DEVELOPMENT OF USE OF AGRICULTURAL LAND IN THE SELECTED AREA

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Abstract: Paper deals with analysis of historical development LAND USE and ecological stability coefficients calculations. Three cadastral areas Čečkovice, Ječišno and Maleč were used for analysis. The goal is to determine how land use has changed over the years 1845 and 2000. The overall stability of the land was detected using the coefficient of ecological stability. Historical data analysis Land use showed significant changes in landscape use. The increase of arable lands and forest areas was due to change of farming management. Changing farming also affects the loss of pastures. Calculations of ecological stability coefficients showed difference between two methodologies. Even though it can be stated that the area is generally less stable and its stability decreases with time. Since the area of interest is located in a protected part of the Iron Mountains, there should be a higher ecological stability.

Key Words: coefficient of ecological stability, methods according to Miklós and Míchal, Vysočina Region

INTRODUCTION

"Land use" analyzes the current and historical state of the land. It assesses the land in terms of suitability for individual usage patterns. The aim of the assessment of land use changes is comparison and subsequently quantification of data from two or more time periods. "Land use" constitutes a major base in landscape planning (Novakova et al. 2006).

Agricultural ecosystem can be defined as a functional unit of economically important organisms and their environment. It is the most common type of environment in the Czech Republic and occupies about 54% of the country area (Marada et al. 2013). Biodiversity is greatly influenced by a person who contributes to the increasing loss of species and thereby reducing the biological diversity of ecosystems (Bertrand 2003).

Ecological stability is the ability of the ecological system to persist even under the interference and reproduce its essential characteristics. This ability is reflected by minimal change after the interference or spontaneous return to its initial state (Jares 2007).

The aim of this paper is to determine how land use has changed over the years 1845 and 2000. The overall stability of the land was detected using the coefficient of ecological stability.

MATERIAL AND METHODS

The analyzed area is located in the Vysočina Region, about 7.5 km from the town Chotebǒř. Part of the territory lies in a protected area of Iron Mountain. Evaluation was carried out in three cadastral areas Čečkovice, Ječišno and Maleč. Analysis of historical development LAND USE consisted in comparison of percentage representation of various parts of the land country in a historic row and evaluation of the development of the landscape over time. How this portion of the landscape has evolved over time. In the analysis were compared to the years 1845, 1948, 1990 and 2000. The coefficient for these areas was calculated according to the methodology of Agroprojekt.

Furthermore, the ecological stability coefficients were calculated. Methods according to Miklós and Míchal were used for the calculation. The coefficients were determined for the year 1845

and 2000. Method according to Míchal expresses index number and determines the ratio of the areas of stable and unstable landscape features in the area. The method is based on a clear and final classification of landscape element in stable or unstable group and does not allow evaluation of the particular condition of these elements. The method according to Miklós is not based on the distribution to stable and unstable areas, but differentiates their ecological significance using numerical coefficients. The underlying data were obtained from the Database of long-term changes in land use of Czech Republic (Bicik 2015).

RESULTS AND DISCUSSION

Analysis of the historical development of land use

The following tables (Table 1, Table 2 Table 3) show data about land use in the individual cadastral areas in 1845, 1948, 1990 and 2000. The tables are divided according to particular areas on permanent cultures (gardens, orchard, vineyard and hopgarden), different areas (other, built up and water areas) and farmlands (arable land, permanent culture, meadows and pastures).

Cadastral area Čečkovice

An analysis of historical data "Land use" indicates significant decrease of pasture areas (about 12.76 hectares for 155 years), while there was a slight increase in the area of arable land (about 9.33 hectares per 155 years). A significant loss of pasture may have occurred due to changes in farming and increase in built-up areas. Meadows, forest areas and water areas are moving more or less in the same range.

Table 1 Data about land use in cadastral area Čečkovice

	1845		1948		1990		2000	
	ha	%	ha	%	ha	%	ha	%
Arable land	132.30	54.53	155.00	63.94	152.60	62.93	152.60	62.98
Permanent c.	3.30	1.36	5.10	2.10	5.60	2.31	5.50	2.27
Meadows	39.50	16.28	37.20	15.35	40.10	16.54	40.20	16.59
Pastures	33.20	13.69	8.60	3.55	1.80	0.74	1.70	0.70
Farmland	**208.30**		**205.90**		**200.00**		**200.00**	
Forest areas	**26.10**	10.76	**25.00**	10.31	**30.90**	12.74	**30.90**	12.75
Water areas	1.80	0.74	1.80	0.74	2.90	1.20	2.90	1.20
Built up areas	1.20	0.49	2.50	1.03	2.70	1.11	2.70	1.11
Other areas	5.20	2.14	7.20	2.97	5.90	2.43	5.80	2.39
Different areas	**8.20**		**11.50**		**11.50**		**11.40**	
Sum	**242.60**	100.00	**242.40**	100.00	**242.50**	100.00	**242.30**	100.00

Legend: Permanent c. – permanent cultures

Cadastral area Jeřišno

A significant decrease in pasture areas occurred in the cadastral area Jeřišno (about 68.01 hectares), and there was a slight decline in grassland areas (7.7 ha). Conversely, there was an increase of arable lands (21.1 ha), permanent crops (6.4 ha), other areas (11.3 ha) and urban areas (4.6 ha). The increase of forest and water areas can be assessed positively, where the woodland area increased for 27.4 hectares and water areas increased by 3.3 hectares.

