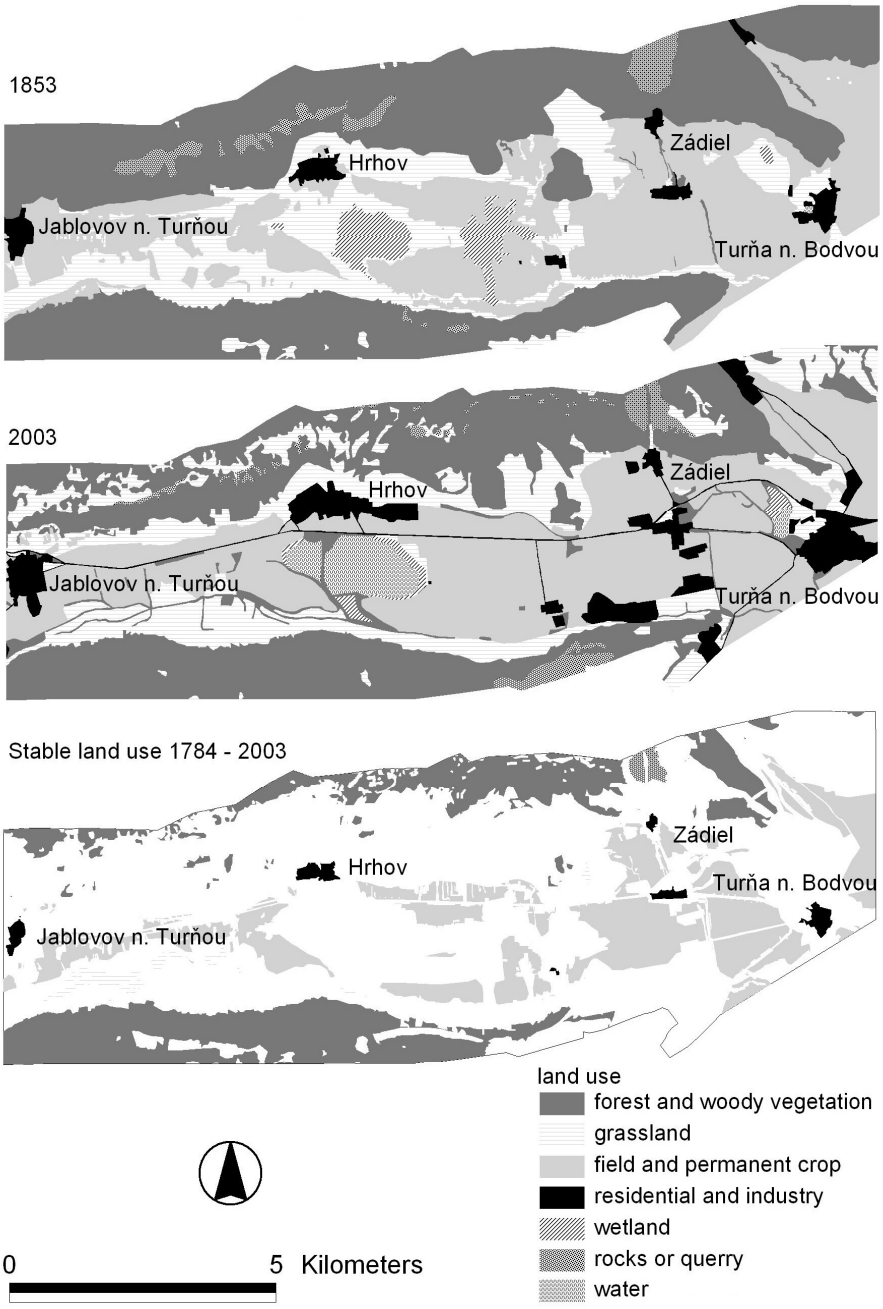
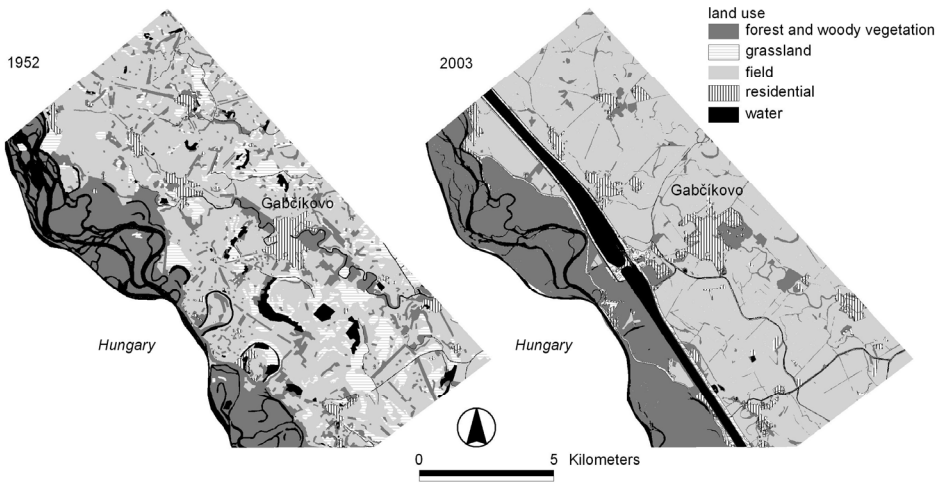


