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Fotografija na naslovnici: Raziskave udornice, kot je ta pri Malem Naravnem mostu v Rakovem Škocjanu, so v zadnjih letih omogočile globlje razumevanje kraških procesov (fotografija: Matej Lipar).

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LONG-TERM LAND-USE / LAND-COVER CHANGES IN CZECH BORDER REGIONS

Lucie Kupková, Ivan Bičík, Zdeněk Boudný

MARCIN SZALA, WIKIPEDIA

Čížov (German: *Zaisa*), Moravia: the only remaining part of the Iron Curtain in Czechia.

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Long-term land-use / land-cover changes in Czech border regions

ABSTRACT: This article describes the long-term development of land use and land cover in Czech border regions from 1845 to 2015. It provides an overview of the main works involving Czech border regions and findings by the Faculty of Science at Charles University. The study used the Land Use / Land Cover Changes Czechia (LUCC Czechia 2018) database with six time horizons (1845, 1896, 1948, 1990, 2000, and 2010) and eight categories of land use for approximately nine thousand territorial units, and CORINE Land Cover data for 1990, 2000, and 2006. It also presents a detailed analysis of land-use and land-cover change in one locality in the eastern part of the Krkonoše (Giant Mountains) range, based on land-registry and field-survey data. Development of the LUCC was influenced by the expulsion of ethnic Germans along the western border after the Second World War. The natural conditions in the Czech border areas were identified as another significant factor influencing changes. Changes influenced by these two factors, in combination with several other drivers, are reflected in changes in proportions of land-use and land-cover categories. In the communist period (1948–1990), a significant increase in forests and grasslands accompanied by an extreme decrease in arable land was documented, and the trend of extensification also continued in the transition period from 1990 to 2010.

KEY WORDS: land-use / land-cover change, border regions, driving forces, Czechia

Dolgoročne spremembe rabe/pokrovnosti tal na češkiih obmejnih območjih

POVZETEK: V članku je opisan dolgoročni razvoj rabe in pokrovnosti zemljišč na češkiih obmejnih območjih med letoma 1845 in 2015. Predstavljen je pregled glavnih del o češkiih obmejnih območjih in izsledkov, do katerih so prišli na Naravoslovni fakulteti Karlove univerze v Pragi. Avtorji so uporabili podatkovno zbirko o spremembah rabe/pokrovnosti tal na Češkem (LUCC Czechia 2018), ki vključuje podatke za šest različnih let (1845, 1896, 1948, 1990, 2000 in 2010) in osem kategorij rabe tal za približno 9000 teritorialnih enot, poleg tega pa so proučili tudi podatke iz podatkovne zbirke CORINE Land Cover za leta 1990, 2000 in 2006. Predstavljena je podrobna analiza sprememb rabe in pokrovnosti zemljišč na območju vzhodnih Krkonošev, izvedena na podlagi podatkov zemljiškega katastra in izsledkov terenske raziskave. Na spremembe rabe in pokrovnosti zemljišč na Češkem je vplival izgon čeških Nemcev z območij ob zahodni meji po drugi svetovni vojni. Drug pomemben dejavnik, ki je vplival na te spremembe, so bile naravne razmere na češkiih obmejnih območjih. Spremembe, na katere sta ta dva dejavnika vplivala v kombinaciji z več drugimi dejavniki, se odražajo v spremembi deleža posameznih kategorij rabe in pokrovnosti zemljišč. V obdobju med letoma 1948 in 1990 se je močno povečal delež gozdov in travnatih površin, hkrati pa se je precej zmanjšal delež njiv. Ekstenzifikacija se je nadaljevala tudi v obdobju preobrazbe med letoma 1990 in 2010.

