

ASSESSING LANDSCAPE CHANGES IN A REGION AFFECTED BY MILITARY ACTIVITY AND URANIUM MINING (PRAMENY MUNICIPALITY AREA, WESTERN BOHEMIA, CZECH REPUBLIC): A MULTI-SCALE APPROACH

Pavel RAŠKA, Karel KIRCHNER

Abstract

Areas of military activity and mining are parts of the most typical examples that enable study of the effects of anthropogenic landscape transformations. In this project, the municipality of Prameny and its surrounding area, located in the western part of the Czech borderlands, is examined. The landscape changes in the study area were affected by several events, including population loss after World War II, the operation of a military training camp, uranium mining, and the foundation of a protected landscape area. All of these events were influenced by macroregional factors. Analyses of population data, old maps and aerial photographs, as well as the results of field mapping, were used to assess the long-term effects of past events on the local landscape and its position within the region at several scales. The results demonstrate variations in persistence, and the qualitative importance of the effects of military activity and mining on the social and natural subsystems of the landscape.

Shrnutí

Hodnocení změn v krajině v regionu postiženém vojenskou aktivitou a těžbou uranu (Prameny, západní Čechy, Česká republika): víceúrovňový přístup

Území vojenské aktivity a těžby náleží k typickým případům, na nichž je možné studovat antropogenní transformace krajiny. V předkládané studii se zaměřujeme na obec Prameny a její okolí v západní části českého pohraničí. Místní krajina byla postižena několika zásadními událostmi, zahrnujícími vysídlení po 2. světové válce, fungování vojenského výcvikového tábora, těžbu uranu a konečně vyhlášení CHKO Slavkovský les, přičemž tyto události byly podstatně ovlivněny makroregionálními faktory. S využitím analýzy dat censů, starých map a leteckých snímků a výsledků terénního mapování jsou studovány dlouhodobé efekty dřívějších událostí v krajině, stejně jako její pozice v regionu, a to v několika měřítkách. Provedený výzkum ukazuje variabilitu v trvalosti efektů způsobených vojenskou aktivitou a těžbou na úrovni sociálního a přírodního subsystému krajiny.

Key words: *military training camp, mining, periphery, landscape development, Prameny municipality area, West Bohemia, Czech Republic*

1. Introduction

Landscape development over the past few hundred years is characterized by increasing intensity of human influence, which was conditioned by growing and changing demands of society and has resulted in transformation of the Earth's surface with an increasing extent of human-made, human-induced and human modified landforms as well as human influence on natural processes (Jones, 2001). Therefore, it has to be emphasized that the

anthropogenic transformations and changes to the natural environment form a process which is mutually linked to modifications of social structures (Balej et al., 2008), and research in this field calls for an interdisciplinary approach. In some areas, the gradual landscape development was interrupted by events of a rather political nature, which have caused significant changes to landscape utilization, to overall landscape design and to the functions of the territory. Among these areas, certain attention has been devoted to

military training fields (MTFs), which represent large areas with limited permeability of borders and specific functions in contrast to their surroundings.

The main aims of previous studies focused on MTFs have had two dimensions. Firstly, emphasis was given to the effects of military activities on the natural environment. Attention was paid especially to military constructions (Illyés, 2010), to impacts of foot traffic and off-road vehicles on soils and to disturbances of vegetation cover (e.g., Whitecotton et al., 2000; Anderson et al., 2005), and reflects an increasing appreciation of the environmental responsibility of military activity in MTFs (Demarais et al., 1999). Moreover, the recent studies suggest that local disturbance combined with limited access to some parts of MTFs frequently allows the evolution of diverse ecosystems. Secondly, the attention devoted to MTFs at a regional level was focused on their effects on and position in regional social and economic structures. This approach is mostly related to a conversion process that was intensified after the end of the Cold War period (Brzoska et al., 1995, 2000; Gazenbeek, 2005). In the Czech Republic, three of eight MTFs have been transferred to civil administration since 1989, while some others are expected to be abandoned by the army in the future. The evaluation of environment, conversion process and potential regional development of MTFs in the Czech Republic is quite specific as it emphasizes the fact that these territories represent a specific type of peripheral or marginal area (Seidl, Chromý, 2010). In this respect, the research was focused on several MTFs in the Czech Republic during the past two decades (e.g., Komár, 1993; Poštolka, 1998; Raška, 2006).

