Ekológia (Bratislava) Vol. 25, Supplement 3/2006, p. 232–248

PATTERNS AND CHANGES OF INTENSIVELY UTILISED AGRICULTURAL LANDSCAPE IN THE CZECH REPUBLIC BETWEEN 1937 AND 2002: AERIAL PHOTOGRAPHY ANALYSIS

JAN SKALOŠ

Czech University of Agriculture Prague, Faculty of Forestry and Environment, Laboratory of Landscape Ecology, 281 63 Kostelec nad Černými lesy, The Czech Republic
Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Květnové nám. 391, 252 43 Průhonice, The Czech Republic, email: janskalos@yahoo.ca

Abstract

Skaloš J.: Patterns and changes of intensively utilised agricultural landscape in the Czech Republic between 1937 and 2002: aerial photography analysis. Ekológia (Bratislava), Vol. 25, Supplement 3/2006, p. 232–248.

Results of the analysis of landscape changes at the local scale are presented on a case study site Stíčany (159 ha) located in the Eastern Czech Republic. Eight land use types have been determined, quantified and analyzed on the basis of aerial photograph interpretation. Aerial photos from six time layers (1937, 1950, 1966, 1983, 1992, and 2002) were used. Permanent landscape structures (PLS) (grasslands, non-forest wood species, water areas and gardens) and landscape matrixes (arable land) were investigated. The percentage of PLS decreased (17.5–16.4%) between 1937 and 2002 due to rapid decline in the area of grassland (11.3–5.9%), but there was a local raise observed between 1966 and 1983 (13.7–16.5%) due to the spread of scattered vegetation that took place on sites that were not directly affected by mining, thus being opened for succession. The length of ecotones decreased from 1937 until 1992, while it enlarged after 1992, which might be a sign of positive trends after 1989. The percentage of the matrix was abnormally high compared to the whole country and it decreased from 75.2 to 70.6 percent following the country's trend. The total number of matrix sites was steady decreasing from 1950 until 1992 (344–23). It increased from 1937 to 1950 (255–344) and from 1992 to 2002 (23–44). Changes in the landscape structure are characterized by negative tendencies until the early 1990s. Since the 1990s, positive changes have occurred in the Czech landscape reflecting political changes in 1989. The total area of arable land was continuously decreasing (119.9–110.8 ha). The total number of arable land plots decreased between 1937 and 1992 (255–23) while it increased between 1992 and 2002 (23– 44). The average plot size of a matrix increased almost ten times between 1937 and 1992 (0.47–4.85 ha), while this tendency slowed from 1992 to 2002 (4.85–2.52 ha).

Key words: landscape, landscape changes, landscape structure, agricultural landscape, permanent landscape structures

Introduction

Landscape is heterogeneous and complex system, and there is a large number of different concepts through which it can be perceived. Consequently, the number of different definitions of landscape is large (Forman, Godron, 1993; Jones, 1988). Cultural landscape is the result of the interaction between the natural environment and man's activities driven by actual needs (Antrop, 1998). Landscape is characterised by dynamic and continuous change, which may be expressed by quantitative changes of landscape structural characteristics. The rate of change varies in accordance with fluctuations of natural and anthropogenic processes (Skånes, 1996). Natural conditions represent the most important factors that set limits to the utilisation of land. It is the framework for the way in which land is finally used, as it is the "land user" and his actions that "have the last word" about the way in which landscape will look (Hellström, 2002). Changes in permanent structures of the landscape will be focused on since they have positive effects on the ecological stability of the landscape. Antrop (1998) defines at least four questions that should be considered in order to study changes in landscape: (1) Change of what? (2) What is the frequency of change? (3) What is the magnitude of change? (4) What time-based reference is used? However, following revised list of nine basic questions should be taken into account: (1) Change of what landscape elements? In what landscape type? (2) Change why? (factors behind change) (3) Quantity of changes (4) Quality of changes (5) Frequency of changes (6)Magnitude of change (7) Change where in the landscape? (and why?) (8) What is the trend? (9) What are the consequences for landscape planning?

Ecological stability has become a widely discussed term in present landscape and nature protection (Mimra, 1993). It is defined as the ability of ecological systems either to resist against disturbing outside factors or to reproduce its substantial characteristics (Míchal, 1994). We may use this term for evaluating the ecological stability of the landscape as such, in terms of the coefficient of ecological stability (Löw et al., 1986). Permanent landscape structures (grassland, non-forest wood species, gardens and water areas in the study area) that have become the main subjects of this research, play a substantial role here since they represent ecosystems with positive effects on the ecological stability of the landscape (Lipský, 1998).

Landscape history in the Czech Republic during the past 200 years

Up to the 19th century, human activities had been estimated as being in balance with natural processes. Despite rapid industrialisation at the turn of the 20th century, even during the 1930s and the 1940s, cultural landscape was still regarded as diverse and harmonic. The end of WWII is taken as a turning point for the Czech landscape, which is true for the whole of Europe as well (Lipský, 1995). Modern technologies in agriculture began to develop, along with intensification and specialisation. Changes in landscape had never been so pronounced before 1945. Changes in the landscape after 1948 mainly reflect political

changes after the Communist Party took power in the Czechoslovakia in 1948. Collectivisation of agriculture was one of several significant actions in the history of the former Czechoslovakia after 1945, which left great marks not at least on the face of the Czech cultural landscape. It officially made its start in 1951 (Jech, 2001). In the former Czechoslovakia, these changes were characterised by large-scale socialist farming (agricultural co-operatives and so-called Russian kolkhozes were typical of this Soviet system). Apart from political, economic and landscape-ecological consequences, collectivisation had also negative implications from the sociological point of view due to severe repression of private landowners (Jech, 2001). Many of them were bound with duties, imprisoned, or punished in other ways. The so-called "Velvet Revolution" in 1989 brought about new economic and social conditions as a framework for developing institutional framework, and affecting landscape users in the landscape arena. The period from 1948 until 1989 may be further subdivided to several phases according to several authors. For example, Sýkora (1998) distinguishes the following periods: (1) Socialist collectivisation (1950–1970), and (2) The concentration of agricultural production (1970s–1980s). Löw and Míchal (2003) divide landscape history in the former Czechoslovakia into following distinct periods: (1) Displacement of the German population from the Sudety Mountain region and the following resettlement of the Czech population (1945–1948), (2) First phase of collectivisation (1950s), (3) Second phase of collectivisation (1970s), (4) Land consolidation in Cadastres (1970s– 1980s), (5) Designation of specifically protected areas, (6) Ecological disaster of mountain forest ecosystems, (7) Period after 1989. This may be characterized by: (a) land restitution, (b) political contention, (c) national environmental protection policy and (d) complex land consolidation.