KLJUČNE BESEDE: spremembe rabe/pokrovnosti tal, obmejna območja, gonilne sile, Češka

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1 Introduction

The article deals with Czech border areas with Austria and Germany where the Iron Curtain was built after the Second World War. The Iron Curtain was a strictly guarded border between the democratic countries of western Europe and the communist states of eastern Europe. The protection of the border also included measures that fundamentally influenced the lives of people on both sides of the border. The fall of the Iron Curtain in 1990 created initial conditions for human migration and cross-border cooperation. These changes triggered economic development in the border regions. Consequently, land-use changes occurred in the border landscape straddling the Iron Curtain. These changes were analyzed along the entire line of the Iron Curtain in Europe by Kupková, Bičík, and Najman (2013). In the Czech lands, the changes relating to Iron Curtain were combined with those resulting from the expulsion of roughly three million ethnic Germans between 1945 and 1946 (Bičík and Kabrda 2007; Bičík and Štěpánek 1994; Rašín and Chromý 2010; Mares, Rasin and Pipan 2013). Studies of landscape changes in the Czech borderland can be divided into two groups. The first ones are based on land-registry data. Differences in land-use changes on both sides of the Iron Curtain are presented in the timespan between 1845 and 2000 (Bičík et al. 2010; Bičík and Kabrda 2007; Bičík and Štěpánek 1994; Štěpánek 1992; Kučera and Kučerová 2012; Rašín and Chromý 2010). The second ones are based on CORINE Land Cover data and deal with land-cover changes after the removal of the Iron Curtain (Najman 2008; Kupková, Bičík and Najman 2013). This article presents spatial transformation of the borderland using both methods and data. Based on an overview of the studies mentioned above, this article describes specific aspects of land-use change in the unique area of Czech border regions that were affected by several distinctive driving forces over the last two centuries.

2 Methods and data

The analysis is mainly based on a land-use database prepared at the geographic departments of the Faculty of Science at Charles University in Prague (LUCC Czechia 2018). The database is based on a cadaster (Jeleček 2006) and comprises eight land-use categories for roughly nine thousand stable territorial units (STUs; Bičík et al. 2015). The data are available for crucial time horizons that depict land use in specific, important periods of Czech social and economic development:

- 1845: the landscape at the onset of a market economy;
- 1896: the culmination of extensive development of agricultural land use, a horizon with an increasing role played by intensification of farming;
- 1948: the end of the market economy and onset of a centrally planned economy;
- 1990: the end of the centrally planned economy and return to a market economy;
- 2000: the first decade of a market economy in Czechia;
- 2010: twenty years of a market economy, influenced by admission into the European Union.

These data make it possible to survey long time sequences that provide vital information on trends in the development of individual land categories and the total land-use structure in each cadastral unit. In this database, however, it is not possible to capture the changes within a cadastral unit at the parcel level.

In order to conduct detailed research inside the cadasters at the level of parcels or ecosystems, we employ geoecological methods, fieldwork (surveys and mapping) in small model areas, and datasets derived from remote sensing data such as the CORINE Land Cover dataset (Corine Land Cover 2018). The results of the evaluation of trends in land-use changes are a starting point for examining the driving forces of these changes and their impact on local and regional development.

Similar approaches suitable for analyses of long-term land-use changes and utilizing the land registry data were applied in Slovenia (Gabrovec, Petek and Kladnik 2001; Gabrovec and Petek 2003; Gabrovec and Kumer 2019) and Austria (Haberl, Batterbury and Moran 2001; Krausmann 2001; Haberl et al. 2003).

3 Results

3.1 Land-use changes in Czech border regions based on land-registry data

Bičík and Štěpánek (1994) published one of the first studies focused on land-use changes in the borderland using the LUCC Czechia database. They used three time horizons (between 1845, 1948, and 1990) and eight land-use categories, documenting a significant decrease in the agricultural function in the borderland. The decrease was most significant in western border regions, especially in comparison with interior regions. Bičík and Kabrda (2007) conducted an analysis of the individual sections of the Czech border using the LUCC database. They examined the differences in land-use changes in four time horizons in relation to their distance from the border. They delineated three zones of STUs near the border (the first zone includes STUs touching the border: »at border zone«; the second includes STUs adjoining the first one zone: »intermediate zone«; and the third zone includes STUs adjoining the second zone: »at interior zone«; see Figures 1 and 2). They compared these three zones to each other and with all other STUs in Czechia, or the »interior.« As anticipated, the intensity of change was strongly influenced by differences in elevation, inclination, and soil fertility in individual sets, and also by the ethnic structure of the population. In border zones with a predominantly ethnic Czech population, the total intensity of changes in the landscape was smaller than in the areas primarily or fully inhabited by ethnic Germans, who were expelled after the Second World War. Figures 1 and 2 document changes in arable land and forest areas in the borderland zone compared with the interior. The share of arable land was lower in border regions compared to interior regions. In addition, it decreased significantly in the first »at border« zone, especially between 1948 and 1990. The percentage of forest areas was significantly lower in the interior and experienced little change in the years studied, whereas in the border zones, especially in the »at border« zone, forest areas increased permanently and covered more than 50% of the territory in 1990 and 2000.