While studies in the 1990s reflected the newly established situation and their aim was to evaluate potential development (scenarios) of MTFs, we can observe a lack of studies that focus on areas of former military activity that have been abandoned in past years and which offer the opportunity to study the conversion process with pre-existing long-term datasets. The example of such an area used in this study is the former MTF Prameny (later known as Kynžvart) in the western part of the Czech Republic, which operated between 1947 and 1954. Nevertheless, the conversion process of this MTF after 1954 has to be evaluated carefully for two reasons:

- a) the development of the area consists of two periods with different political, economic and social driving forces, i.e. the socialist (industrial) period and the period of transition since 1989 (post-industrial);
- b) the conversion process and regeneration of the local and regional landscape was influenced by uranium mining that replaced MTF in the early '50s.

On the other hand, both of these reasons strengthen the rationale for the research, the aims of which were to identify the landscape change (regeneration) between the 1950s and the present-day at several spatial scales. At a local to a microregional scale, our aim was to evaluate the persistence of earth surface transformation and land use patterns in the area of military and mining activity. At a microregional to a mesoregional scale, we primarily used the socioeconomic data to discuss integration of the former MTF into the regional socioeconomic structures (system). Furthermore, our focus enables us to document and extend the results of former research in the whole region, which concluded that "there is not another region of this size in the Czech Republic that experienced all basic types of regional development after the Second World War" (Hampl, 2003).

2. Conceptual remarks

The research conducted for this study was based on conceptual assumptions that have to be explained in order to justify the methodical procedures that were used to achieve the results presented and to enable discussion of these results.

These conceptual assumptions are as follows:

1. The concrete effects of landscape disturbances (herein understood as disturbing impacts of military activity and mining within the study area) will differ with varying spatiotemporal scales;
2. While some effects at certain spatiotemporal scales will be more apparent in the ecological subsystem within the environmental system of any landscape, the others will be important in its social subsystem (cf. Balej et al., 2008). Therefore, a variety of approaches has to be applied;
3. The regeneration of a landscape after disturbance and integration of a local landscape into regional structures is also dependent on development before the disturbance and necessitates the application of long-term data.

The assessment of the regional context of landscape regeneration, which is often represented by social characteristics, can only be carried out using combined quantitative and qualitative data; the use of which reflects the transition from industrial to postindustrial society at a macroregional scale (Hampl, 2003).

3. Methods

3.1 Study area – hierarchical levels

According to the concepts mentioned above, we determined different spatial levels at which the landscape change is assessed. The base level is

represented by the municipality of Prameny, which lies in the center of the Slavkov region, located in the Western Czechia, southward of the towns of Karlovy Vary and Cheb (Fig. 1). The municipality is located in the Karlovarská vrchovina Highland, a slightly undulating elevated area (360–983 m a.s.l.; Balatka, Kalvoda, 2006), which was formed with Variscan granitoids and Upper-Proterozoic metamorphites. The presence of uranium bearing ores and Sn-W ores is related to the existence of metamorphic rocks at the intersection of deep faults in the area. The larger part of the highland is protected under the conservation law as the Slavkovský les (Forest) since 1974 due to its natural and cultural values. The municipality of Prameny was a center of Prameny MTF, which was operating from 1947 until 1954 when it moved to the Doupovské hory Mts. (the Hradiště MTF; Fig. 1).

In order to analyze the effects of landscape disturbances at a local scale, we focused on the surroundings of the Čistá town (Lauterbach, Litterbachy), which was most intensively affected by both military activity and mining; the town was totally destroyed during military training. At this hierarchical level, we studied geomorphic effects of military training and mining and we discuss the rate of landscape regeneration during the latter half of the 20th century.

The third hierarchical level was determined to evaluate integration of the post-military landscape into the regional structures. The level was delimited as two groups of municipalities around the municipality of Prameny. At first, it consists of the inner perimeter consisting of 6 municipalities that have slightly homogeneous natural conditions, and were partly affected by military activity and mining, and secondly, the outer perimeter (40 municipalities) that forms a transition belt into a chain of mesoregional to regional centers. This chain of centers is linked by main transportation connections, which are considered to represent the outermost junctions of commuting. This belt has a heterogeneous natural environment, but in general, it was considered as a reference territorial and functional horizon that enables the evaluation of the integration of a microregional level of the study area into the regional structures.

