GEOGRAFICKÝ ČASOPIS

60 2008 3

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THE CHANGING SPATIAL STRUCTURE OF AGRICULTURAL LAND USE IN CZECHIA SINCE THE MID-19TH CENTURY

J. Kabrda: The changing spatial structure of agricultural land use in Czechia since the mid-19th century. Geografický časopis, 60, 2008, 3, 7 figs., 4 tabs., 29 refs.

The objective of this article is to assess changes in the spatial structure of agricultural land use (SALU) in Czechia in four time horizons – 1845, 1948, 1990 and 2000. A quantitative approach was adopted based on a combination of two indicators – share of agricultural land in the total area (SAGL) and share of arable land in the agricultural land (SARL). The Basic Territorial Units (BTU's) of Czechia (8 903) were classified into four types of SALU – intensive (A), sharply intermediate (B), moderately intermediate (C) and extensive (D). Two different methods of classification based on median values of SAGL and SARL were used.

It was found that each SALU type creates compact zones found in specific natural conditions. The A type with prevailing arable land occupies lowlands and lower highlands whereas the D type with prevailing forests can be found in mountains and higher highlands. The two intermediate types (B and C) create a transition, but the pattern of their occurrence is less obvious, compact and stable. During development, the occurrence of intermediate types decreased, and all SALU types tended to separate spatially to create more compact zones. It was a result of the changing energy and material "metabolism" of Czech economy, modernization of agriculture and growing regional specialization.

Key words: land use changes, agricultural land, arable land, transformation of agriculture, Czech agriculture, Czechia

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THEORETICAL BACKGROUND, OVERVIEW OF LITERATURE

In recent years, research into land use and its changes has attracted much attention across the global scientific community. *Land use* can serve as an indicator of the state and changes of nature – society interaction (Bičík et al. 2001b), and thus provides a good framework for interdisciplinary research in social and environmental sciences. Land use is also easy to quantify with a relative abundance of "hard" reliable data – cadastral statistics, remote sensing, etc. Today, research into *agricultural land use* deserves special attention in Europe, and hence also in Czechia. Several reasons underpin this statement: (a) agriculture is still the most important "user" of land (see below, Tab. 1); (b) there is a lively discussion within the European Union (EU) about the future of one of its largest and financially most demanding policies – the Common Agricultural Policy (CAP) – with large impacts on the countryside; (c) there is growing interest in and enthusiasm for sustainable land management both among politicians and the public (preventing natural hazards – floods, soil erosion, etc.); (d) demand is increasing for renewable energy sources (particularly biomass in our conditions); (e) alternative forms of recreation in agricultural landscape (agrotourism, biking, etc.) are becoming more and more popular. All these factors emphasize the importance of research both into *processes* (energy cycles, decision making, etc.) and *structures* (patterns) occurring in agricultural landscapes.

As a result of economic and technological development, radical changes have occurred in European agricultural landscapes since the 19th century. Krausmann (2001), Haberl et al. (2003) or Krausmann et al. (2003) call it "a transformation of *socio-economic metabolism"*. This term refers to the volume and structure of energy and materials used (extracted, processed and emitted back) by the human economy. Simply, the economic system and its different subsystems are understood in an analogy to a living organism, in an input-output model (see e.g. Fischer-Kowalski and Haberl eds. 2007 for an overview).

Generally, increasing yields led to a decrease of the area of agricultural land and to a growth of forested areas; while urbanization and industrialization led to an increase of built-up and other artificial areas. For the situation in Czechia, see e.g. Bičík et al. (2001a and 2001b), or Tab. 1. *In spatial terms*, processes of functional differentiation and specialization resulted in two contradictory tendencies. On the one hand, localities in favourable natural conditions or in economically exposed regions experienced a strong *intensification* of agriculture – growth of the area of arable land, investments of capital, large-scale mechanization and use of chemicals, field amalgamation, etc. On the other hand, localities in less favourable conditions or in remote peripheral regions suffered from marginalization and *extensification* – depopulation, land abandonment, grassing-over, afforestation, etc.

Several methods were developed to quantify, assess and explain the abovementioned spatial trends. Many of them do so by depicting changing correlation between land use and natural or socio-economic factors. Most of the studies confirm the long-term trends of *land use specialization / differentiation based on local conditions* – see e.g. Himiyama et al. (2001) for Japan or Sporrong et al. (1996) for Sweden. The research activities and experience from the *Central European countries* are especially important for us.

Tab. 1. Land use changes in Czechia 1845-2000: shares of land use categories in the total area (%)

	1845	1948	1990	2000
Arable land	48.2	49.9	41.0	39.1
Permanent cultures	1.1	1.9	3.0	3.0
Meadows	9.3	9.1	7.3	8.6
Pastures	8.1	3.9	3.3	3.6
Forested areas	28.9	30.2	33.3	33.4
Water areas	1.4	1.1	2.0	2.0
Built-up areas	0.6	1.1	1.6	1.7
"Other" areas	2.3	2.9	8.6	8.6
Total	100.0	100.0	100.0	100.0
SAGL	66.8	64.7	54.5	54.3
SARL	72.2	77.1	75.2	72.0

Note: SAGL = Share of agricultural land in the total area, SARL = Share of arable land in the area of agricultural land, see text for more explanations
Source: LUCC UK Prague Database

In *Slovakia*, a methodology has been developed for assessing land cover changes by comparing remote-sensing data from the *CORINE Land Cover Database*, which covers approximately the last 30 years. Oťaheľ et al. (2002a and 2002b) compared a theoretical "natural landscape" with the current land cover. Šúri (2003), with the same database, examines the influence of relief – altitude, slope and aspect – on the current (1990s) land cover of Slovakia.

For *Slovenia*, many works describe the *influence of natural conditions* on land use changes. Gabrovec and Kladnik (1997) show an unambiguous dependence of current (1994) land use and its recent changes (1961-1994) on the division of Slovenia into "natural geographical units". Consequently, the authors evaluate the influence of various natural factors – lithology, climate types and altitude – on the current land use pattern. Petek (2002) examines land use changes in Slovenia from 1896 to 1999 at the cadastral level. Petek and Gabrovec (2002) emphasize the problem of rapid urbanization in Alpine plains; and, on the other hand, extensification and thus disappearance of the cultural landscape in Dinaric and Mediterranean regions and in Slovenian Alps. Gabrovec et al. (2001) examine the dependence of land use changes in Slovenia in the years 1896-1999 on various natural factors.

In *Czechia*, Bičík and Kupková (2002) used a method of "weighed averages" to confirm the dependence of land use development in Czechia on the quality of *natural conditions*, expressed by the "official price of agricultural land". This dependence has strengthened since the mid-19th century. Štych (2003) studied the dependence of land use changes in Czechia since the mid-19th century on altitude. Mareš and Štych (2005) stressed the reversal of a historical trend of grassland shrinkage after 1990, especially at higher altitudes. They also assessed the influence of *socio-economic spatial exposedness* on land use

changes. Kabrda et al. (2006) examined the relationship between soil quality and land use changes within the whole territory of Czechia.

Put together, most of the studies revealed a growing correlation between land use structure and the natural (but also socio-economic) conditions of a given locality. This can serve as an evidence of *growing differentiation of the spatial pattern of land use*.

OBJECTIVES AND HYPOTHESES

Another method of assessing the changing spatial pattern of land use is applied in this article. It is based on the approach of Hurbánek and Spišiak (2005) who used it for *current* (2002) Slovakia. Thanks to the existence of the LUCC UK Prague Database (see below), we managed to apply this methodology in Czechia to assess the *development* – in four time horizons since the mid-19th century.

The aim of this article is to classify the whole area of Czechia, or all its 8 903 Basic Territorial Units (BTU's) to be precise, into four basic types of *structure of agricultural land use* (hence SALU). This classification is based on a combination of two basic indicators used widely in agricultural geography. The first is *share of agricultural land on total area* (hence SAGL), defined as SAGL = AGL / TA * 100 (%), where AGL is the area of agricultural land and TA is the total area of a given spatial unit (both in hectares). The second indicator, *share of arable land in agricultural land* (hence SARL), is defined in a similar way – as SARL = ARL / AGL * 100 (%), where ARL is the area of arable land (in hectares). If we assume that the values of both these indicators in any BTU are simply either "high" or "low", *four combinations / types are possible*. Exact figures (specification of "high" and "low" values) for Czechia are given in chapter on methodology; this section serves only for a general overview of the four types and their hypothesized characteristics.