Table 2 Data about land use in cadastral area Jeřišno

	1845		1948		1990		2000	
	ha	%	ha	%	ha	%	ha	%
Arable land	28.70	36.53	300.00	38.89	297.00	38.50	302.80	39.25
Permanent c.	6.90	0.89	10.90	1.41	13.30	1.72	13.30	1.72
Meadows	74.50	9.66	76.40	9.90	73.40	9.52	66.80	8.66
Pastures	73.80	9.57	25.10	3.25	5.70	0.74	5.70	0.74
Farmland	**436.90**		**412.40**		**389.40**		**388.60**	
Forest areas	**307.70**	39.90	**327.80**	42.49	**335.20**	43.45	**335.10**	43.43
Water areas	7.00	0.91	6.70	0.87	11.60	1.50	12.30	1.59
Built up areas	3.40	0.44	5.40	0.70	7.80	1.01	8.00	1.04
Other areas	16.20	2.10	19.10	2.48	27.40	3.55	27.50	3.56
Different areas	**26.60**		**31.20**		**46.80**		**47.80**	
Sum	**771.20**	100.00	**771.40**	100.00	**771.40**	100.00	**771.50**	100.00

Cadastral area Maleč

The analysis pointed to a significant loss of pasture (29.2 ha). The slight decline of area can be also observed in arable land (3.5 ha). Increasing the acreage occurred in all the other analyzed areas. The largest increase occurred in the area of other land (10.3 ha) and permanent crops (8.4 ha). The slight increase was observed in water surfaces (0.9 ha) and acreage of forest areas increased about 3.3 ha.

Table 3 Data about land use in cadastral area Maleč

	1845		1948		1990		2000	
	ha	%	ha	%	ha	%	ha	%
Arable land	170.90	57.12	188.10	62.89	167.50	56.00	167.40	56.01
Permanent c.	4.40	1.47	13.70	4.58	12.80	4.28	12.80	4.28
Meadows	72.70	24.30	70.00	23.40	77.00	25.74	77.00	25.76
Pastures	29.40	9.83	8.60	2.88	0.30	0.10	0.20	0.07
Farmland	**277.40**		**280.40**		**257.60**		**257.40**	
Forest areas	**1.40**	0.47	**0.90**	0.30	**5.20**	1.74	**4.70**	1.57
Water areas	6.70	2.24	5.10	1.71	7.60	2.54	7.60	2.54
Built up areas	2.60	0.87	4.90	1.64	7.40	2.47	7.80	2.61
Other areas	11.10	3.71	7.80	2.61	21.30	7.12	21.40	7.16
Different areas	**20.40**		**17.80**		**36.30**		**36.80**	
Sum	**299.20**	100.00	**299.10**	100.00	**299.10**	100.00	**298.90**	100.00

Calculations coefficient of ecological stability

Coefficient of ecological stability – Míchal

Used formula for calculation

$$K_{es} = \frac{\text{Stable ecosystem}}{\text{Unstable ecosystem}} = \frac{FA + WA + PG + Pa + Mo + Or + Vi}{AL + HA + Hg}$$

Legend:

FA = forest area	Or = orchards
WA = water area	Vi = vineyard
PG = permanent grassland	AL= arable land
Pa = pastures	HA = human areas
We = wetlands	Hg = hopgarden

Cadastral area Čečkovice

Year 1845

$$K_{es} = \frac{\text{Stable ecosystem}}{\text{Unstable ecosystem}} = \frac{26.1 + 1.8 + 3.3 + 39.5 + 33.2}{132.3 + 1.2 + 5.2} = \underline{\underline{0.75}}$$

Year 2000

$$K_{es} = \frac{\text{Stable ecosystem}}{\text{Unstable ecosystem}} = \frac{30.9 + 2.9 + 5.5 + 40.2 + 1.7}{152.6 + 2.7 + 5.8} = \underline{\underline{0.50}}$$

Cadastral area Ježišno

Year 1845

$$K_{es} = \frac{\text{Stable ecosystem}}{\text{Unstable ecosystem}} = \frac{307.7 + 7 + 6.9 + 74.5 + 73.8}{281.7 + 3.4 + 16.2} = \underline{\underline{1.56}}$$

Year 2000

$$K_{es} = \frac{\text{Stable ecosystem}}{\text{Unstable ecosystem}} = \frac{335.1 + 12.3 + 13.3 + 66.8 + 5.7}{302.8 + 8 + 27.5} = \underline{\underline{1.28}}$$

Cadastral area Maleč

Year 1845

$$K_{es} = \frac{\text{Stable ecosystem}}{\text{Unstable ecosystem}} = \frac{1.4 + 6.7 + 4.4 + 72.7 + 29.4}{170.9 + 2.6 + 11.1} = \underline{\underline{0,62}}$$