Fig. 8: Village Hrhov, the Hrhovské Rybníky ponds and a limestone quarry in the Turnianska Kotlina basin (study area 4)

For example, in the Turnianska Kotlina basin (Fig. 7 and 8), a small but an important international (gas and oil pipeline) and a national corridor (road, railway and electric lines), up to the 19th century the alluvium was occupied by large wetlands that were lately, in the 20th century, either turned into fish ponds or arable land (following ameliorations). The stable areas (without any land use change during the studied period of 219 years) remained only on locations that provided either the most preferable conditions for use (settlements or fields and permanent crops) or, on the other hand, strict limits (bare rocks or forests on steep slopes). The collectivisation of agricultural lands also led to a significant homogenisation of the landscape structure (e.g. in the Podunajská Nížina plain area it caused the 31% reduction of the total number of patches and the 45% increase in the mean patch size, Fig. 9, Fig., the study area 1) The landscape hydrological conditions were adjusted to the society water supply (construction of large water dams or drinking water reservoirs – VN Starina, Fig. 10), transportation and energy needs (river channels and hydroelectric (power) plants (e.g. Gabčíkovo – Fig. 9, or the Vážska Cascade). The end of the 20th century was the time for the society and economy transformation leading to a halt of the panel residential areas construction (almost in every larger town), industrial recession (mainly heavy industry) and land abandonment (especially mountainous and marginal areas).

Fig. 9: The changes in the Danube river system (study area 1 – Podunajská Rovina plain) and land use due to socialist collectivisation in 1950s and the Gabčíkovo hydroelectric plant construction and transport channel in 1990s (study area 1)



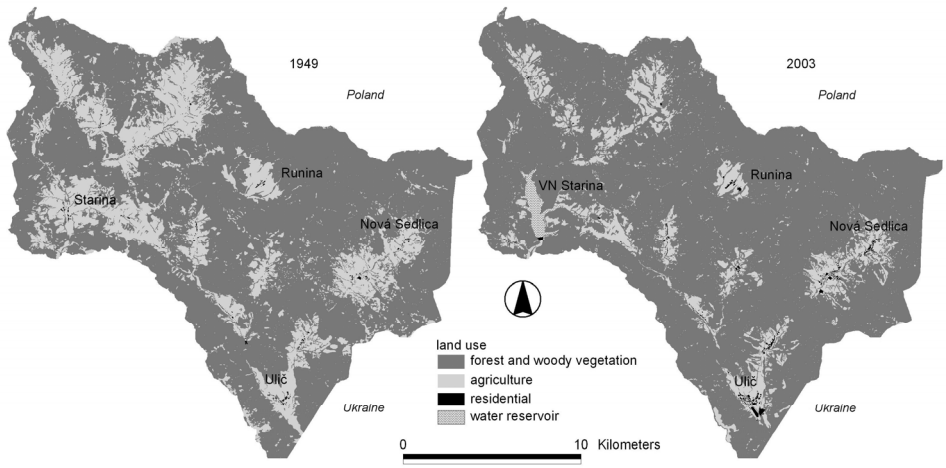
Recent transformation trends

The last decade landscape transformation represents 2 rather polarised trends. On one hand it is the intensification of land use – massive development of suburbs, new industrial parks construction, highways and motorway construction. Massive suburbanisation takes place in the vicinity of almost every Slovak city or town. Increasing income of the upper-middle class means that former panel housing residents can afford their own house and garden within the proximity of a city. The highway and motorway construction is a response to continuously growing numbers of cars and heavy local and transition traffic. It is considered to be an important precondition for future economic development of the entire Slovak Republic and especially for remote and marginal regions therefore it is strongly supported by national and regional authorities. New industrial parks, logistic trade centres and multifunction shopping centres spread on fertile arable land around cities. Everyday life of people is more and more dependent on cars. The new residential areas are usually remote from the city centre, where people commute to their work, large shopping centres, where people use to shop are remote form the city centres and the residential areas. These remote locations and consequent transport needs then shape the land use patterns around the cities.