These four types are graphically expressed in Fig. 1 with two major simplifications that somehow constrain this methodology (see below): (1) Agricultural land consists only of arable land and permanent grasslands, and non-agricultural land only of forests. (2) Natural conditions (slope / altitude) are the only factor influencing land use pattern. The *underlying hypothesis, which this article aims to verify,* is that each of the four combinations / types has its own spatial pattern and should be found in specific natural and socio-economic conditions, because of its structural character, as follows:

The first type (A), having a high share of both agricultural land (SAGL) and arable land within it (SARL) can be called *intensive*. This type should be found in lowlands with best climate and most fertile soils, but not directly in the vicinity of larger cities – not influenced by urbanization. It forms the agricultural core, or the "granary" of the country.

The second type (B) can be called *sharply intermediate*. It has a low share of agricultural land (SAGL) but a high share of arable land within it (SARL). This type, with a sharp distinction between arable land and non-agricultural land, should surround the type (A). We assume that this type can represent two different sub-types and therefore can be found in two different geographical set-

tings – either (a) on foothills or in larger valleys with flat bottoms and steep slopes (arable land vs. forested areas) or (b) in urban fringe (arable land vs. built-up and other artificial areas).

The third type (C), which can be called *moderately intermediate*, has a high share of agricultural land (SAGL), but a low share of arable land within it (SARL). Two sub-types can exist in this case as well: (a) in highlands and lower mountains, or in flat basins with heavy and wet soils (high share of grasslands); or (b) in specifically favourable natural conditions – such as fertile soils, good climate, sunny slopes, etc. (in the Czech case as at Hustopeče and Mikulov) – or in the vicinity of cities (high share of permanent cultures – orchards, vineyards, hop-gardens). The sub-type (a) with grasslands in highlands and lower mountains should, however, prevail.

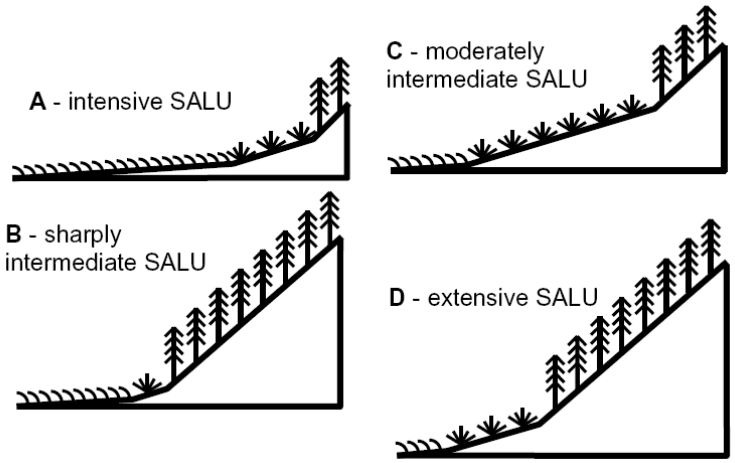

Fig. 1. Graphical model of four types of structure of agricultural land use (SALU)

Note: see text for explanations
Source: Hurbánek and Spišiak (2005), modified

The fourth type (D), called *extensive*, is typical of a low share both of agricultural land (SAGL) and arable land within it (SARL). We presume that this type will (a) prevail in higher highlands and mountains – with a high share of forested areas, and grasslands dominating agricultural land. However, it can probably be found, although to a lower extent, (b) within urban zones, where built-up and other artificial areas cover most of the non-agricultural land and permanent cultures (especially gardens) dominate the agricultural land. Therefore, the name of this type – "extensive" – is an over-simplification; actually, it will be found also in urban areas, where the proper name would rather be "*urbanized*". However, our methodology hardly enables us to separate these two sub-types. We have to bear in mind this drawback when analysing the results of the research.

METHODOLOGY AND DATA SOURCES

Used data – LUCC UK Prague database

Land use data for this work were extracted from the *LUCC UK Prague Database* (hence "database", LUCC for Land Use / Cover Changes and UK for Charles University). This dataset, compiled and used by researchers at the Faculty of Science, Charles University in Prague, has been described many times before – see e.g. Bičík (1998) or Bičík et al. (2001a and 2001b). Thus, we will only provide a short overview here.

The database is based on aggregated data from cadastral statistics, starting with the so-called Stable Cadastre (statistics dated 1845). The whole area of Czechia is divided into 8 903 Basic Territorial Units (BTU's), each consisting of one or more cadastres. The land use structure of each BTU is recorded in four time horizons, representing the main milestones of modern Czech history – 1845 (before first impacts of complex modernization on land use), 1948 (communist coup d'état), 1990 (the "Velvet revolution") and 2000 (after ten years of transformation). In each time horizon, the areas (in hectares) of eight basic land use categories are recorded in the database for each BTU – (a) arable land, (b) permanent cultures (gardens, vineyards, orchards and hop-gardens), (c) meadows and (d) pastures (together permanent grasslands), (e) forested areas, (f) water areas, (g) built-up areas and (h) "other" areas (non-productive land, bare land, infrastructure, mines, waste deposits, etc.). These eight basic categories can be aggregated into three general categories – (i) agricultural land (a + b + c + d), (ii) forested areas (e) and (iii) "remaining" areas (f + g + h).

Land use changes in Czechia, as recorded in the database, can be seen in tab. 1, together with the values of SAGL and SARL. These data were interpreted in the above-mentioned articles, but it is necessary to present their findings briefly here, as an introduction to the analysis of changing SALU. For further information, differences between the time-periods and the "driving forces" of changes see e.g. Jeleček (2002).

Arable land and forested areas are the most widespread land use categories – either one or another constitutes the "landscape matrix" (Lipský 2000) in most Czech regions. The share of arable land was increasing until the 1880s or 1890s (with some regional variations), when a steady decrease started and has continued until now (Jeleček 2002). The main reason for this decrease is intensification of agriculture (yields growing faster than consumption) – e.g. Krausmann (2001). The area of grasslands was gradually decreasing for almost the whole studied period, especially due to changing agricultural technologies (from pastures to stables, from hay to silage etc. – ibid.). The area of grasslands started to increase in the second half of the 1980s. This trend continued and intensified in the 1990s, with a slump in agricultural production and a new system of state policies (Kabrda and Jančák 2007). As a result of all these trends, the area of agricultural land (SAGL) was decreasing during the whole monitored period, and, vice-versa, the area of forested areas was increasing. The share of arable land in agriculture land (SARL) was decreasing in the last two time-periods, but increasing in the first one, when (especially in the 2nd half of the 19th century) the area of permanent grasslands was decreasing to the advantage of arable land.

As a result of urbanization and the complex modernization of society and the economy, built-up areas were growing steadily. This applies to permanent cultures (especially gardens) and "other" areas (mostly artificial) as well. Particularly the rapid growth of artificial "other" areas during the era of socialism (1948-1990) had large negative impacts on the Czech landscape and environment.

Methodology of the study

As stated above, our objective is to classify all the BTU's into the four types of SALU on the basis of a combination of SAGL and SARL values. However, the key question is *how exactly we should combine these two indicators* (i.e. how to determine the "low" and "high" values). Hurbánek and Spišiak (2005) proposed four different methods, but, as a result of their study, they suggested that only two of them were useful – median and cluster analysis (K-Means cluster). Furthermore, preliminary calculations done by Kabrda (unpublished) led to a conclusion that cluster analysis was not suitable for assessment of SALU in different time horizons. Thus, for analysis of the development of SALU, only the *median method* is appropriate. Let us explain it.