Methods

Study area

Case study site Stíčany is located in Eastern Bohemia in the Pardubice county cca 120 km east of Praha (Fig. 1). It is a very productive old residential landscape (Lipský, 1998) located on the Bohemian Cretaceous basin. The area covers 159 ha. It provides a typical example of an intensively utilised type of a collective open fields landscape (Meeus, 1995). It is mainly due to agricultural activities that have dominantly affected this landscape since the Neolithic Period (Roček, 1926) (Table 1). Arable land formed the most abundant type of land use between 1937 and 2002 (75.2–70.6%). The village of Stíčany dominates the centre of the study area, which is administratively a part of the Hrochův Týnec Municipality (cca 1 400 inhabitants). To the southwest, there are grounds of the brickworks factory operating and considerably affecting landscape between 1909 and the late 1990s.

T a b l e 1. Some basic climate data on the Stíčany study area (Anonymous, 1961)

Annual mean temperature in C°	Climate region	Annual precipitation in mm	Beginning of vegetation season (date)	Total length of vegetation season in days
8.2	Slightly Warm (SW)	622	26.3	226

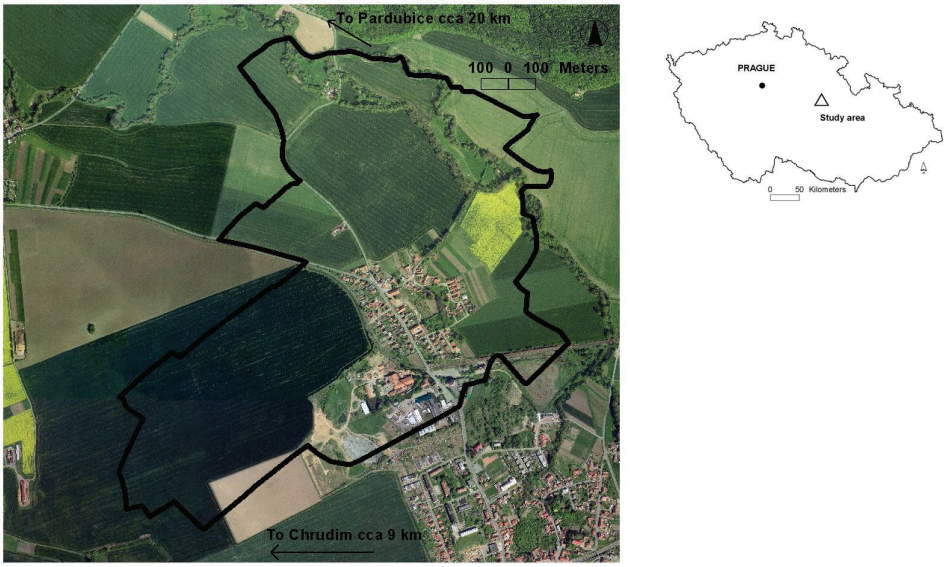

Fig. 1. Localisation of the study site.

The study area was delimited in accordance with cadastral boundaries. Another reason behind the choice is that the study area, Stíčany, represents a case of landscape that the European Landscape Convention (Weber et al., 2004) defines as an ordinary landscape. Even if it this is not characterised by any special phenomena, it is valuable and unique because of its cultural heritage value. Analysis of landscape development may provide with data that can help to delimit some values of such ordinary landscape, e.g. landscape memory structure (Skaloš, 2004).

Official statistical data sets on land use (Table 2) in the Czech Republic and interpreted land use data for the study site Stíčany (Table 3) were compared. Landscape of the study area Stíčany is abnormally dominated by

T a b l e 2. Development of land use in the Czech Republic between 1937 and 2002 (Sklenička, 2002)

Land use	The Czech Republic (78 864 km^2)							
	area in %							
	1938	1948	1958	1968	1978	1988	1998	2002
Arable land	48.6	44.6	42.9	42.2	42.0	41.2	39.3	38.9
General grassland	13.4	13.6	13.1	11.9	11.1	10.5	12.3	12.3
Hop-fields	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Vineyards	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2
Forest land	29.8	30.5	32.3	33.0	33.2	33.3	33.4	33.5
Water areas	0.6	0.7	0.6	0.7	0.6	0.6	0.6	0.4
Others	7.3	10.4	10.9	12.0	12.8	14.0	14.1	14.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

T a b l e 3. Developments of land use at the Stíčany study locality between 1937 and 2002

Land use	Stíčany study area (159 ha)							
	area in %							
	1937	1950		1966		1983	1992	2002
Arable land	75.2	76.0		72.1		69.3	71.4	70.6
Grassland	11.3	7.3		4.9		5.2	4.6	5.9
Hop-fields	0.0	0.0		0.0		0.0	0.0	0.0
Vineyards	0.0	0.0		0.0		0.0	0.0	0.0
Forest land	0.0	0.0		0.0		0.0	0.0	0.0
Water areas	0.1	0.1		0.3		0.5	0.5	0.1
Others	13.3	16.6		22.8		25.0	23.5	23.3
Total	100.0	100.0		100.0		100.0	100.0	100.0

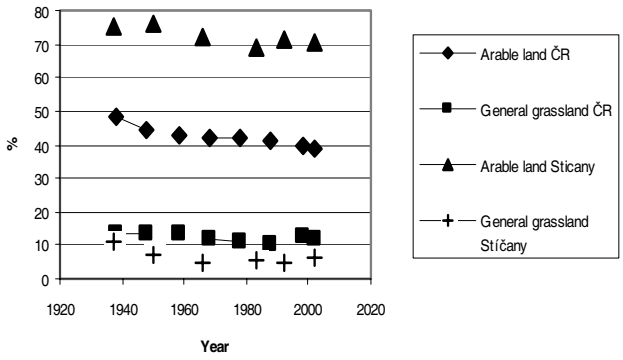

Fig. 2. Proportional development of grassland and arable land in % between 1937 and 2002. Comparison between the Czech Republic and study area of Stíčany.

arable land (70.6%) compared to the entire country (38.9%). On the other hand, the percentage of grassland had been slightly substandard between 1937 and 2002, and it reveals similar decreasing tendency (11.3–5.9%). .