3.2 Data and methods

The analysis at a regional hierarchical level was based on population and economic data from historical census data (Collective, 2005a, 2005b). In addition, the land use structure development was evaluated using the databases of LUCC in Czechia (Bičák, Kabrda, 2008) in the municipality of Prameny and in inner perimeter municipalities. While the

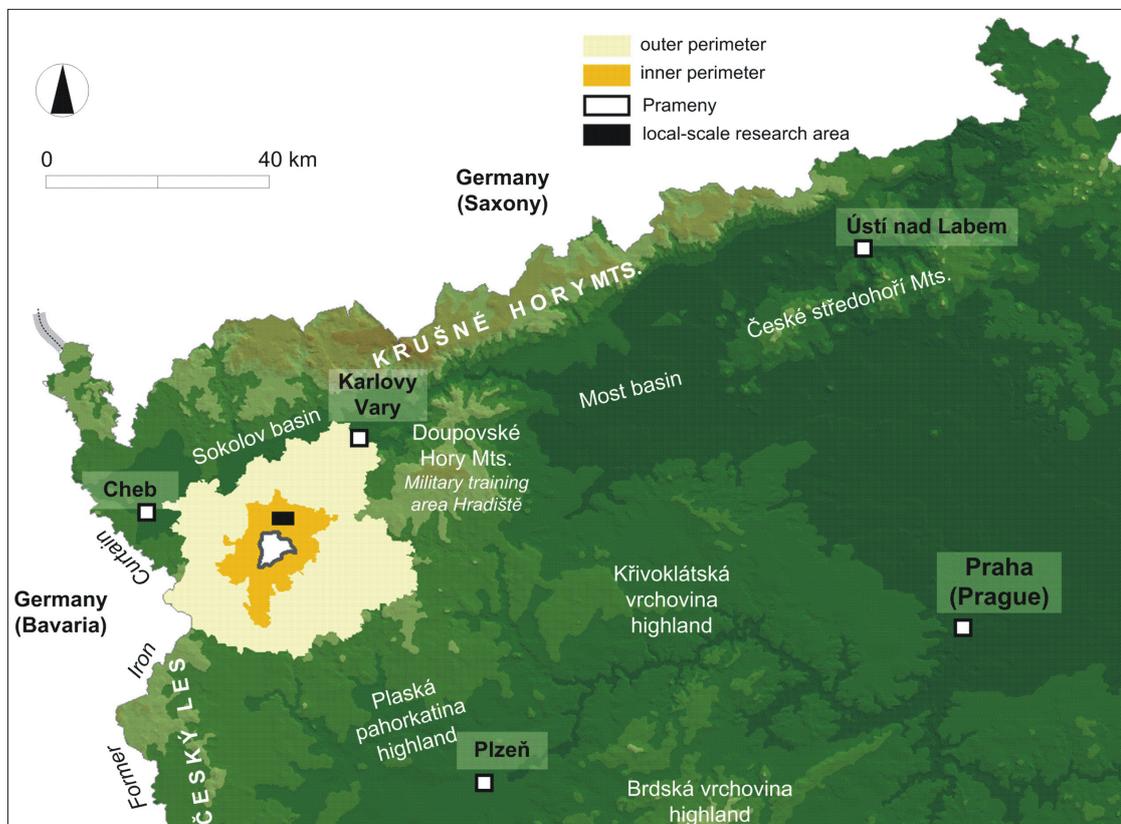


Fig. 1: Location of study areas in three hierarchical levels: (a) local scale “Čistá” – black rectangle, (b) microregional scale “municipality of Prameny” – white with grey margin, (c) mesoregional scale of inner and outer perimeter – orange and yellow

population and economic data can be evaluated at a municipal scale, the territorial units for land use structure development are accessible for so-called basic territorial units (BTU; Bičík, Kabrda, 2007). In our case, five municipalities remain similar to the BTUs (Prameny, Rovná, Krásno, Nová Ves, Mnichov), while the two remaining (Mariánské Lázně, Lázně Kynžvart) have been grouped with surrounding cadastrals into one BTU. At a local level, we carried out field mapping and analyses of aerial orthophotos in ArcGIS 9.2. We used the orthophotos from 1952 and 2007 to evaluate the regeneration of the landscape. We analyzed spatiotemporal changes of two major effects of landscape disturbance:

1. the length and structure of off-road tracks caused by military vehicles in the first time horizon and by agriculture in the present day, and
2. the area and structure of forest cover.

For this purpose, the orthophotos have been georeferenced and all visible off-road tracks and forest patches have been detected. The statistical results were obtained by zonal statistics for sampling hexagonal net.

4. Results

4.1 Integration of regenerating landscape into the regional structures

Regional development of the study area was affected by several events of different nature (Fig. 2A) which influenced the integration of the area into the regional structures. The area belongs to the Czech borderland belt, which was inhabited by the prevailing German population before World War II. The most distinct effects of post-war displacement of the German population

can be identified in mountainous areas, representing peripheral territories in contrast to sub-mountainous regional centers. Nevertheless, contrary to industrial microregions in the Krušné hory Mts., in which the post-war depopulation and functional changes caused transition from stable areas to new peripheries, the study area ranks among classic peripheries with long-term population deficits and low economic productivity (cf. Hampl, 2003). The displacement of inhabitants from the study area has caused a loss of more than 50% of the population in the outer and inner perimeter municipalities, and of more than 70% in the municipality of Prameny (see Fig. 2C, Tab. 1). Total depopulation in the Rovná municipality was connected with the destruction of buildings and, recently, the majority of the population lives in six new prefab houses.