Let M_{SAGL} be the median value of SAGL for the whole set of BTU's and M_{SARL} the median value of SARL for this set. Then each BTU_I can be placed in one of the four classes of SALU (see Fig. 1) according to the following rules (Hurbánek and Spišiak 2005): Type (A) – intensive: $SAGL_I \geq M_{SAGL}$ and at the same time $SARL_I \geq M_{SARL}$. Type (B) – sharply intermediate: $SAGL_I < M_{SAGL}$ and at the same time $SARL_I \geq M_{SARL}$. Type (C) – moderately intermediate: $SAGL_I \geq M_{SAGL}$ and at the same time $SARL_I < M_{SARL}$. Type (D) – extensive: $SAGL_I < M_{SAGL}$ and at the same time $SARL_I < M_{SARL}$.

Nevertheless, it was found that generally two ways of determining median values exist when studying SALU in development (different time horizons). Firstly, M_{SAGL} and M_{SARL} can be calculated for each year *separately* – that is from 8 903 values. Or, secondly, we can calculate only one M_{SAGL} and one M_{SARL} *together* for all four time horizons – that is from 35 612 values (4 * 8 903). In the following text, these two approaches will be called simply "median separately" and "median together" methods.

The former ("median separately") method provides a series of static snapshots, where a spatial pattern is easy to recognize, frequencies of the four SALU types are proportionate, but characters of these types differ from one time horizon to another (because of changing overall land use structure, i.e. M_{SAGL} and M_{SARL}).

On the other hand, in the latter ("median together") method, characters of the four SALU types are fixed, so it can be used to make a cartographic "animation" of the development of agricultural land use structure. As both SAGL and SARL are changing (generally decreasing – Tab. 1) at different paces, proportions between the four SALU types are changing as well, when assessed with the help of the "median together" method. The BTU's of types B and D should be getting more frequent (decreasing share of agricultural land)

and the BTU's of type C less frequent (decreasing share of permanent grasslands). We can then examine and assess where these "switching" BTU's lie – in which natural and socio-economic conditions, because geography is "the where of why". Both methods were used in this work, but the latter one ("median together") seems more appropriate for development (assessing different time horizons), and thus more space will be devoted to it in this article. The median values of SAGL and SARL are given in Tab. 2.

Tab. 2. Median values of SAGL and SARL for both methods (Median separately and Median together)

	Separately				Together
	1845	1948	1990	2000	
M_{SAGL}	74.98	72.86	63.34	63.18	68.84
M_{SARL}	74.39	78.30	76.66	74.97	76.18

Note: see text for explanations
Source: own calculations

The results section of this article starts with an assessment based on the "median separately" method, and continues with a discussion of the results of the "median together" method. The results are displayed in tables and maps. The tables (Tabs. 3 and 4) show frequencies of occurrence (%) of BTU's in the four types of SALU. Furthermore, shares of *stable BTU's* were calculated. A stable BTU had the same type of SALU in all four time horizons. The figures in tables show the share of stable BTU's in the total number of BTU's (8 903), so that stable + "unstable" BTU's = 100 %. Because of the length of this article, we managed to include all four maps for all four time horizons only for the more useful "median together" method (Figs. 4 to 7). For the "median separately" method, only the maps for the first (1845) and last (2000) time horizons were included (Figs. 2 and 3), but the results of both methods are rather similar, and changes of SALU in case of the "median separately" method were not so dramatic, so we hope this reduction is acceptable.

Finally, a few words must be said about the *reliability and downsides of our methodology*:

1 – Firstly, any classification of the complex patterns of landscape into four SALU types is a major simplification. Thus, it can only serve for a rough comparison and overview of the whole territory of Czechia, not for a detailed assessment of individual BTU's.

2 – Secondly, we have to bear in mind that each SALU type is rather heterogeneous (except A – intensive). This is caused by the fact that "non-arable" agricultural land consists not only of permanent grasslands, but also of permanent cultures, the importance of which has increased. The ratio between permanent grasslands and permanent cultures changed from 16:1 in 1845 to 4:1 in 2000 (see Tab. 1). Similarly, "non-agricultural" land includes not only forested areas, but also faster grow-

ing built-up and other artificial areas. The ratio between forests and "remaining" areas changed from 7:1 in 1845 to 3:1 in 2000 (ibid.). Thus, generally, it is a simplification to apply the indicators used by agricultural geography (SAGL and SARL) to the whole territory. The "extensive" type will be found also in and around cities, where the proper name would be "urbanized". This fact can complicate the analysis and explanation of the resulting spatial pattern.

3 – Thirdly, because of the "socio-economic" character of the statistical distribution of the values of SAGL and SARL (a deformed Gauss curve – Hampl 2000), a significant portion of BTU's (modus) can be found close to the median. But cutting a distribution (in "low" and "high" values) close to its modus is always unnatural to some extent.

4 – And finally, the ecological quality (intensity of use, application of fertilizers, etc.) of each land use category (arable land, pastures, etc.) changed dramatically during the monitored period (1845-2000), together with simplification of landscape microstructure (Lipský 2000). Landscape macrostructure, which is assessed in this article, provides only a partial picture of dramatic changes occurring in the Czech landscape due to massive modernization of the economy and agriculture during the 19th and 20th centuries. But despite these problems we still hope this method provides a clear, comprehensible and useful tool for assessment of the changing spatial pattern of the structure of agricultural land use.

RESULTS AND DISCUSSION

Results of the "median separately" method

Firstly, let us turn our attention to the *"median separately" method* (Tab. 3 and Figs. 2 and 3). Several conclusions can be drawn from these results:

Tab. 3. Frequencies of occurrence of BTU's (% of the total number of BTU's) in the four types of SALU, method (1) – Median separately for each year

	1845	1948	1990	2000	Stable BTU's
A	29.9	31.7	33.7	34.1	20.3
B	20.1	18.3	16.3	15.9	6.9
C	20.1	18.3	16.3	15.9	6.4
D	29.9	31.7	33.7	34.1	18.6
Total	100.0	100.0	100.0	100.0	52.2

Note: see text for more explanations
Source: own calculation

The maps prove that all four SALU types (especially A and D) create relatively *compact areas of occurrence*, that can be found *in specific natural and socio-economic conditions*, as was hypothesized. Their occurrence complies with the rules and logic of the so-called "differential rent" (Jeleček 2002). Inten-