3.2 Evaluation of land-use changes in Czech borderland using remote sensing data

Najman (2008) analyzed land-cover changes using Corine land cover data for 1990 and 2000 along the whole of the former Iron Curtain in Czechia. Analyzing land-cover changes in the area straddling the border between those years, he delineated a belt with a width of about 15 km along both sides of the Czech border with Germany and Austria. Kupková, Bičík, and Najman (2013) extended the dataset by using the 2006 Corine Land Cover data. Changes in land cover in two periods (1990–2000 and 2000–2006) were evaluated.

The results (Table 1) documented a considerably lower intensity of the transformation of the landscape on the Austrian side of the border (west) in comparison with larger changes that occurred on the Czech side (east) in both periods under observation. This result reflects the fact that land use has not been influenced by the border on the Austrian side, whereas the situation was different on the Czech side. Only state farms (not agricultural cooperatives or private farmers) could farm in the proximity of the Iron Curtain. They had specially trained employees, many of whom were members of the auxiliary corps of the border guard. For this reason, farming intensity was substantially lower on the Czech side of the Iron Curtain, where the land previously designated for agriculture was abandoned, often giving way to new wilderness (Lipský 1995, 2010).

The results confirm a varying representation of individual land-cover categories in 1990 in the area to the east and west of the Iron Curtain, and their differing changes between 1990 and 2006. Before 1990, the centrally planned economy and subsidy system pressured farms to use the land to the east of the Iron Curtain for agriculture, even under unfavorable conditions. To the west, the market economy made intensive agriculture untenable under unfavorable conditions, even when high subsidies were provided. The land cover was very diverse, and the land use respected more natural conditions. The analysis also confirmed a varying intensity of changes in the individual border sections examined and more intensive land-cover changes to the east of the Iron Curtain after 1990. Between 1990 and 2000, changes occurred on 3.96% of the area under study to the east of the Iron Curtain; in the west similar changes only occurred on 0.52% of the area studied. From 2000 to 2006, changes occurred on 0.61% of the area on the east side and on 0.16% of the area on the west side. The biggest changes were recorded in Czech border sections, which saw relatively large-scale agricultural extensification and reforestation. The changes occurred in over 8% of the area from 1990 to 2000. This contrasts with the border section in Austria, which was very stable throughout the period under observation (changes in both periods only occurred on 0.13% of the Austrian region).