Year 2000

$$K_{es} = \frac{\text{Stable ecosystem}}{\text{Unstable ecosystem}} = \frac{4.7 + 7.6 + 12.8 + 77 + 0.2}{167.4 + 7.8 + 21.4} = \underline{\underline{0.52}}$$

Coefficient of ecological stability – Miklós

Used formula for calculation

$$K_{es} = \frac{\sum p_{ni} \times \sum k_{pi}}{\sum p}$$

Legend: p_{ni} – acreage of individual area; k_{pi} – the coefficient of ecologically significant areas; p – acreage of the area

Used coefficients of ecologically significant areas:

Arable land:	0.14	Pastures:	0.68
Pernament culture:	0.65	Forests, water area:	1.0
Meadows:	0.62	Other areas:	0.1

Cadastral area Čečkovice

Year 1845

$$K_{es} = \frac{132.3 \times 0.14 + 3.3 \times 0.65 + 39.5 \times 0.62 + 33.2 \times 0.68 + 26.1 + 1.8 + 1.2 \times 0.1 + 5.2 \times 0.1}{246.6}$$

K$_{es}$ = 0.39

Year 2000

$$K_{es} = \frac{152.6 \times 0.14 + 5.5 \times 0.65 + 40.2 \times 0.62 + 1.7 \times 0.68 + 30.9 + 2.9 + 2.7 \times 0.1 + 5.9 \times 0.1}{242.4}$$

K$_{es}$ = 0.35

Cadastral area Ježišno

Year 1845

$$K_{es} = \frac{287.1 \times 0.14 + 6.9 \times 0.65 + 74.5 \times 0.62 + 73.8 \times 0.68 + 307.7 + 7 + 3.4 \times 0.1 + 16.2 \times 0,.1}{771.2}$$

K$_{es}$ = 0.59

Year 2000

$$K_{es} = \frac{302.8 \times 0.14 + 13.3 \times 0.65 + 66.8 \times 0.62 + 5.7 \times 0.68 + 335.1 + 12.3 + 8 \times 0.1 + 27.5 \times 0.1}{771.5}$$

K$_{es}$ = 0.58

Cadastral area Maleč

Year 1845

$$K_{es} = \frac{170.9 \times 0.14 + 4.4 \times 0.65 + 72.7 \times 0.62 + 29.4 \times 0.68 + 1.4 + 6.7 + 2.6 \times 0.1 + 11.1 \times 0.1}{299.2}$$

K$_{es}$ = 0.34

Year 2000

$$K_{es} = \frac{167.4 \times 0.14 + 12.8 \times 0.65 + 77 \times 0.62 + 0.2 \times 0,.68 + 4.7 + 7.6 + 7.8 \times 0.1 + 21.4 \times 0.1}{298.9}$$

K$_{es}$ = 0.32

Table 4 Calculation results

	Čečkovice		Ježišno		Maleč	
K$_{es}$ accor. to:	Míchal	Miklós	Míchal	Miklós	Míchal	Miklós
1845	0.75	0.39	1.56	0.59	0.62	0.34
2000	0.50	0.35	0.52	0.58	0.52	0.32

Table 4 shows the results of calculations of the ecological stability coefficients. The coefficient of ecological stability decreases over the last 155 years in cadastral area Čečkovice. Based on the calculation K$_{es}$ according to Míchal it has been found that this is a landscape type A - Creation (landscape completely transformed by man). It is a very stable area with intensive use of cultural (agricultural) land. Results by Miklós ranged from 0.39 to 0.35. This methodology evaluates K$_{es}$ by using a scale from 0 to 1, and closer to number one means more stable areas. Based on the determined values could be stated that the area is not very stable and their stability decreases with time.

Based on the calculation K$_{es}$ according to Míchal it has been found that this is a landscape type B – Maintenance (territory moderately stable, with normal cultural landscape with technical objects

in relative conformity with the character of natural elements) for cadastral area Ježišno. Results by Miklós almost unchanged (values from 0.58 to 0.59). Based on this result we can say that the area is stable and its stability during the reporting period was not significantly affected.

Based on the calculation K_{es} according to Míchal it was found that cadastral area Maleč is a landscape type A - Creation. This is an area above average used, with a clear disruption of natural structures, where the fundamental ecological functions must be continually replaced by technical interventions. Results by Miklós were in the range of values from 0.34 to 0.32. Based on this calculation, this is very little stable area and the stability decreases with time.

CONCLUSION

Historical data analysis Land use showed significant changes in landscape use. Due to the change of farming management, arable and forest areas have increased. Change of farming management caused loss of pasture as well.

Calculations of ecological stability coefficients showed difference between the two methodologies. Even though it can be stated that the area is generally less stable and its stability decreases with time. Since the area of interest is located in a protected part of the Iron Mountains, there should be a higher ecological stability.

The form of the agricultural landscape has dramatically changed during the 20th century. These developments have occurred due to political changes and expansion of intensive farming. These changes have resulted a reduction in species diversity in the agricultural landscape and contributed to the uniformity. Agri-environmental measures should reverse these changes and help restore the Czech agricultural landscape of its original character. If they are properly designed, they will encourage the occurrence of animal and plant species.

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