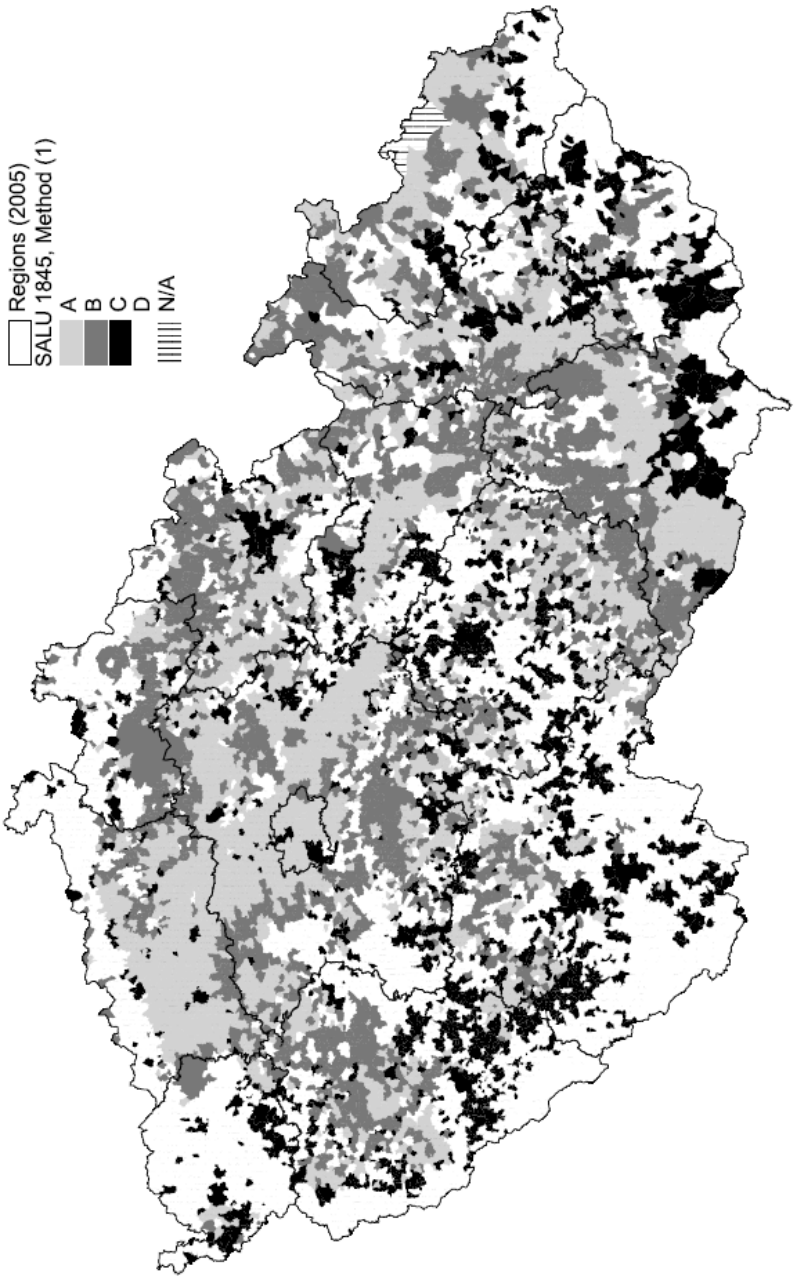

Fig. 2. SALU types in Czechia in 1845, method (1) – Median separately

Source: own calculations; see text for explanations

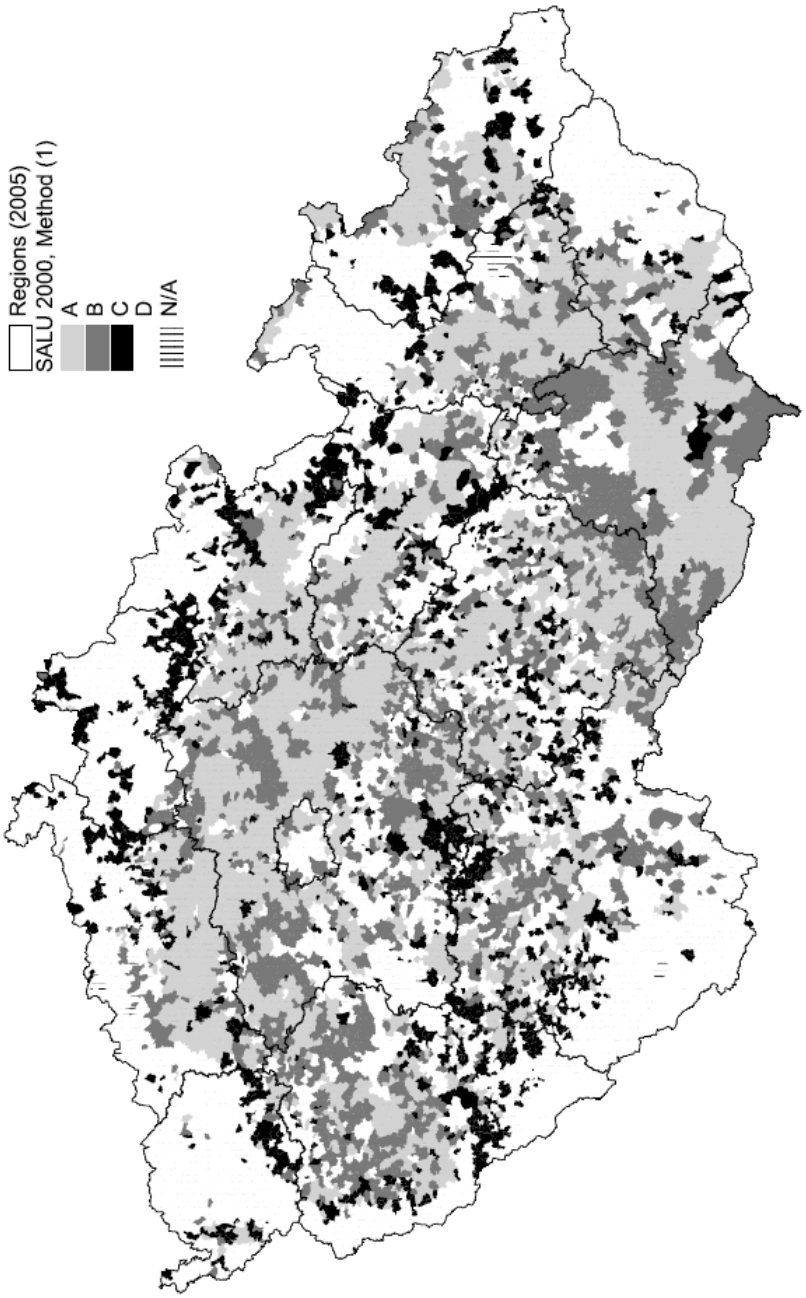

Fig. 3. SALU types in Czechia in 2000, method (1) – Median separately

Source: own calculations; see text for explanations

sive SALU (type A) covers our most fertile soils in the main lowlands both in Bohemia and Moravia, but can also be found in some lower highlands with flat relief and soils that are relatively easy to cultivate (southern and western Bohemia, Bohemian – Moravian Highland, etc). Extensive SALU (type D) can be found in mountainous, peripheral border regions encircling almost the whole territory of Czechia, and also in higher highlands and inner peripheries. It lies within or around large cities as well, where the type should be called "urbanized". Intermediate types are more scattered and create a transition between the A and D types. The B type (sharply intermediate) seems to be more interconnected with the A type, and can be found mostly in better natural conditions. The C type (moderately intermediate) is more connected with higher highlands and generally less favoured areas.

In development (Tab. 3), the most striking feature is the gradually decreasing occurrence of BTU's in both intermediate types (1845-2000 by 5 % in total) and a consequent growth of importance of the A and D types. This suggests a general and long-term trend towards homogenization on a micro-regional level (decreasing occurrence of BTU's with "mixed" / diverse land use) and, on the other hand, a *heterogeneization on a macro-regional level*. Land use categories are being separated within the whole national system according to local natural and socio-economic conditions. This complies with the comments on the effects of modernization of the economy and agriculture, spatial differentiation, specialisation, growing regional division of functions (Hampl 2000), etc. The growth of occurrence of BTU's of the A type may be seen as evidence of increasing intensification in better / more attractive natural and socio-economic conditions, while the growing occurrence of BTU's of the D type is evidence of increasing extensification in worse conditions but also of urbanization in the main urban cores (although to a lesser extent). Interestingly, these trends were gradual and occurred in all three time periods, suggesting that they were a result of economic / technological rather than political changes (Haberl et al. 2001).

Explanation of the growing macro-regional differentiation lies in *changing socio-economic metabolism*. In pre-industrial agriculture (1845), the land use of all BTU's of Czechia was relatively similar. There had to be a forest (wood for construction, fuel, tools, etc.), arable land (nourishment of the population) and grassland (nourishment of domestic animals) in almost every BTU. But then, since the 2nd half of the 19th century, a new pattern started to emerge. On the one hand, agricultural yields started to grow together with the consumption of non-renewable (spatially independent) energy resources. On the other hand, traffic interconnection, integration and competition within the whole system improved. These trends enabled (or enforced) specialization of each BTU on a particular land use type, more suitable for local natural and/or socio-economic conditions. The urban function was preferred in some places, elsewhere agricultural (either intensive – arable land, or extensive – permanent grasslands), horticultural, silvicultural, recreational, etc. The products of other land use types were easily transported from other BTU's. In this way, a new socio-economic system was established, interconnected on a hierarchically higher level (Hampl 2000, Haberl et al. 2003, Krausmann et al. 2003).

This explanation is also supported by the *spatial pattern of SALU changes* (compare Figs. 2 and 3). In 2000, the regional pattern of SALU was more organized and compact than in 1845. The D type became very typical in the border mountain ranges (afforestation and land abandonment here followed the expulsion of Czech Germans after 1945) where it created large compact areas. The A type, with scattered remnants of BTU's of the B type in somehow worse natural conditions, covered most of the lowlands and lower highlands. The C type was pushed from many average altitudes in southern Bohemia and Bohemian – Moravian Highland, and also from southern and south-eastern Moravia (decline of traditional pastoral farming in the mountains). In 2000, the BTU's of the C type formed a typical fringe separating the relatively intensively used interior of the country from the forested borderland, with only rare occurrence in the inner periphery (border between Central and Southern Bohemia, river Svratka valley, etc.).