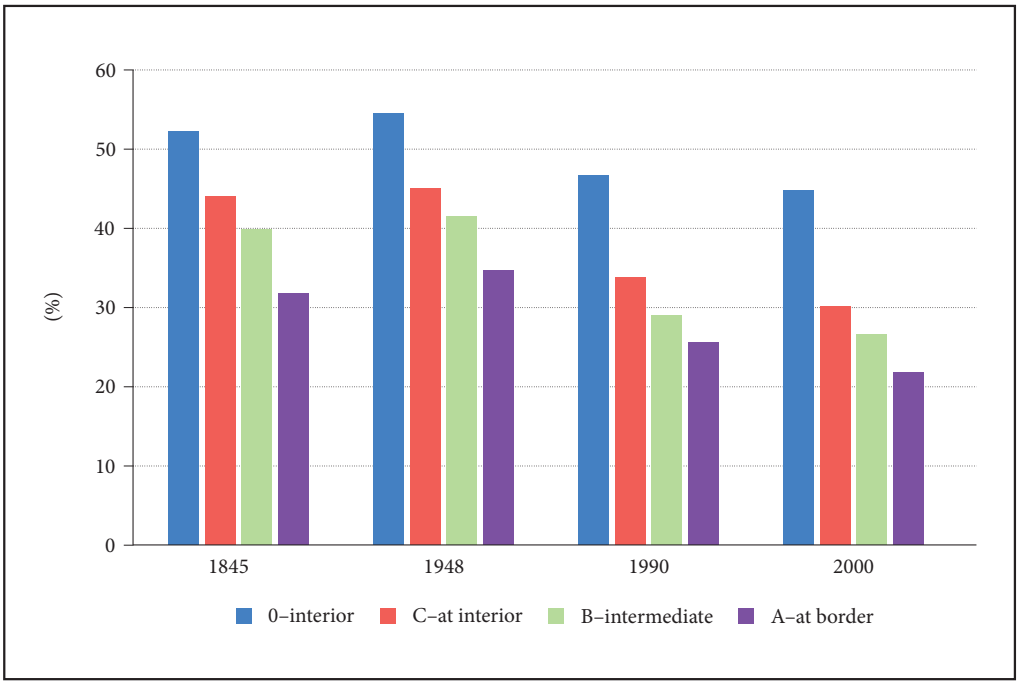


Figure 1: Percentage of arable land in various Czech border zones (Bičík and Kabrda 2007).

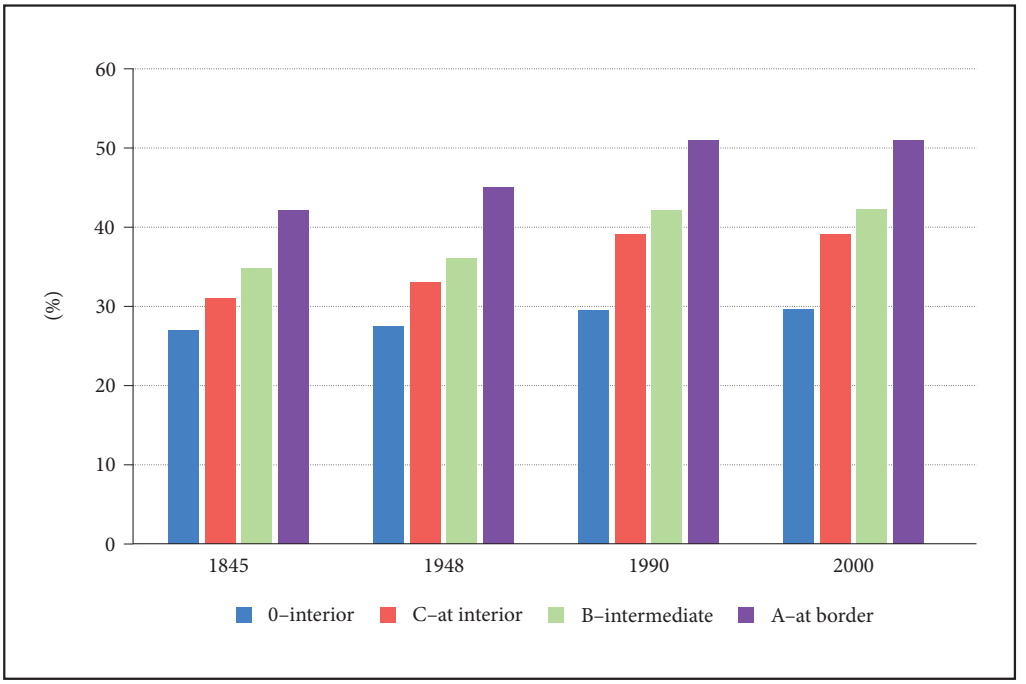


Figure 2: Percentage of forest areas in various Czech border zones (Bičík and Kabrda 2007).

The results are presented in Figure 3, capturing the extent of the changes in mapping units larger than 25 hectares. There is substantially higher transformation on the Czech side, especially in the first period after the fall of the Iron Curtain.

Table 1: Land cover in the Czech–Austrian borderland in 1990 and land-cover changes for 1990–2000 and 2000–2006 (15 km along both sides of the border; east = 15 km border section in Czechia; west = 15 km border section in Austria; Kupková, Bičík and Najman 2013).