Landscape elements

The range of landscape elements that can be analysed as well as statistical indexes that describe them quantitatively might be rather wide (Forman, 1995). In this paper, main attention has been paid to "natural" landscape elements, such as non-forest wood species, grasslands, water elements and gardens. Based on aerial photo interpretation, the following land use types have been determined:

Built-up and other areas. These areas comprise built-up areas as examples of sites totally altered by man with minimal ecological stability, e.g. various types of buildings, communications inside settlement, various types of manipulation areas and aprons etc. *Ecologically unstable.*

Industrial areas. Comprise sites that were directly affected by mining activities together with other sites within the brickworks territory. These areas feature minimal ecological stability. However, on sites that are not under direct mining or construction, there was rapid succession observed since this area is sort of "protected from agriculture" within the brickworks territory. *Ecologically unstable.*

Communications. Various types of roads located out of the village. *Ecologically unstable*.
Arable land. This dominating land use is characterized by minimal ecological stability. *Ecologically unstable*.

Ecologically unstable

Gardens. Consist of sites located inside or at the edge of the Stíčany village. These areas are dominated by grasslands with no trees that have been classified as different land use. *Ecologically stable*.
Grasslands (these areas consist of land used as pastures or meadows, since it is very difficult to differentiate these two from aerial photos). *Ecologically stable*.
Water areas (contain different types of water basins, e.g. village ponds or water reservoirs for brickworks or sugar refinery factory purposes). *Ecologically stable*.
Non-forest wood species. This group category includes all wood species stands, clusters of trees, or solitary trees except forest land. These ecosystems are characterized by a variety of function and they positively affect ecological stability of landscape (Bulíř, Škorpík, 1987). Especially in this intensively utilised landscape, non-forest wood species play a substantial role. *Ecologically stable*. This category consists of: (1) *Non-forest wood species inside the village* and, (2) *Scattered vegetation*, which has been further standardized according to different functional and structural dynamics: (a) *Scattered vegetation along river banks*, (b) *Scattered vegetation in the open landscape (mainly woodlots located inside of blocks of arable land),* (c) *Scattered vegetation along communications*, (d) *Scattered vegetation within industrial area*.
Permanent landscape structures (PLS) (i.e. ecosystems characterized by permanent character of ecological conditions having positive affects on ecological stability of the landscape. They encompass grasslands, gardens, water areas, and non-forest wood species category.)
Landscape matrix (arable land was recognized here as a matrix between 1937 and 2002 since it dominates the study area and it essentially affects the dynamics of the studied landscape)

Quantitative characteristics

Methods of landscape metrics or statistical indices have been widely used (Fjellstad, Dramstad, 1999) to describe quantitative changes of landscape patterns, but its significance for practical application still remains questionable. Also, there is high dependence of landscape metrics upon data quality. In this paper, landscape changes have been quantified using characteristics of landscape macrostructure and microstructure. *Landscape macrostructure* is based on the proportion of different land use types in the territory; it can be quantified by so-called coefficients of ecological stability. However, they do not offer any information on inner interactions of landscape elements-ecosystems (Drgoňa, 2004; Lipský, 1998). The proportion of land use types have been calculated for 1937, 1950, 1966, 1983, 1992 and 2002 using data that have been generated from aerial photos. These results have been compared with the development of official statistical data on land use development in the Czech Republic. There is also a unique database of historic statistical data on land use covering almost the entire territory of the Czech Republic. This database was established in the 1990s at the Faculty of Science of Charles University in Prague. These data sets relate to four time horizons, which might be taken as breaking points in the country's and landscape history (1845, 1948, 1990 and 2000). Data is available for cca 9 000 administrative units (Bičík, 2004). These data were analysed earlier by Skaloš (2005). Data on *landscape microstructure* provide information on the inner interaction of landscape structural components. The following aspects of landscape microstructure were considered and analysed using GIS instruments:

– Characteristics of PLS: Total number of elements – n (No), Relative frequency of landscape elements – Q (No/ha), Average size of elements – S (ha), Lt – Total relative frequency of edges – stands for the total relative length of edges of all elements of permanent landscape structures per entire area of the study site.
– Characteristics of the matrix: Total number of elements – n (No.), Average size of matrix elements – Sa (ha).
– Characteristics of interaction: Le (km/ha) – Relative frequency of ecotones – i.e. for the relative length of edges of such elements of permanent landscape structures that border with arable land (per entire area of the study site).

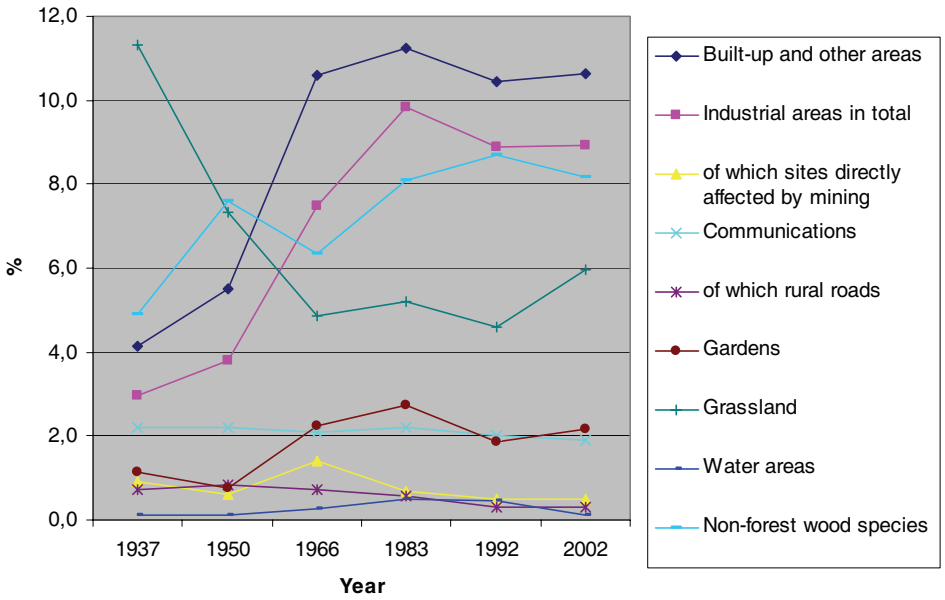

Fig. 3. Development of all land use categories in the Stíčany study site between 1937 and 2002.