The opposite significant land use trend is the extensification (or a total abandonment) of the agricultural landscape as a result of unprofitable management and changing social preferences. Fields and permanent grasslands as secondary vegetation formations demand a certain amount of subsidiary energy in a form of human utilisation in order to be preserved. Approx. 80% of the Slovak permanent grasslands are located in the agriculturally less profitable submountainous and mountainous areas with prevailing small to medium urbanisation of villages. The economic regression of the 1990s combined with negative demographic trends (emigration of young people to larger towns and broken links between farmers and their land as a result of the 40 years of collectivised property) rapidly led to

a large land abandonment and secondary succession overgrowing (Fig. 10). The overgrowing not only impacts the grasslands biodiversity and causes conflicts with the NATURA 2000 main goals but its side effect is a significant loss of the cultural landscape, its scenery and traditional character. The overgrowing is affected by natural conditions but more significant are social and economic factors (unwillingness to use the grasslands). Though it is rather easy to identify overgrowing patches in the landscape an exact quantification of its rate is quite difficult due to a continuous spread character of the process. The results from the middle Slovakia The Poľana Mt. applying the method developed by Gallayová (2008) showed that in the period of 1949-2003 almost 2/3 of the grasslands had been overgrown.

Fig. 10: Vanishing open agricultural landscape in the Bukovské vrchy Mts. due to the Starina water reservoir (VN Starina) construction and land abandonment (study area 15)



Relatively new phenomena affecting recent land use in Slovakia are natural disasters. Although these effects do not represent land use trends they occur almost periodically. In the mountain and high mountain areas they are mainly wind calamities in forests causing significant economic losses and consequent nature conservation problems. These wind calamities are considered to be a serious problem of the last few years but historical maps showed that they have already occurred several times in the same territory (Fig. 4, large deforested areas in NE part in 1822). For centuries floods have meant a serious trouble and limited a potential use of alluvium plains. In the past people unable to avoid periodical floods built their settlements in higher situated localisations above the inundation zones. After the disastrous plain floods in the 1960s the largest rivers were regulated and the nearby land ameliorated. It opened alluvial zones, formerly excluded from settling, for urbanisation. At present time floods do not endanger the plains but the submountainous and upland areas instead. Floods of smaller streams are very intense and destroy mainly objects localised in alluviums. The predisposition for floods is affected by the site natural conditions (relief, soil and hydrology) and land use but it is often triggered by local extreme climate events (Gallay, 2009).

Fig. 11: The wind calamity area in the High Tatras National Park in 2004 (study area 16)

CONCLUSIONS

The Slovak cultural landscape transformation trends could be summarised into the following main points:

- from the long-term point of view the most stable land use was bound to low situated parts with low inclination on one hand (fields and settlements on the plains, basin and deep valleys) and to higher parts with steeper slopes (high mountain vegetation, forests, shrubs, local secondary grasslands) on the other hand. The majority of changes occurred between these 2 locations.
- intensification of land use prevailed also on lower situated areas and extensification on higher and remote locations. Exceptions were recorded only in the territories where the land use was affected by new socio-economic phenomena as tourism centres development in the Hight Tatras Mts. or the water reservoir construction (the Bukovské Vrchy Mts).
- the second half of the 20th century represents the most dynamic part of the cultural landscape transformation with a significant changes to natural conditions (mainly hydrological and climatic) and large block agriculture intensification and industrialisation interconnected with urbanisation,
- the contemporary trends are the intensification of agricultural land use in the plains and alluviums and the urbanisation in the vicinity of cities and the land abandoning and overgrowing in higher and remote areas.