The *transitional character of both intermediate SALU types* (B and C) is well documented with the share of stable BTU's (Tab. 3). Approximately 60 % of BTU's having either A or D types in 1845 were stable – having the same type of SALU in 2000. The same applies only for approximately 35 % of BTU's having B or C types in 1845.

Results of the "median together" method

Now, we shall focus on the "*median together*" *method* (Tab. 4 and Figs. 4 to 7). Obviously, the results are similar to some extent, but this method helps us to examine differences between the three time periods with different "driving forces" (1845-1948-1990-2000). The following conclusions, different from the previous method, may be drawn:

Tab. 4. Frequencies of occurrence of BTU's (% of the total number of BTU's) in the four types of SALU, method (2) – Median together for all four years

	1845	1948	1990	2000	Stable BTU's
A	31.0	39.6	29.4	28.1	19.4
B	12.0	18.0	21.9	19.5	5.5
C	31.7	18.8	10.3	11.3	5.0
D	25.3	23.6	38.4	41.1	15.6
Total	100.0	100.0	100.0	100.0	45.4

Note: see text for more explanations
Source: own calculation

The frequencies of occurrence of BTU's in the four SALU types are not proportionate here (Tab. 4), but they reflect changing structure of land use in the whole of Czechia (Tab. 1). Thanks to the increasing share of arable land, the occurrence of BTU's of the A type (intensive) was growing between the years 1845 and 1948, but since then it has been sharply decreasing. The D type (extensive) witnessed a reverse trend – a sharp growth of importance after 1948

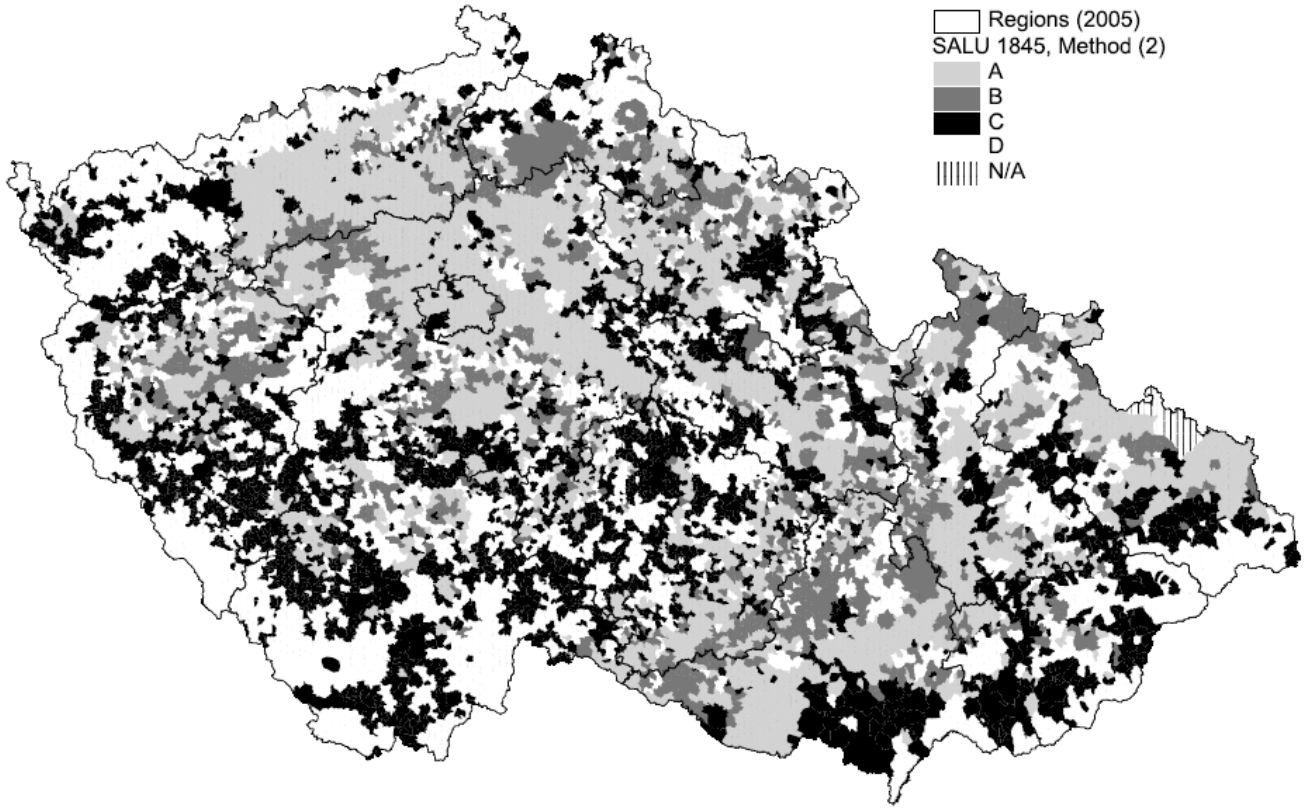

Fig. 4. SALU types in Czechia in 1845, method (2) – Median together

Source: own calculations; see text for explanations

thanks to the growing share of forested areas, but also of built-up and other artificial areas. It is currently the most frequent SALU type in Czechia. Changing occurrence of the C type (moderately intermediate) reflects the changing share of permanent grasslands: a decline until the 1980s (especially 1845-1948) and then a slow recovery. Number of the BTU's of the B type (sharply intermediate) fluctuates. The share of BTU's in the two intermediate types (B and C) was decreasing here as in the "median separately" method (gradually from 44 % in 1845 to 31 % in 2000 – Tab. 4). Now, let us turn to the changing spatial pattern of SALU (Figs. 4 to 7).

The types A (arable land) and C (meadows and pastures) were the most frequent SALU types in 1845. BTU's of the A type were typical in lower altitudes and socio-economically exposed areas, accompanied by the rare B type on its outskirts (central and western Moravia, northern and western Bohemia). The *relative abundance of the BTU's of the C type* was a result of pre-industrial mixed agriculture (arable land and permanent grasslands together, importance of livestock which was fed from meadows and pastures, etc.). BTU's of the C type could be found especially at average altitudes, in highlands and lower mountains of western and southern Bohemia, Bohemian – Moravian Highland and "Walachian" eastern Moravia. They also occupied some lowlands and flat basins with wet, heavy soils (e.g. Southern and Eastern Bohemia). In southern Moravia, the C type was connected with a traditionally high share of permanent cultures (orchards, vineyards).

Types A and B expanded thanks to the growing area of arable land during the period 1845-1948. This was happening mainly to the detriment of the C type (permanent grasslands), diminishing due to changing agricultural technology and management practices. This trend occurred in almost all regions, particularly in eastern Bohemia, Bohemian-Moravian Highland and eastern and south-eastern Moravia. There it was connected with an abandonment of traditional pastoral farming and afforestation of species-rich meadows. Hence, in 1948, most of the lower and average altitudes in Bohemia and especially in Moravia were very compactly covered with either A or B types of SALU. The C type was pushed to less favoured conditions of southern, eastern and western Bohemia. The D type was relatively stable, although it had eaten up some BTU's previously classified as type C – especially in southern and south-eastern Moravia (afforestation of meadows).