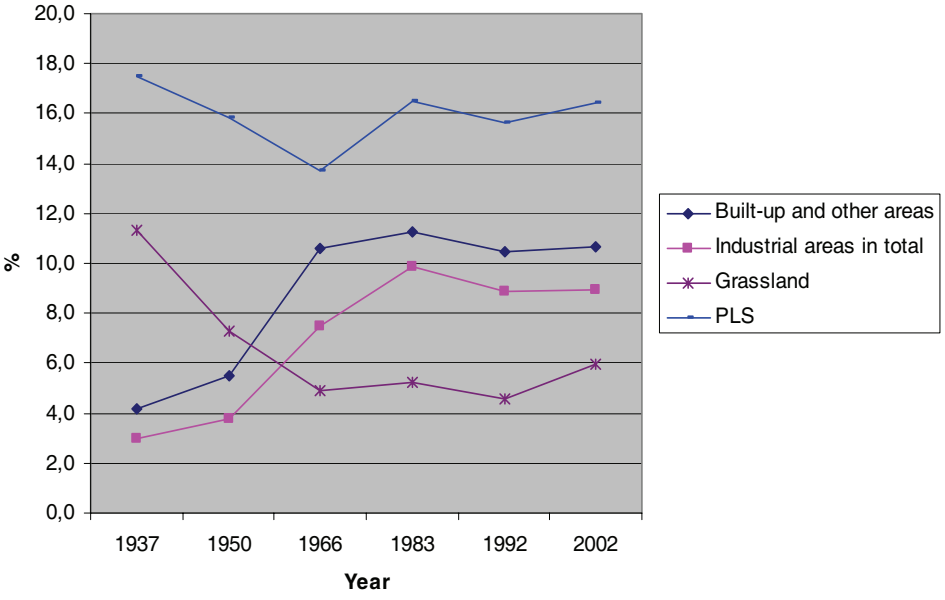

Fig. 4. Development of PLS, grassland, built-up, and industrial areas, land use categories in the Stíčany study locality between 1937 and 2002.

Data collection and analysis

The official statistics on land use of the Czech Republic was used to receive some background information (Anonymous, 2005). Another source of data used to quantify landscape changes were aerial photographs. There is a wide range of work that deals with aerial photograph interpretation, e.g. Ihse (1995). Aerial photos were scanned at high resolution (900 dpi), transformed in TopoL vs. 6.5 software and digitized using ArcView 3.2. The interpretation of aerial photographs was checked by terrain inspection in the study area. Basic characteristics for eight land use types have been calculated and analysed for each of six time layers – 1937, 1950, 1966, 1983, 1992 and 2002.

Results

Built-up and other areas, and the total industrial area reveal increasing tendency due to rapid urbanisation after 1950 (Fig. 3). It is accompanied by the increasing area of communications and gardens whose dynamics follow dynamics of built-up and industrial areas. Slight reduction in the area of communications is caused by the diminishing area of rural roads (0.7–0.3%).

Correlations among the area of PLS, built-up areas, industrial areas and grasslands are evident (Fig. 4). Increasing area of built-up and other areas, as well as industrial areas, is understandably followed by the decreasing percentage of grassland. Nonetheless, the total area of permanent landscape structures had increased between 1966 and 1983 because of the increasing area of scattered vegetation located on brickworks grounds due to "delayed" effect of succession of scattered vegetation in the vicinity of the brickworks factory.

Non-forest wood species category was divided to several subcategories, as various types of non-forest wood species have their own dynamics according to their location and management (Fig. 5). This research confirms the statement that bank vegetation represents the most extensive natural vegetation type in intensively utilized landscapes (Lipský, 1998). Scattered vegetation along the riverbanks prevails in the study site Stíčany. It had been proportionally increasing before 1992, while it slightly decreased between 1992 and 2002. Bank vegetation spreads here mainly due to the fact that one of riverbeds served as a millrace.

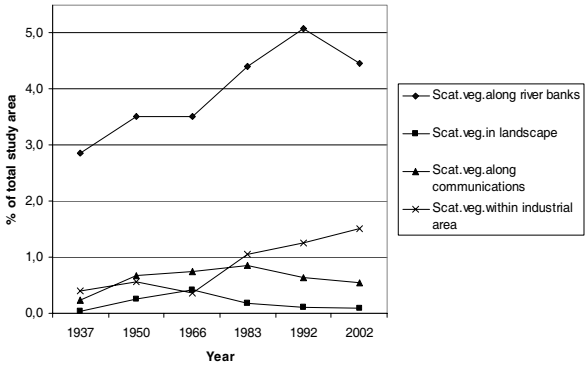

Fig. 5. Development of non-forest wood species category (non-forest wood species inside the village, scattered vegetation along river banks, scattered vegetation in the open landscape, scattered vegetation along communications and scattered vegetation within industrial area).

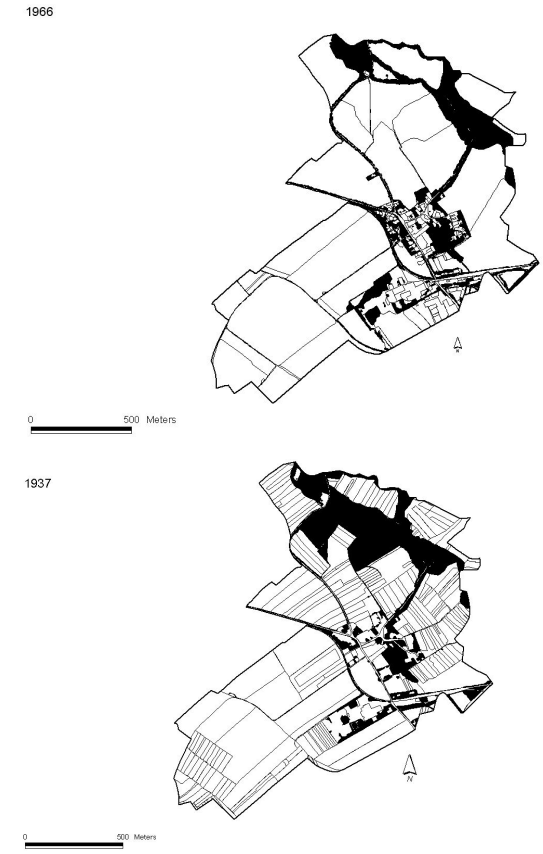

Fig. 6. Changes in landscape mosaics 1937, 1966 and 2002 (permanent landscape structure in black).