Category	Share of category 1990 (%)		Decrease/increase in area of category, 1990–2000 (%)		Decrease/increase in area of category, 1990–2006 (%)	
	East	West	East	West	East	West
Urban fabric	2.65	3.28	0.90	0.42	1.33	0.61
Industrial, commercial, and transport units	0.36	0.01	3.11	0.00	3.75	9.51
Mine, dump, and construction sites	0.13	0.00	−39.52	0.00	−20.98	+
Artificial, non-agricultural vegetated areas	0.14	0.00	0.00	+	21.79	+
Arable land	43.06	31.96	−12.87	−0.01	−15.97	−0.06
Permanent crops	1.47	3.10	5.04	−0.06	36.06	−0.27
Pastures	4.18	3.47	127.43	−0.77	146.03	−1.15
Heterogeneous agricultural areas	6.88	25.16	1.98	−0.08	1.93	−0.20
Forests	34.41	32.86	5.83	−0.20	5.74	−0.36
Scrub and/or herbaceous vegetation	0.40	0.01	−2.60	69.67	−1.62	39.70
Transitional woodland/shrubs	2.85	0.04	−69.56	127.55	−67.63	217.82
Inland wetlands	0.48	0.05	3.17	0.00	2.19	0.00
Inland waters	2.98	0.05	−0.35	0.00	0.01	0.00

Note: The sign + means that the initial area in 1990 was 0 and the share of the category increased during the period (the share of the total area in the second year was lower than 0.1% of the total area).

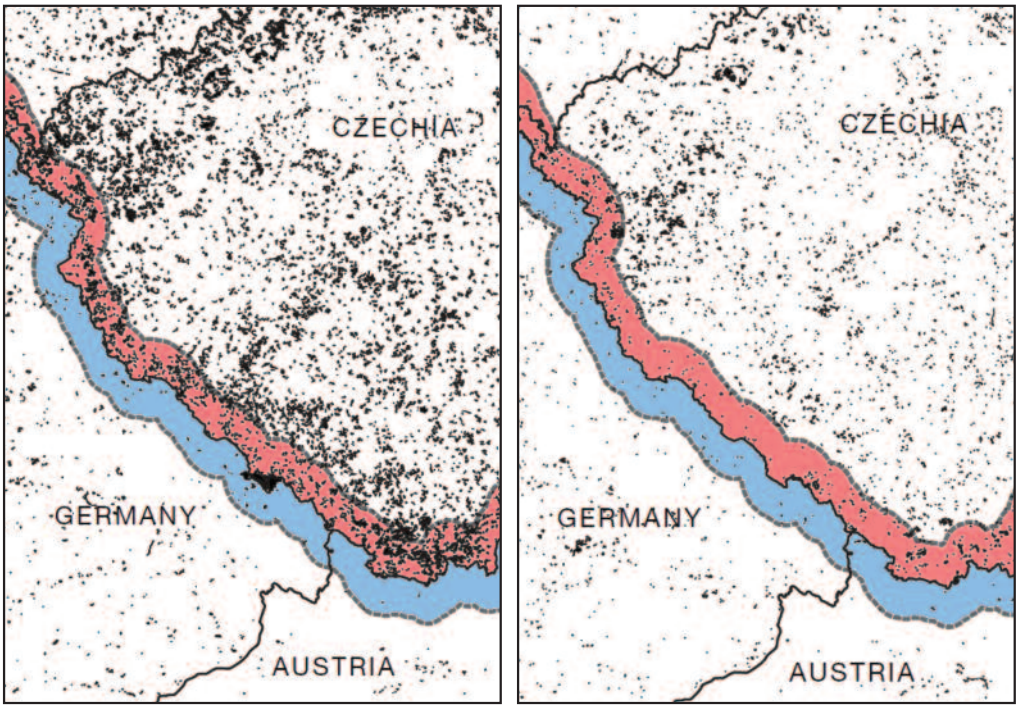


Figure 3: Land-cover changes between 1990 and 2000 (left), and 2000 and 2006 (right; adapted from Kupková, Bičík and Najman 2013).

3.3 A case study of Chvaleč and Petříkovice: a combination of land-registry data and a field survey

The area studied is in northeastern Bohemia in the Krkonoše foothills. The selection of this area was due to its position in the Czech–Polish borderland, which had not yet been analyzed for land-use / land-cover development.

Both the LUCC Czechia (2018) database and field survey (in 2015) were used to analyze this area. The data showed (Table 2) that the major changes in the Chvaleč region occurred after the Second World War and in the last thirty years, when its function changed from agricultural to recreational. Table 2 shows the differentiation of land use in six time horizons, with a visible trend of decreasing size in arable and agricultural land and an increase of forest from one-third to half. Similar processes were observed in Slovenian borderlands close to the Croatian border (Ribeiro, Burnet and Torkar 2013). The political and economic driving forces between 1845 and 1948 and the forced nationalization of local agriculture influenced changes in landscape functions after 1945 without the installation of the Iron Curtain there. The expulsion of ethnic Germans and the decline of coalmining in the vicinity (in the 1960s) were important factors responsible for transforming the landscape into an economic and settlement periphery (Boudný 2018).