As a result of *dramatic changes of Czech agriculture during the socialist era* (1948-1990), the frequencies of occurrence of both the A (arable land) and C (permanent grasslands) types of SALU decreased, especially to the advantage of the D type (forested or artificial areas). The once compact zones of the A type BTU's (intensive SALU) were scattered and divided by the slowly growing B type (sharply intermediate) – not only in highlands, but also in some lowlands (especially in Bohemia). The importance of the C type decreased to its historical minimum (10 % of BTU's). The remnants of this type lay scattered across higher highlands, lower mountains and (with permanent cultures) in some specific regions (southern Moravia). *The D type witnessed a massive growth* during this period – from 24 % (1948) to 38 % (1990) of the number of BTU's. It marked particularly *extensification* in almost all our mountains, occurring there because of unsuitable natural conditions, peripheral socio-economic position

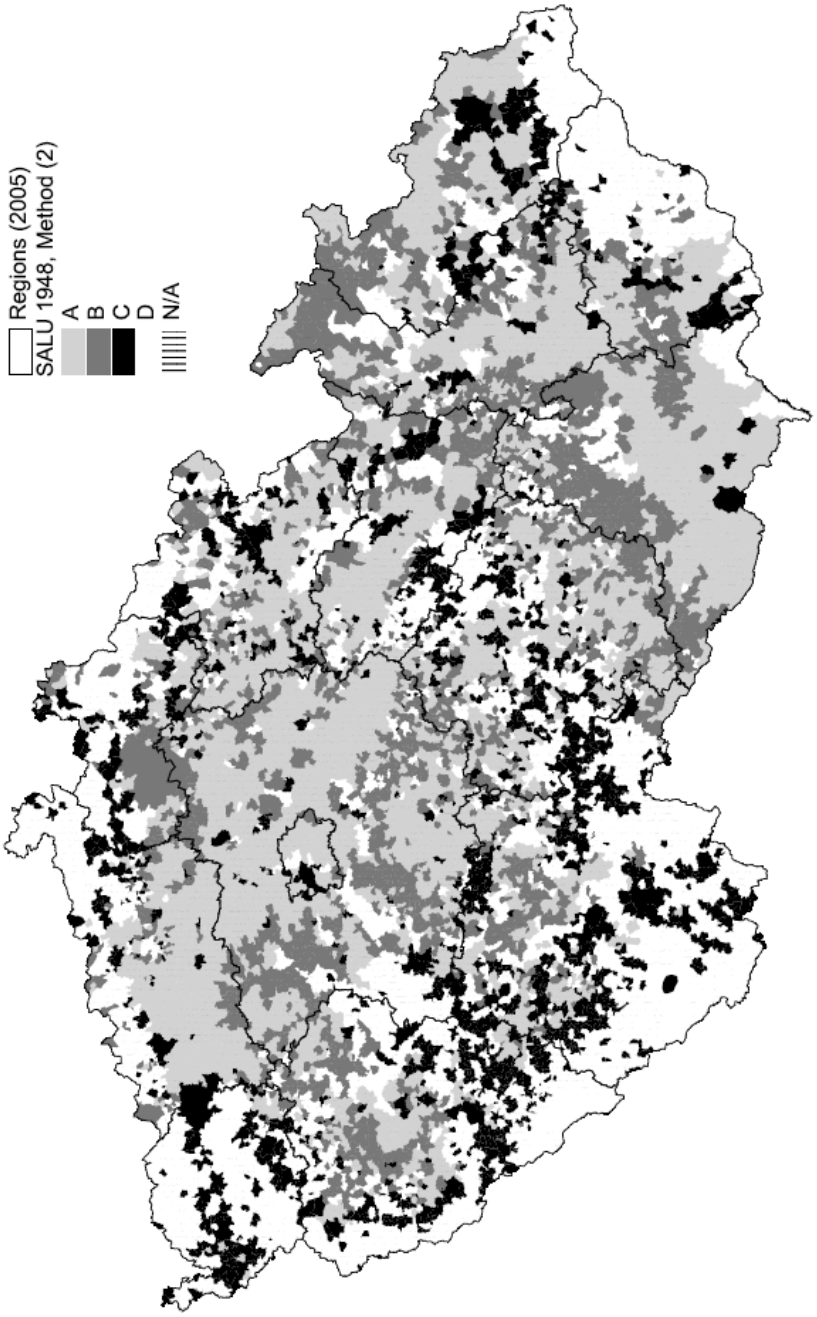

Fig. 5. SALU types in Czechia in 1948, method (2) – Median together

Source: own calculations; see text for explanations

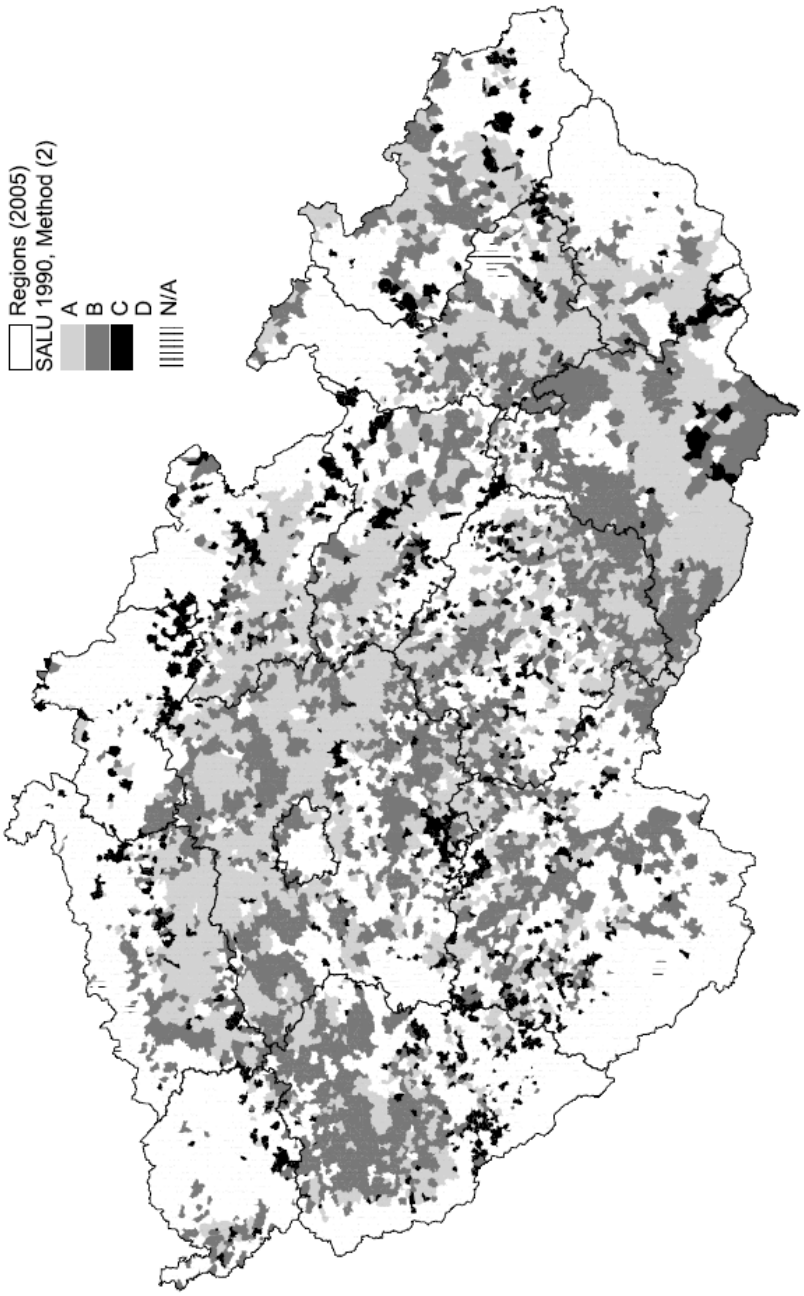

Fig. 6. SALU types in Czechia in 1990, method (2) – Median together

Source: own calculations; see text for explanations

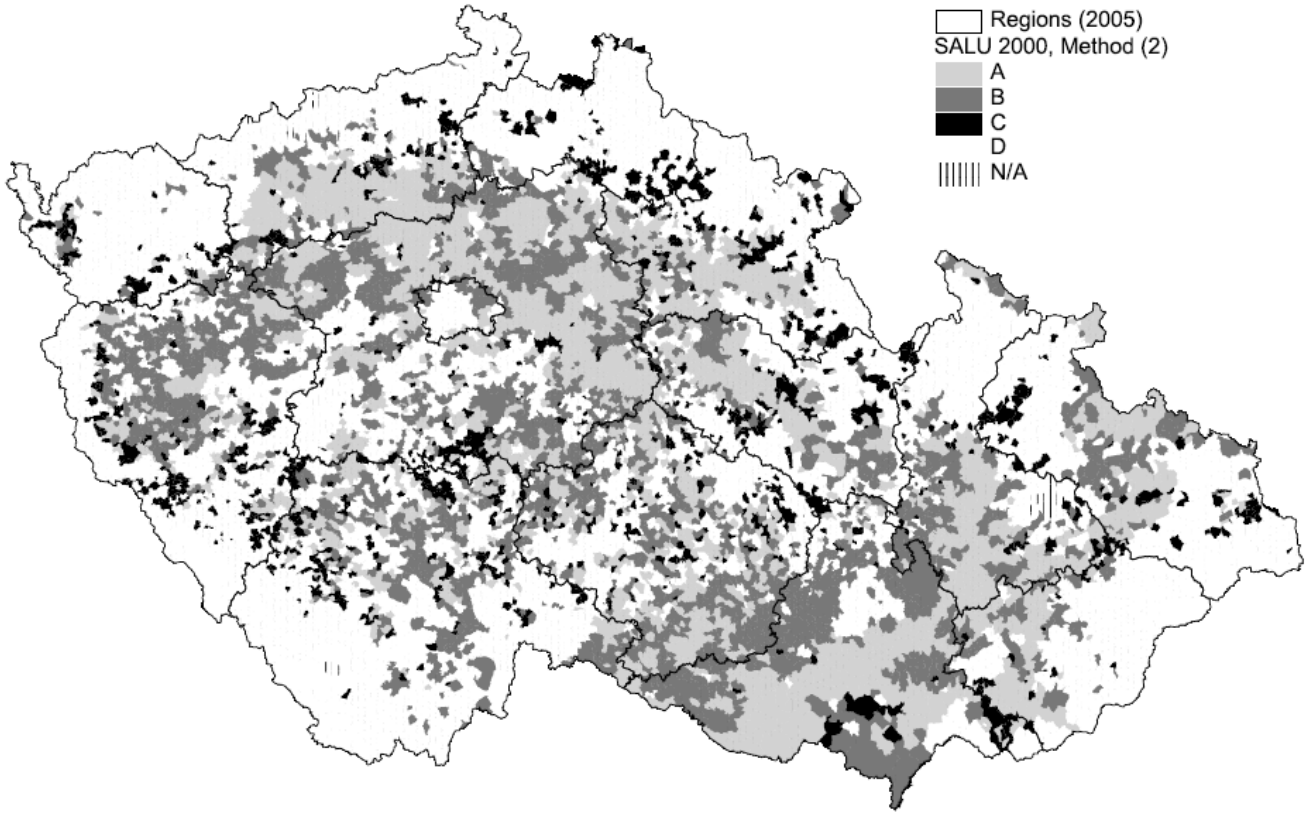

Fig. 7. SALU types in Czechia in 2000, method (2) – Median together

Source: own calculations; see text for explanations

and the expulsion of Czech Germans after WWII. In this way, a wide belt of D type BTU's was constituted encircling almost the whole Czechia (except fertile southern Moravia and densely inhabited parts of Silesia). Similarly, the occurrence of the D type was rising in many highlands in the interior of the country. To the contrary, the growth of the area of the D type within and around the main urban centres of the country (Prague, Brno, Ostrava, etc.) was connected with *urbanization* (increasing share of built-up and other artificial areas).

In the latest time *period of economic and political transformation (1990-2000)*, land use changes were rather insignificant (Tab. 1). Because of the shrinking area of arable land to the advantage of meadows and pastures, the occurrence of both A and B types was decreasing and that of C and D was increasing. This trend of grassing-over (generally extensification) occurred mostly in worse natural conditions, because of the renewed functioning of the "differential rent" (Jeleček 2002, Kabrda 2004). The D type became by far the most important type of SALU (41 % of the number of BTU's).

CONCLUSIONS

The objective of this article was to describe and explain changes in the spatial structure of agricultural land use (SALU) in Czechia between the years 1845 and 2000. A quantitative approach was adopted based on a combination of two simple indicators – share of agricultural land in the total area (SAGL) and share of arable land in agricultural land (SARL). Basic Territorial Units (BTU's) of Czechia (8 903) were classified into four types of SALU – intensive (A), sharply intermediate (B), moderately intermediate (C) and extensive (D). This classification was applied to four time horizons – 1845, 1948, 1990 and 2000 – with the help of two slightly different methods based on median values of SAGL and SARL. Medians were calculated (1) separately for each time horizon and then (2) together for all four time horizons. The results were depicted in tables and maps.