After the mill discontinued activities in the late 1940s, the millrace was no longer in use and the vegetation started to spread without being managed as it used to be before. Until 1983, the proportion of scattered vegetation along communications was increasing, while it is steadily declining after 1983. This reflects the change in the road alleys management run by the Road Administration Office after 1983. Almost the same could be stated for scattered vegetation in the landscape with the breakage in 1966. The proportion of landscape wood vegetation was increasing until 1966, while it is steady decreasing after 1966. The area of scattered vegetation within industrial grounds remarkably increased after 1966, which might be a result of a rapid succession processes in the vicinity of the brickworks area on sites that are not directly affected by mining or other destructive activities.

As shown in Fig. 6 and Fig. 8a, the percentage of PLS decreased between 1937 and 2002 (17.5 from to 16.4%). But the decrease was not continuous. From 1937 to 1966, it was proportionally decreasing, while it increased between 1966 and 1983 (13.7–16.5%). It was mainly due to the increase of scattered vegetation in the area of the brickworks territory in the areas that were not directly affected by mining, and being set aside for succession. After a slight decrease between 1983 and 1992, there was an increase again observed after 1992, which may be related to political changes after 1989.

Development of the PLS microstructure can be characterized as negative between 1937 and 1992 due to ongoing processes of fragmentation of PLS ecosystems. Two divergent processes might be easily recognizable on the Fig. 7 and Table 4. Almost continuous increase in

T a b l e 4. Basic characteristics of landscape microstructure for permanent landscape structures between 1937 and 2002

			PLS			PLS ecotons
	P	n	Q	S	Lt	Le
Year	ha	No.	No.ha^{-1}	ha	km.ha^{-1}	km.ha^{-1}
1937	27.8296	194	6.9710	0.1435	0.2593	0.187
1950	24.9053	356	14.2804	0.0700	0.2640	0.167
1966	22.4083	467	20.8405	0.0480	0.3018	0.154
1983	26.0512	385	14.7975	0.0676	0.3061	0.155
1992	24.3916	362	14.8412	0.0674	0.3222	0.155
Change 1937–1992 in %	-12.3538	86.5979	112.8989	-53.0294	24.2555	-17.1
2002	25.6634	388	15.1188	0.0661	0.3539	0.220
Change 1937–2002 in %	-7.8	100.0	116.9	-53.9	36.5	17.7

Total number of elements – n (No), Relative frequency of landscape elements – Q (No/ha), Average size of elements – S (ha), Lt – Total relative frequency of edges – stands for the total relative length of edges of all elements of permanent landscape structures per entire area of the study site, Le (km/ha) – Relative frequency of ecotones – i.e. for the relative length of permanent landscape structures edges that border with arable land (per entire area of the study site).

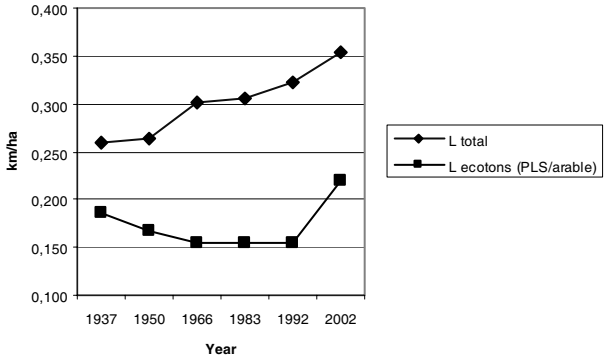

Fig. 7. Development of total length of PLS elements and PLS ecotones (PLS/arable) between 1937 and 2002.

the total length of PLS element edges (+ 37% between 1937 and 2002), accompanied by an increasing number of PLS elements as well as relative frequency (more than 100% between 1937 and 2002, Table 4), may be caused by processes of fragmentation. On the other hand, the length of ecotones between PLS and the matrix decreased (about – 17% between 1937 and 1992), which is caused by intensification of agriculture and getting rid of PLS elements located on agricultural land (Figs 8b, c). Changes between 1937 and 1992, compared to total changes between 1937 and 2002, were found different (Table 4). The length of ecotones Le (+ 17.7%) and the area of PLS (15.6–16.4%) developed positively from 1992 up to 2002 in the view of the changes after 1989, while there could be seen a negative trend from 1937 to 1992 (the length of PLS ecotones decreased by 17.1%). The total length of PLS edges and the number of PLS elements rise all over the period, which means that apart from positive tendencies after 1992, fragmentation of ecosystems keeps an increasing tendency.

During 1937 and 1950, the total number of matrix elements increased (255–344) because intensification of agriculture had not yet started before 1950 and agricultural land

T a b l e 5. Basic characteristics of landscape matrix and their change between 1937 and 1992 (2002)

	Landscape matrix		
	Pm	n	Sa
Year	ha	No.	ha
1937	119.8639	255	0.4701
1950	119.7944	344	0.3482
1966	117.6317	51	2.3065
1983	109.2480	23	4.7499
1992	111.4895	23	4.8474
Change 1937-1992 in %	-6.9866	-90.9804	931.2356
2002	110.7650	44	2.5174
Change 1937-2002 in %	-7.5910	-82.7451	435.5520

Pm – total area of matrix (ha), n – total number of elements (No.), Sa – average size of matrix elements (ha).

management and ownership still remained diverse (Table 5, Figs 8d, e, f). This does not apply for the next period (1950–1966), when the number of arable land plots decreased by 80%. After a rather stable period between 1966 and 1992, a minor increase was observed between 1992 and 2002 (23–44 plots), which has to do with agricultural land restitution and diversification of the ownership. The total area of arable land was continuously decreasing (119.9–110.8 ha). The total number of arable land plots decreased between 1937 and 1992 (255–23) while it increased between 1992 and 2002 (23–44). The average plot size of a matrix increased more than ten times between 1937 and 1992 (0.47–4.85 ha), while this tendency slowed from 1992 to 2002 (4.85–2.52 ha).