Figures 4 and 5 show the conversion of arable land into permanent grassland and forest areas from 1845 to 2015. These changes primarily occurred after the Second World War as a result of the expulsion of the ethnic Germans, and again after 1990 due to the abandonment of agricultural land under less favorable conditions for agriculture and its subsequent grassing over.

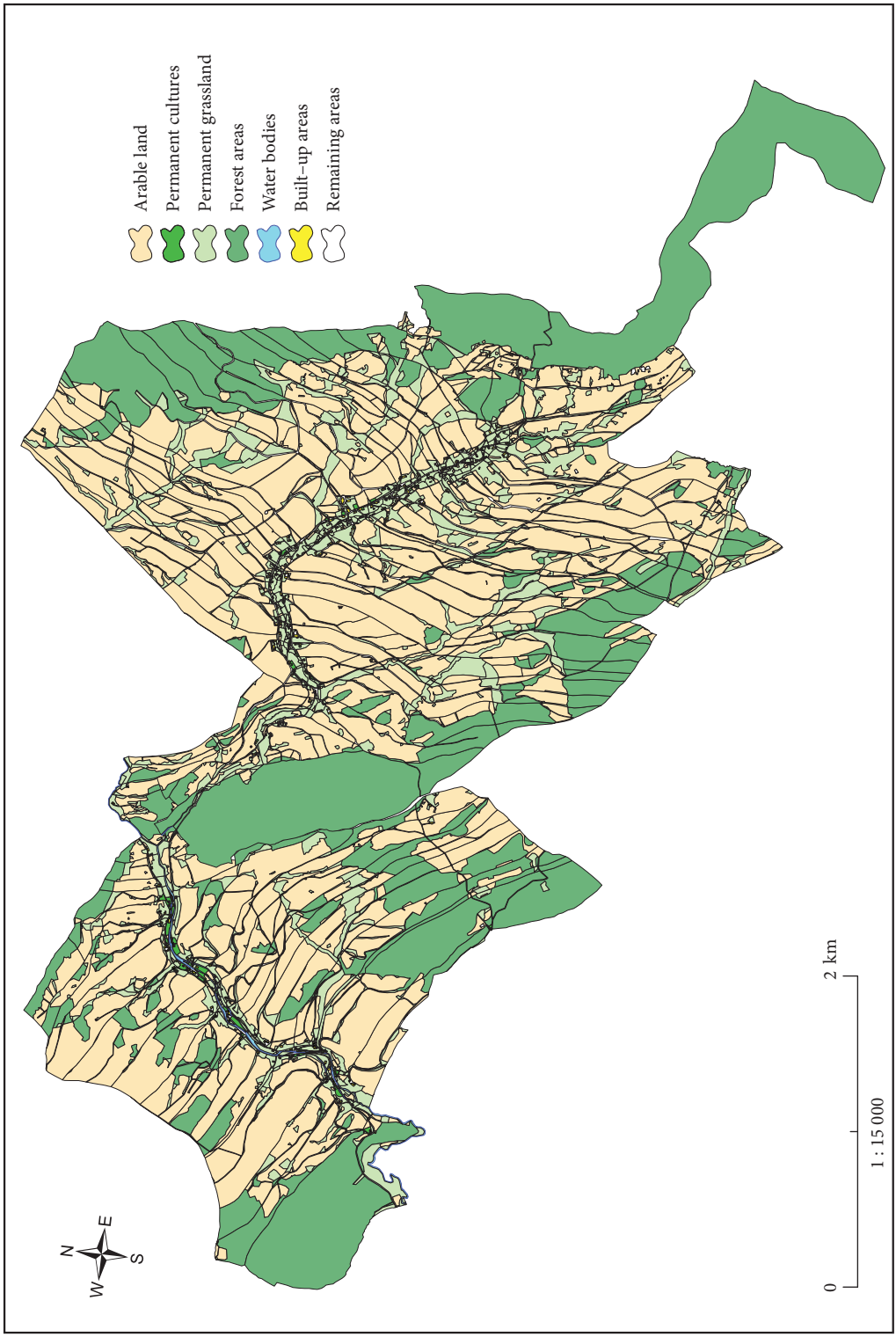
4 Discussion and conclusions

This selection of landscape change in the Czech borderland has demonstrated a clear result. Although they are variously delineated, the regions were influenced by a number of similar driving forces after 1990. Nevertheless, it is striking that the crucial driving forces were the political changes that occurred after the Second World War, as well as between 1989 and 1990. The landscape changes in Czechia were greater than those detected on the other side of the western border between 1990 and 2012 (Najman 2008; Kupková, Bičík and Najman 2013; Rašín and Chromý 2010).