The identified transformation trends are supported by the results form other authors studying long-term landscape changes in Slovakia – amelioration and collectivisation in the Záhorská Nížina plain (Cebecauerová, 2007), rapid urbanisation of larger cities since 1950s (Pucherová, 2004; Chrastina, 2005), land abandonment in remote dispersed settlements areas (Petrovič, 2006), relative stable high mountain areas (Boltižiar, 2007) or forest wind calamities (Falťan et al., 2008). The landscape changes studies from the closest neighbour post-socialist countries such as the Czech Republic or Hungary revealed almost

the same long-term but also recent transformation trends, e.g. continuous land use intensification in lowlands (Lipský, 2000; Demek et al., 2008; Skokanová, 2009), conversion of agricultural landscape since 1950s (Kubeš, 1994; Lipský et al., 1999), land abandonment in marginal areas after the 1990s (Bartoš et al., 1999; Kolejka and Marek, 2006), or unstable land use in the Tokaj mountains foothill (Csorba, 1996) and agricultural land abandonment in the Hungarian agricultural plains (Chrastina and Boltižiar 2006).

The most recent transformation trends of the Slovak landscape correspond also with the pan-European land cover changes identified by CORINE the Land Cover methodology (EEA, 2007). Land use intensification (urban residential sprawl, construction of new industrial sites and transport infrastructure, intense agriculture) and land abandonment with following afforestation occurring mainly on former permanent grasslands (EEA, 2006). The land use polarisation causes a loss of highly valuable landscape types (e.g. low intensity farmlands) and on the other hand, it increases a pressure on the environment, human health and well-being.

The study results and their comparison with neighbouring post-socialist countries and pan-European trends supports the hypothesis that thought natural conditions determine the basic land use distribution the land use change driving forces are mainly socio-economical.

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REFERENCES

BARTOŠ, M., TĚŠITEL, J. AND KUŠOVÁ, D., 1999: *Marginal areas – historical development, people and land use*. **In: KOVÁŘ, P. (ED)**: *Nature and culture in landscape ecology*. Karolinum, Prague, pp 109 – 113.

BENDER, O., BOEHMENR, H.J., JENS, D. AND SCHUMACHER, K.P., 2005: *Analysis of land-use change in a sector of Upper Franconia (Bavaria, Germany) since 1850 using land register records*. Landscape Ecology, 20: 149 – 163.

BONTEMPS, S., DEFOURNY, P., VAN BOGAERT, E., WEBER, J.-L., ARINO, O., 2009: *GlobCorine – A joint EEA-ESA project for operational land dynamics monitoring at pan-European scale*. Sustaining the Millenium Development Goals. Paper presented at the 33rd International Symposium on Remote Sensing of Environment, Stressa, Italy, 4–8 May, 2009.

BOLTIŽIAR, M., 2007: *Štruktúra vysokohorskej krajiny Tatier* (Veľkomierkové mapovanie, analýzy a hodnotenie zmien aplikáciou údajov diaľkového prieskumu Zeme. UKF, ÚKE SAV a SNK MAB, Nitra.

BÜRGI, M., 1999: *A case study of forest change in the Swiss lowlands*. Landscape Ecology, 14: 567 – 575.

CEBECAUEROVÁ, M., 2007: *Analýza a hodnotenie zmien štruktúry krajiny* (na príklade čati Borskej nížiny a Malých Karpát). Geographia Slovaca 24-2007. Veda, Bratislava.

COUSIN, S.A.O., 2001: *Analysis of land-cover transitions based on 17th and 18th century cadastral maps and aerial photographs*. Landscape Ecology, 16: 41 – 54.