Discussion

The quality of this research relied very much on the quality of source data. Aerial photographs provide a good source of information on the landscape structure. However, there are landscape elements whose character of land use is difficult to read and determination of the land use type based on aerial photo interpretation might be very subjective depending on personal experience. There are few land use categories chosen in this paper for monitoring, which may become a subject of a discussion. For example gardens have been finally classified as rather ecologically stable because they feature relatively stable ecological characteristics compared to other ecosystems in the surrounding intensively utilized agricultural landscape (arable land more than 70%). In such affected landscapes, it could be the only one example of "natural" vegetation. There are several methods applied to delimit boundaries of the study site, which may be discussed. They differ according to the purpose and character of the study, for example, in phytosociology (Moravec et al., 1994), for the purpose of the monitoring of large areas such as islands (Hellström, 2002) or distinct territories such as military areas or alluvial plains (Solon, 1998). The study area in this paper was delimitated in accordance with cadastral boundaries. The area chosen for the study might be evaluated as too small (159 ha) compared to other similar studies (Sklenička, 2002) and analysis of the larger area is to be done by studying landscape changes of neighbouring cadastral areas.

In this paper, time span was limited by 1937 and 2002, since the unique collection of aerial photographs is available for the entire area of the Czech Republic in ten-year intervals. We strictly focus on landscape changes between 1937 and 2002, since the year 1945 is taken as a turning point in the Czech landscape history. But the collection of Stabile Cadastre from the 1830s and the 1840s should be utilized in ongoing research, as they represent the first exact graphical source data related to almost the whole territory of the Czech Republic. Also, this investigation ought to be accompanied by land use data from the present to update results.

Different phases with both positive and negative effects on ecological stability of the landscape may be described. The landscape of the study area until 1950 could be evaluated as heterogeneous (total number of the matrix sites increased as well as the area of non-

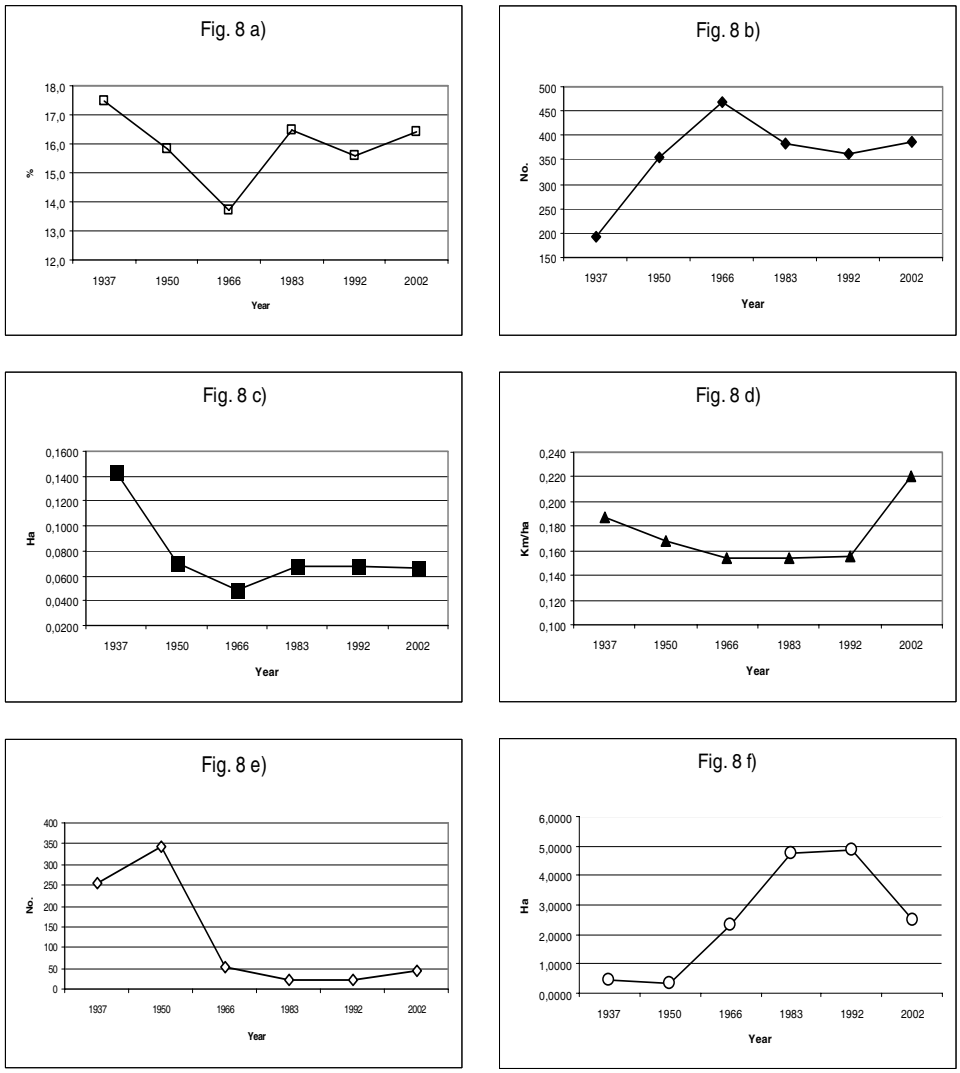

Fig. 8 a – f) Development of some characteristics of the landscape microstructure for permanent landscape structures and matrix between 1937 and 2002 in the study area. a) development of the percentage of PLS, b) development of the total number of the PLS elements, c) development of the average size of PLS elements, d) development of the PLS ecotones, e) development of the total number of matrix elements, f) development of the average size of matrix elements.

forest wood vegetation) but negative ecological effects had already started at this time, far before the collectivisation officially made its start in 1951. Until 1950, the proportion of permanent landscape structures decreased as well as the length of ecotones. It was followed by the intensive period from 1950 to 1966 and 1983 (but with the increase in the area of permanent landscape structures). After a quite constant period between 1983 and 1992, there were positive tendencies observed after 1992.