It is important to repeat that this approach is relatively rough and should serve only for a macro-regional overview of the general pattern of SALU. The major drawback lies in the fact that the indicators used (SAGL and SARL) are not suitable for the whole territory, resulting in *internal heterogeneity of the SALU types* (except A – intensive). For instance, and most importantly, in urban zones, the area of which increases, the occurrence of the D type ("extensive") tends to grow. However, this trend cannot be called "extensification" – on the contrary, it marks urbanization. Inclusion of these two totally different processes into one SALU type stems from the fact that "non-agricultural" land comprises both forested areas and built-up and other artificial areas. Similar examples exist for the B and C types as well. Thus, the results must be interpreted cautiously and with a certain degree of generalization.

Our results show that a pattern can be traced relatively easily and it mostly complies with the hypotheses stated at the beginning of this article. Each SALU type creates *compact zones that can be found in specific natural and socio-economic conditions*, the natural conditions being of prime importance (altitude, soil fertility, etc.). This proves the significance of the so-called "differential rent" (Jeleček 2002).

Several conclusions can be made about *development of the structure of agricultural land use during last ca 160 years*. Firstly, frequencies of intermediate types (B and C) were gradually decreasing. Secondly, all SALU types tended to separate spatially to create larger and more compact zones, more corresponding to local socio-economic and especially natural conditions. Both trends were probably results of growing regional specialization and spatial division of labour and functions. Changing "socio-economic metabolism" (Haberl et al. 2003, Krausmann et al. 2003), dramatic modernization of agriculture and growing influence of the above-mentioned "differential rent" were probably the main underlying factors. And thirdly, according to the results of the "median together" method, the proportions between the four SALU types changed due to changing structure of land use in the whole of Czechia. The number of BTU's classified as A (arable land) or C (meadows and pastures) types generally decreased, whereas the importance of the B and especially D (forested areas; built up and other artificial areas) types increased significantly.

A *comparison of the current state of SALU in Czechia (2000) and Slovakia (2002)* – Hurbánek and Spišiak (2005) can be made. It is based on the "median separately" method. The general patterns are similar, but two main differences can be found. Firstly, the intermediate SALU types are less frequent in Slovakia – the shares of B and C types are 16 % in Czechia (Tab. 3) but only 12 % in Slovakia (Hurbánek and Spišiak 2005). Secondly, SALU types create spatially more compact zones in Slovakia – they are less scattered and mixed than in Czechia. It applies for all four SALU types, but mainly for the intermediate ones. The reasons for these differences probably lie in internally more extreme natural conditions within Slovakia. Slovakia has larger lowlands (with the A type – arable land) and mountain areas (with the D type – forested areas and permanent grasslands). Also Carpathian sub-mountain and mountain basins with sharper relief transitions (B type) and permanent grasslands (C type) are more typical in Slovakia. Czechia on the other hand is typical of a highland landscape (Korčák 1938, Štych 2003), gently undulating at average altitudes, where a richer mixture of land use categories is more natural.

I would like to express my thanks to Pavol Hurbánek from Comenius University in Bratislava, who provided me with most of the methodological framework for this article and helped me to solve several technical problems. I also wish to thank my supervisor, Ivan Bičík, for his support and help; and two anonymous reviewers for their valuable comments.

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Data sources:

LUCC UK Prague Database – database of the project of the Grant Agency of the Czech Republic GAČR 205/05/0475: "Driving forces of land use differentiation in Czechia and in neighbouring countries; prospects of development after joining the EU."