CSORBA, P., 1996: *Landscape-ecological change of the land use pattern on the east foothill area of the Tokaj Mountains (Hungary)*. Ekológia (Bratislava), 15: 115-127.
DEMEK, J., HAVLÍČEK, M., CHRUDINA, Z. AND MACKOVČIN, P., 2008: *Changes in land-use and the river network of the graben Dyjsko-Svratecký úval (Czech Republic) in the last 242 years*. Journal of Landscape Ecology, 1 (2): 22 – 51.
EEA, 2006: *Land accounts for Europe 1990-2000*. Towards integrated land and ecosystem accounting EEA technical report 11/2006.
EEA, 2007: *CLC2006 technical guidelines*. EEA technical report 17/2007.
FALŤAN, V., BÁNOVSKÝ, M., JANČUŠKA, D., SAKSA, M., 2008: *Zmeny krajinnej pokrývky úpätia Vysokých Tatier po veternej kalamite*. Geo-grafika, Bratislava.
FÜLEKY, G., MAJOR, I., 1993: *Changes in the landscape during the last 200 years in the region of the Zala Valley and effect on the economic activity of the area*. Landscape and Urban Planning, 27: 265 – 267.
GALLAY, I., 2009: *Krajinnoekologické hodnotenie abiotického komplexu CHKO – BR Poľana.* TU vo Zvolene, Zvolen.
GALLAYOVÁ, Z., 2008: *Krajinnoekologická analýza a využívanie trvalých trávnych porastov v Chránenej krajinnej oblasti – biosférickej rezervácii Poľana*. TU vo Zvolene, Zvolen.
HRONČEK, P., 2008: *Antropogénne vplyvy na vývoj krajiny maloplošných chránených území* (na príklade Ipeľskej kotliny. Univerzita Mateja Bela, Banská Bystrica.
CHRASTINA, P., 2005: *Vývoj krajiny ako fenomén environmentálnych dejín (na príklade Trenčianskej kotliny a jej horskej obruby).* Historická geografie, 33: 9 – 19.
CHRASTINA P., BOLTIŽIAR M., 2006: *Kultúrna krajina SV okraja Bakoňského lesa v Maďarsku (súčasnosť v kontexte minulosti).* Historická geografie, 34, suppl. 1: 175 – 188.
KOLEJKA, J., 1987: *Landscape-historical synthesis materials, methods and results*. Ekológia (ČSSR), 6 (1): 51 – 62.
KOLEJKA, J., MAREK, D., 2006: *Sustainable land use convergence in border area in Central Europe*. **IN: VOGTMANN, H., DOBRETSOV, N. (EDS)**: *Environmental security and sustainable land use - with special reference to Central Asia.* Springer, pp 183 – 198.
KUBEŠ, J., 1994: *Bohemian agricultural landscape and villages, 1950 and 1990 land use, land cover and other characteristics.* Ekológia (Bratislava), 13 (2): 187 – 198.
LIPSKÝ, Z., 2000: *Sledování změn v kulturní krajině*. ČZU LF, Praha.
LIPSKÝ, Z., KOPECKÝ, M. AND KVAPIL, D., 1999: *Present land use changes in the Czech cultural landscape*. Ekológia (Bratislava), 18 (1): 31 – 38.
OLAH, B., BOLTIŽIAR, M., PETROVIČ, F. AND GALLAY. I., 2006: *Vývoj využitia krajiny slovenských biosférických rezervácií UNESCO*. TU a SNK MaB, Zvolen.
Olah, B., Žigrai, F., 2004: *The meaning of the time-spatial transformation of the landscape for its sustainable use (A case study of the transition zone of the Poľana biosphere reserve).* Ekológia (Bratislava), 23 suppl. 1: 231 – 243.
OŤAHEL, J., ŽIGRAI, F. AND DRGOŇA, V., 1993: *Landscape use as a basis for environmental planning (case studies of Bratislava and Nitra hinterlands*. **IN: DRGOŇA, V. (ED)**: *Geographical studies 2*. University of Education, Nitra, pp 7 – 84.
Petit, C.C., Lambin, E.F., 2002: *Impact on data integration technique on historical land-use/land-cover change: Comparing historical maps with remote sensing data in the Belgian Ardennes*. Landscape Ecology, 17: 117 – 132.
PETROVIČ, F., 2005: *Vývoj krajiny v oblasti štálového osídlenia Pohronského Inovca a Tribeča*. ÚKE SAV, Nitra.
PETROVIČ, F., 2006: *The changes of the landscape with dispersed settlement*. Ekológia (Bratislava), *25*, suppl. 1: 65 – 89.

PUCHEROVÁ, Z., 2004: *Vývoj využitia krajiny na rozhraní Zobora a Žitavskej pahorkatiny* (na príklade vybraných obcí). FPV UKF, Nitra.

SCHNEIDER, A., FRIEDL, M. A., POTERE, D., 2009: *A new map of global urban extent from MODIS satellite data.* Environ. Res. Lett. 4 (2009)044003 (11 pp).

Skanes, H.M., Bunce, R.G.H., 1997: *Directions of landscape change (1741 - 1993) in Virestad, Sweden - characterised by multivariate analysis*. Landscape and Urban Planning, 38: 61 – 75.

SKOKANOVÁ, H., 2009: *Application of methodological principles for assessment of land use changes trajectories and processes in the Czech Republic for the period 1836 – 2006*. Acta Pruhoniciana (in press)

ŽIGRAI, F., DRGOŇA, V., 1995: *Landscape-ecological analysis of the land use development for environmental planning (case study Nitra)*. Ekológia (Bratislava), 14, suppl. 1: 97 – 112.