The area of scattered vegetation within industrial grounds remarkably increased after 1966, which might be a result of a rapid succession processes in the vicinity of the brickworks area. This succession took place on sites that are not directly affected by mining or other destructive activities. Areas of the "industrial greenery" may locally increase the percentage of the PLS since they are kind of "protected from agriculture". Anyway, ecological quality (biodiversity and naturalness) of such vegetation might be very discussible.

Conclusion

Landscape changes in the studied area reflected political and socio-economic changes in society. In general, they are characterised by negative tendencies until the early 1990s from the ecological point of view. Since the 1990s, positive changes have occurred in the study site landscape reflecting political transformations after 1989. However, it has to be strongly stressed that the development of the landscape was not uniform and different phases; with both positive and negative affects on ecological stability of the landscape may be distinguished. Even though that the intensification of agriculture has had negative ecological consequences for the landscape, there are destructive activities that may positively influence the landscape from the ecological point of view. In this case, the total area of permanent landscape structures had increased between 1966 and 1983 as a consequence of an increasing area of scattered vegetation within the brickworks grounds due to kind of "delayed" effect of succession on the brickworks grounds. It represents an example of natural reclamation of the landscape. In that case, the "industrial greenery" may locally increase the percentage of the PLS in the landscape. It is due to the fact that they are kind of "protected from agriculture", which usually gives only a little chance for the natural ecosystems located on agricultural land.

Two basic divergent processes have been distinguished. The positive effect is that the percentage of PLS increases between 1966 and 1983 and from 1992 to 2002, as well as the length of ecotones started to increase after 1992. But the total number of PLS elements are increasing (between 1937 and 1966 and from 1992 to 2002), as well as the total length of PLS edges (from 1937 to 2002), which may be the affect of landscape fragmentation. This research confirms that bank vegetation stand for the most extensive or the only example of natural vegetation types in certain landscapes and vegetation along the riverbanks prevails. The percentage increased before 1992, while it decreased between 1992 and 2002. One of the riverbeds served as a millrace. After the mill discontinued activities in the late 1940s, millrace was no longer in use and the vegetation started to spread without being managed.

Until 1983, the proportion of scattered vegetation along communications was increasing, while it is steadily decreasing after this year. This fact might reflect the change in management of the wood vegetation along communications run by the Road Administration Office after 1983. Until 1966, the proportion of landscape wood vegetation was increasing, while it was steadily decreasing after 1966 due to intensive agriculture in the study area regardless of positive changes after 1989. The area of scattered vegetation within industrial grounds remarkably increased after 1966, which might be a result of a rapid succession processes in the vicinity of the brickworks area on sites that are not directly affected by mining or other destructive activities.

Number of arable land sites as well as the average field size reflects different managements during landscape history between 1937 and 2002. The total number of matrixes was increasing from 1937 to 1950, which implies that the process of Collectivisation had not started before 1950. The average size of arable plots decreased. However, the number of plots decreased between 1950 and 1992 by 90% as a result of land consolidation accompanied by the increase in the average plot size (by 930%!). After 1992, the number of plots started to increase as a result of land privatisation and land ownership diversification. Decreased average plot size during this period was consequent. We may separate the entire period studied from 1937 to 2002 into several phases based on different tendencies in landscape characteristics development.

Period 1937–1950. This period might be judged as well balanced from the ecological point of view by reason of the increasing proportion of non-forest wood vegetation in the landscape as well as increasing number of matrixes and PLS elements. It is the period during which the area of non-forest vegetation in the urban area substantially increased. We can observe some negative ecological effects on landscape structure before collectivisation started in 1950s (decreasing percentage of PLS, decreasing length of ecotones). This means that the negative effects on landscape from the ecological stability point of view started earlier before Collectivisation was launched after 1950.

Period 1950–1966. Collectivisation of agriculture started and the negative ecological effects on landscape accelerated. This period stands for the one of the most intensive phases. The number of arable land plots firstly and dramatically decreased during this period (344–51). The proportion of PLS kept the reduction tendency due to the decreasing area of grasslands and non-forest vegetation in the urban area. The length of PLS ecotones decreased (0.167–0.154 km/ha).

Period 1966–1983. The proportion of PLS increased between 1966 and 1983 (13.7–16.5%), which was caused by an increase in the area of scattered vegetation inside the area of the brickworks territory.

Period 1983–1992. This period is characterized by more or less constant development of landscape characteristics.

Period 1992–2002. The period is typical for accelerating positive trends in the development of landscape structure. The area of PLS increased mainly thanks to a slight increase of the percentage of grasslands. The length of PLS ecotones have firstly increased since 1937. Characteristics of matrixes also disclose positive trends – the number of arable fields

increased firstly after 1950 accompanied by the slight decrease in the average plot size. Theses positive changes reflect political changes after 1989 (privatisation of agricultural land, land ownership diversification, slight decrease in the agricultural land use intensity, etc.). Theses positive changes are evident regardless of the ongoing decrease in the area of the scattered vegetation along communications and riverbanks.

Translated by the authors

References

Anonymous, 1961: The Climate Czechoslovakia (in Czech). HMÚ, Praha, Bratislava.

Anonymous, 2005: Statistical Yearbook CR 2005. ČSÚ, Praha.

Antrop, M., 1998: Landscape change: Plan or chaos? Landscape and Urban Planning, *41*, p. 155–161.

Bičík, I., 2004: Long term changes in land use of the Czech Republic territory. Život. Prostr., *38*, p. 81–85.

Bulíř, P., Škorpík, M., 1987: Diffused Green in the Landscape (in Czech). VUOZ Průhonice.

Drgoňa, V., 2004: Assessment of the landscape use changes in the city of Nitra. Ekológia (Bratislava), *23*, p. 385–392.

Fjellstad, W.J., Dramstad, W.E., 1999: Patterns of change in two contrasting Norwegian agricultural landscape. Landscape and Urban Plann., *45*, p. 177–191.

Forman, T.T., Godron, M., 1993: The Landscape Ecology (in Czech). Academia, Praha.

Forman, R.T.T., 1995: Land Mosaics – the Ecology of Landscapes and Regions. Cambridge University Press.

Hellström, K., 2002: Agricultural Reforms and Policies Reflected in the Farming Landscapes of Hiiumaa from 1850 to 2000. Doctoral thehis, Swedish University of Agricultural Sciences, Dept. of Landscape Planning, Alnarp.