Table 2: Overview of land use development in Chvaleč through six time horizons (Boudný 2018).

Category	1845		1896		1948		1990		2000		2010	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Arable land	833.8	48.6	885.0	51.6	834.3	48.7	363.2	21.09	358.5	20.8	358.1	20.8
Permanent cultures	3.1	0.18	2.9	0.17	7.2	0.42	26.1	1.52	23.7	1.38	23.4	1.36
Permanent grasslands	224.5	13.1	234.0	13.65	219.3	12.8	295.0	17.1	306.0	17.8	303.2	17.6
Agricultural land	1061.4	61.9	1121.9	65.5	1060.8	61.9	684.3	39.74	688.2	39.9	684.7	39.8
Forest areas	591.3	34.4	559.0	32.6	599.9	35.0	881.6	51.2	882.1	51.2	893.0	51.9
Water bodies	3.5	0.2	–	–	3.5	0.2	5.9	0.3	5.9	0.3	6.6	0.38
Built-up areas	5.3	0.3	–	–	12.6	0.7	13.7	0,8	13.8	0.8	13.3	0.8
Other areas	54.0	3.2	–	–	36.3	2.12	136.4	7.9	132.0	7.7	124.6	7.2
Remaining areas	62.8	3.7	33.1	1.93	52.4	3.1	156.0	9.1	151.7	8.8	144.5	8.4

Figure 4: Land use in Chvaleč and Petříkovice near Trutnov in 1845 (Boudný 2018). ► p. 114
Figure 5: Land use in Chvaleč and Petříkovice in 2015 (Boudný 2018). ► p. 115