Jan K a b r d a

ZMENY PRIESTOROVEJ ŠTRUKTÚRY POĽNOHOSPODÁRSKEHO VYUŽITIA KRAJINY ČESKA OD POLOVICE 19. STOROČIA

Cieľom príspevku bolo zhodnotiť zmeny priestorovej štruktúry poľnohospodárskeho využitia krajiny (ŠPVK) Česka v štyroch časových horizontoch – 1845, 1948, 1990 a 2000. Metodicky práca vychádza z príspevku Hurbánek a Spišiak (2005), ktorý sa venuje súčasným ŠPVK na Slovensku (rok 2002), ale obohacuje ich o vývojový rozmer. Použitý bol kvantitatívny prístup založený na kombinácii dvoch ukazovateľov – podielu poľnohospodárskej pôdy na celkovej rozlohe (PPOP) a podielu ornej pôdy na poľnohospodárskej pôde (PORP). Empirickú základňu tvorila databáza dlhodobých zmien využitia krajiny Česka („Databáze LUCC UK Prague"). Táto obsahuje pre uvedené štyri časové horizonty dáta o využití krajiny (osem kategórií) pre 8 903 tzv. Základných územných jednotiek (ZÚJ) Česka. ZÚJ boli pre účely tohto príspevku klasifikované do štyroch typov ŠPVK: typ A – intenzívny (vysoké PPOP i PORP), typ B – výrazne prechodný (nízke PPOP, vysoké PORP), typ C – mierne prechodný (vysoké PPOP, nízke PORP) a typ D – extenzívny (nízke PPOP i PORP). Použili sa dve odlišné metódy klasifikácie, založené na hodnotách mediánov PPOP a PORP – mediány sa počítali buď oddelene pre každý časový horizont („medián oddelene") alebo pre všetky časové horizonty dohromady („medián dohromady"). Výsledky boli znázornené v tabuľkách a mapách.

Pri interpretácii výsledkov je nutné mať na pamäti, že použitý prístup je pomerne hrubý a má určité metodologické obmedzenia. Preto k výsledkom treba pristupovať s nadhľadom a nesledovať len zaradenie jednotlivých ZÚJ, ale skôr všeobecný vzorec výskytu väčších zhlukov a spojitých areálov ZÚJ jednotlivých typov ŠPVK. Hlavná nevýhoda metódy je v tom, že nedokáže dobre zohľadniť fakt, že poľnohospodárska pôda neobsahuje iba ornú pôdu a trávne porasty (ale aj trvalé kultúry) a podobne, že nepoľnohospodárska pôda nezahŕňa iba lesné plochy, ale aj plochy iné (najmä zastavané

a ďalšie spojené s urbanizáciou). Z tohto dôvodu napr. v urbánnych priestoroch, v ktorých plošný význam sa zvyšuje, dochádza k rozširovaniu typu D (extenzívny). Nejde tu zrejme o extenzifikáciu, ale o proces celkom opačný – urbanizáciu.

Ukázalo sa, že skutočne existuje pravidelný a dobre vysvetliteľný priestorový vzorec výskytu jednotlivých typov ŠPVK. Každý typ vytvára pomerne kompaktné zóny nachádzajúce sa v špecifických prírodných a socioekonomických podmienkach. Vplyv prírodných podmienok (nadmorská výška, sklonitosť, typy pôd) prevláda. To potvrdzuje význam tzv. „diferenciálnej renty“. Všeobecne platí, že typy A a D sú najzastúpenejšie a vytvárajú najdôležitejšie a najstabilnejšie osi českej krajiny. Intenzívny typ A, s prevládajúcou ornou pôdou, nachádzame predovšetkým v našich hlavných nížinách a pahorkatinách. Význam týchto území zdôrazňoval už v medzivojnovom období československý geograf Korčák, ktorý ich označoval za „kmeňové oblasti“. Extenzívny typ D, s prevažujúcimi lesmi a trvalými trávnymi porastmi, naopak prevláda v pohraničných pohoriach a zasahuje tiež do viacerých vrchovín vo vnútrozemí. Typ D sa však nachádza v kombinácii so zastavanými a ostatnými antropogénne silne ovplyvnenými plochami taktiež v celkom odlišnom prostredí – v hlavných urbánnych oblastiach štátu. Zóny výskytu oboch prechodných typov (B a C) sú menej pravidelné, menej kompaktné a vo vývoji aj menej stabilné. Ich priestorový vzorec je ťažšie interpretovateľný. Všeobecne platí, že typ B (výrazne prechodný) obklopuje alebo miestami aj prestupuje typ A, a to najmä v pahorkatinách a stredných nadmorských výškach, alebo v okolí miest. Typ C (mierne prechodný), najčastejšie s trvalými trávnymi porastmi, naproti tomu vytvára akúsi hranicu medzi zónami typov A a B v lepších prírodných podmienkach a typom D v horších. Nachádza sa najčastejšie vo vrchovinách a nižších pohoriach.

Niekoľko všeobecných záverov je možné urobiť tiež o vývoji priestorovej štruktúry poľnohospodárskeho využitia krajiny Česka medzi rokmi 1845 a 2000. Po prvé, výskyt oboch prechodných typov (B a C) trvale klesal. Po druhé, všetky štyri typy ŠPVK mali tendenciu sa priestorovo oddeľovať a vytvárať väčšie a kompaktnejšie zóny, ktoré viacej odpovedali miestnym prírodným a socioekonomickým podmienkam. Oba tieto trendy možno považovať za dôkazy rastúcej regionálnej špecializácie a prehlbujúcej sa priestorovej deľby práce a funkcií. Tieto vznikli meniacim sa energetickým a materiálovým „metabolizmom“ českej ekonomiky (industrializácia, náhrada biomasy fosílnymi palivami v úlohe hlavného zdroja energie a pod.), dramatickou modernizáciou poľnohospodárstva, zvyšujúcimi sa objemami dopravy a rastom vplyvu už zmienenej „diferenciálnej renty“. A po tretie, podľa výsledkov metódy „medián dohromady“ dochádzalo vplyvom meniacej sa štruktúry využitia krajiny v Česku ako celku ku zmene zastúpenia / významu jednotlivých typov ŠPVK. Množstvo ZÚJ typov A (orná pôda) a C (trvalé trávne porasty) všeobecne klesalo, zatiaľ čo zastúpenie typov B, a predovšetkým D (lesné alebo zastavané plochy) sa trvale a významne zvyšovalo. V roku 2000 bolo viac ako 40 % ZÚJ klasifikovaných ako typ D, zatiaľ čo iba 11 % ako typ C.

Metóda „medián oddelene“ umožňuje aspoň čiastočné porovnanie súčasného stavu štruktúry poľnohospodárskeho využitia krajiny v Česku (2000) so situáciou na Slovensku (2002), a to podľa výsledkov publikovaných Hurbánekom a Spišiakom (2005). Všeobecné rysy ŠPVK sú v Česku a na Slovensku podobné, ale môžeme nájsť aspoň dva podstatnejšie rozdiely. Po prvé, prechodné typy sú na Slovensku menej časté – podiel typov B a C predstavuje v Česku 16 %, zatiaľ čo na Slovensku iba 12 %. Po druhé, jednotlivé typy ŠPVK vytvárajú na Slovensku areály priestorovo omnoho kompaktnejšie, menej roztrieštené a vzájomne premiešané ako v Česku. Týka sa to všetkých typov ŠPVK, ale predovšetkým prechodných (B a C). Dôvody týchto rozdielov je pravdepodobne nutné hľadať v rôznorodejších prírodných podmienkach Slovenska. Slovensko má ako rozsiahlejšie nížiny (s typom A – orná pôda), tak hornatiny (s typy C a D – lesné plochy a trávne porasty). Zároveň na Slovensku hrajú významnú úlohu karpatské údolia, doliny a svahy s ostrejšími prechodmi reliéfu (typ B). V Česku naopak zaujíma

značnú rozlohu hercynská krajina pahorkatín a vrchovín, jemne zvlnená, bez výraznejších pohorí, nížin či ostrých prechodov, v ktorých je prirodzene bohatšia zmes rôznych kategórií využitia krajiny.