Ihse, M., 1995: Swedish agricultural landscapes– patterns and changes during the last 50 years, studied by aerial photos. Landscape and Urban Planning, *41*, 1–3, p. 11–36.

Jech, K., 2001: The owllight of the countrified state in 1945–1960 (in Czech). Sešity Ústavu pro soudobé dějiny AV ČR, 2001/35.

Jones, M., 1988: Progress in Norwegian cultural landscape studies. Norsk geogr. Tidsskr, *42*, p. 153-169.

Lipský, Z., 1995: The changing face of the Czech rural landscape. Landscape and Urban Planning, *31*, p. 39–45.

Lipský, Z., 1998: The Landscape Ecology for the Students of Geographical Subjects.(in Czech). Karolinum, Praha.

Löw, J. et al., 1986: The Instructions for Delimitation and Proposition of the Territorial System of Ecological Stability of Landscape (in Czech). Metodická pomůcka, Agroprojekt, Brno.

Löw, J., Míchal, I., 2003: The Landscape Character (in Czech). Lesnická práce, Kostelec nad Černými lesy.

Meeus, J.H.A., 1995: Landscapes. In Europe's Environment. European Environmental Agency, Kobenhaven.

Míchal, I., 1994: The Ecological Stability (in Czech). Veronika, Brno.

Mimra, M., 1993: The Evaluation of the Spatial Heterogenity (in Czech). Kandidátská disertační práce. VŠZ, Praha.

Moravec, J. et al., 1994: Phytocenology – Vegetation Science (in Czech). Academia, Praha.

Roček, J., 1926: The History of Hrochův Týnec town (in Czech). Nákladem Osvětové komise v Hrochově Týnci.

Skaloš, J., 2004: Landscape Memory As a Concept for Implementation of the European Landscape Convention in the Czech Republic (Retrospective Study Based on Analysis of Old Maps and Aerial Photographs in the Eastern Czech Republic from 1785 until 1992). Sustain Life, Secure Survival II – Socially and Environmentally Responsible Agribusiness, International Conference, Prague, 22-25 September 2004.

Skaloš, J., 2005: Analyzing land use changes of intensively utilized agricultural landscape – an example from the Eastern Czech Republic. In Broumová, H., Pecharová, E. (eds): 2005. EKOTREND 2005 – Obnova a funkce antropogenně ovlivněné krajiny. Sborník z mezinárodního vědeckého setkání. ZF JU České Budějovice. 30.8.–1.9. 2005.

Sklenička, P., 2002: Temporal changes in pattern of one agricultural bohemian landscape during the period 1938–1998. Ekológia (Bratislava), *21*, p. 181–191.

Skanes, H., 1996: Landscape change and grassland dynamics – Retrospective studies based on aerial photographs and old cadastral maps during 200 years in south Sweden. The Department of Physical Geography Stockholm University. Dissertation series, No. 8, papers I–IV, p. 12–14.

Solon, J., 1998: Changes of land cover, vegetation and landscape structure in the Vistula river valley (Poland) between the villages of Ryczywól and Wilga in years 1949 and 1995.

Sýkora, J., 1998: The Landscape Planning I (in Czech). Historický vývoj českého venkova. Skriptum, ČVUT, Praha.

Weber, M., Houdek, K., Hendrych, J., Novotná, G., Dostálek, J., Kažmierski, T., Kosíková Šulcová, S., Löw, J., Martiš, M., Mlčoch, S., Skaloš, J., Zdražil, V., Zetsch, S., 2004: The provision of realisation the Europe agreement about landscape, another activities of Department of Environment (in Czech). 176 s. + 45 příl. na CD, ms. Závěrečná zpráva výzk. projektu VaV 640/6/02; depon in: Knih. VÚKOZ, Průhonice.

Received 10. 4. 2006

Skaloš J.: **Struktura intenzivně využívané krajiny v České republice v období 1937 až 2002: analýza změn s využitím leteckých snímků.**

Některé intenzivně využívané typy krajin lze ve shodě s Evropskou úmluvou o krajině charakterizovat jako „běžnou krajinu“. Ačkoliv není tento typ krajiny charakteristický žádnými přírodovědnými nebo kulturními fenomény, je přesto cenný z hlediska ochrany kulturního a přírodního dědictví. Analýza změn ve vývoji struktury krajiny může poskytnou potřebné informace, které lze využít k identifikaci hodnot těchto typů krajin. Práce prezentuje výsledky analýzy struktury krajiny katastrálního území Stíčany (159 ha), které představuje příklad zemědělsky intenzivně využívané krajiny východních Čech. Letecké snímky z let 1937, 1950, 1966, 1983, 1992 a 2002 zachycují hlavní radikální zlomy ve vývoji české krajiny v průběhu 20. století. Na základě jejich interpretace byly pomocí nástrojů GIS kvantifikovány charakteristiky základních typů využití krajiny, krajinné matric a permanentních krajinných struktur (PLS) (lesy, trvalé travní porosty, zahrady, vodní plochy apod.). Výzkum dokumentuje některé negativní změny v krajině ještě před začátkem kolektivizace, např. pokles podílu PLS v letech 1937 a 1950 (18–16 %). Na rozdíl od obecných tendencí vývoje krajiny po roce 1945 lze pak dokládat některé odlišné skutečnosti. Přestože jsou prvky PLS v krajině pod silným tlakem díky zemědělské činnosti a urbanizaci, v období 1966 podíl PLS vzrostl (14–17 %), což bylo způsobeno přirozenou sukcesí v oblasti těžbou přímo neovlivněných ploch v areálu cihelny. Jedná se zde o plochy, které nejsou pod přímým vlivem zemědělství. Výsledky tak poukazují na jev, kdy lokálně na malých územích mohou mít některé jinak destruktivní činnosti pozitivní vliv na krajinu díky zarůstání nevyužívaných ploch rozptýlenou zelení a TTP (trvalé travní porosty). V období 1992–2002 lze sledovat pozitivní tendence ve vývoji některých charakteristik, např. zvýšení podílu PLS (24–26 ha), zvětšení délky ekotonů PLS/orná půda (matrix), zvýšení počtu plošek matrix (23–44).