Arable land
Permanent cultures
Permanent grassland
Forest areas
Water bodies
Built–up areas
Remaining areas
N
E
S
W
0
2 km
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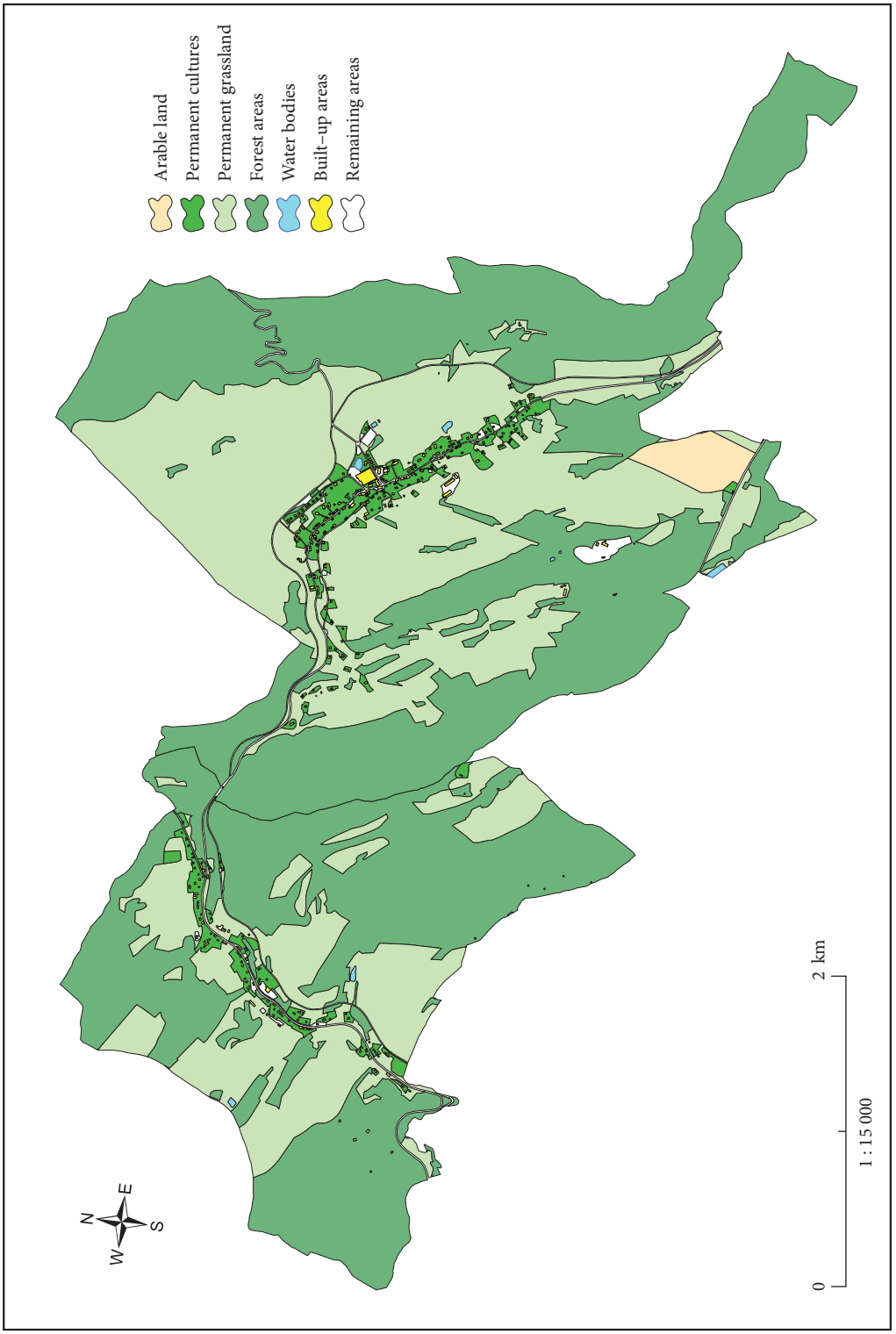
Arable land
Permanent cultures
Permanent grassland
Forest areas
Water bodies
Built–up areas
Remaining areas
N
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The second basic finding highlights a dramatic loss of arable land on the periphery and strong depopulation. The natural conditions that weaken or prevent economic activity in such localities are magnified by the significant shortage of manpower in the present day, primarily in manufacturing and services. Czechs and Slovaks from Czechoslovakia's interior, as well as people repatriated from abroad after 1945, often resettled the foothills and mountain areas and lacked the necessary experience for farming in this difficult terrain (Čapka, Slezák and Vaculík 2005; Vaishar 1992). Then, after the 1949 establishment of the Iron Curtain, many of them were forced to move further into the interior of the country. This resulted in a significant loss of agricultural land in these areas. Between 1948 and 1963, approximately 15% of agricultural land was lost (Bičík et al. 2010).

Hampl and Müller (2011) warned of the differing timing and also the duration of individual social processes. According to Hampl and Müller (2011), as a rule, political processes take place in days or weeks after a situation changes. Economic processes may last months or years, and demographic and social processes last several years. Complex geographical processes that include landscape changes start last and evolve over a longer period of time. This has been confirmed twice in the Czech lands. After the Second World War, the communist coup lasted a few weeks but transformed the political system for forty-two years. The second change followed in 1989, when the Velvet Revolution implemented a fundamental political change within a month, reintroducing Czechoslovakia to the western market economy (Bičík et al. 2015). An examination of the landscape transformation shows that these abrupt political changes initiated a perceptible impact on the entire Czech landscape. These changes took nearly fifteen years to realize, and their duration is substantially longer than their political triggers.

These results further prove the higher intensity of land-use changes in border areas compared to the intensity of landscape changes in core areas of the Czech lands and the countryside. In fact, most semi-peripheral areas and a large part of peripheral areas did not experience any major landscape changes after 1948.

The future development of border areas will be influenced by many drivers, especially by the EU and national subsidy programs, nature preservation, creation of new job opportunities, and so on; however, the land-use / land-cover changes will most likely be less intensive than in the majority of other Czech regions because border regions are usually marginal when there is no political change.

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