Similarly to some other peripheral mountainous areas, the natural environment of the study area had a preconditioned prevailing traditional orientation toward extensive agriculture with a below-average ratio of arable land (cf. Bičík, Kabrda, 2007; Fig. 2B).

Military activities in the Czech borderland started at the end of the 1940s reflecting (i) a necessity to restore order in the abandoned borderland, (ii) a plan to disconnect former cross-border relations, and (iii) a newly established geopolitical situation (Kovařík, 2009; Fig. 2A). The MTF Prameny was established in 1947 and caused further depopulation of the area. After a few years of disputes between the national authorities involved, the MTF was transferred to the Doupovské hory Mts. in favour of uranium mining around Čistá town (Tomíček, 2000, 2006). Both the military activity and uranium mining caused the

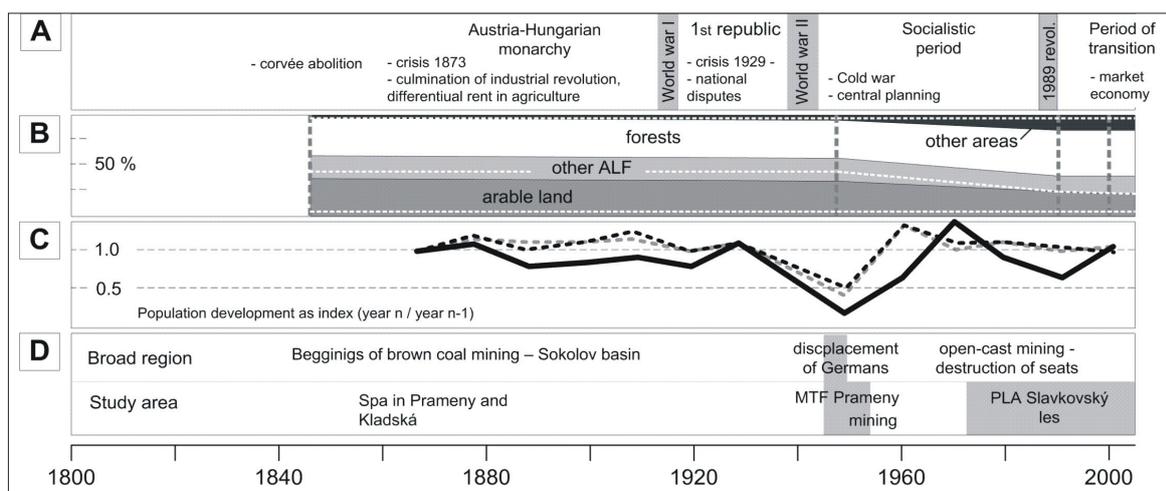


Fig. 2: Coincidence of major political events (A), developmental trends of land use structure (B) and population (C), and driving forces of landscape changes at a regional level and in the Prameny study area (D). Explanation: B - regional trends as filled graph, trends in Prameny as white dotted lines, other ALF (agricultural land fund without arable land); C - black line (Prameny), black dotted line (inner periphery), grey dotted line (outer periphery). Data: own, Collective, 2005b; Bičík, Kabrda, 2007

	Population change (index)			Economic activity in sectors in 2009 [%]		COM (2001)	UNEMP (2008)	Comments (specifics)
	1950/30	1990/50	2010/1990	AGR	SER			
Prameny	0.20	0.45	1.06	23.64	32.73	57.97	moderate	high debt
Rovná	0.00	82.00	1.16	13.58	33.33	18.07	high	
Krásno	0.42	0.45	1.35	8.14	29.07	58.13	low	countryside tourism
Nová Ves	0.09	1.49	1.15	40.43	17.02	42.86	high	
Mnichov	0.29	0.78	0.94	12.00	38.67	58.27	moderate	mineral water
Mariánské Lázně	0.79	1.66	0.88	1.92	36.86	22.68	low	spa
Lázně Kynžvart	0.55	1.09	0.94	5.44	28.24	48.74	low	spa

Tab. 1: Population and economic characteristics of the municipalities of Prameny and the inner perimeter. Explanation: AGR – agriculture; SER – services; COM – commuting to work; UNEMP – unemployment rate (high: > 13.0% , moderate: 8,0–12,9%, low: < 7,9%). Data: Czech Statistical Office

delay in resettlement of the area in contrast to other areas affected by post-war depopulation (see the peaks of population development in the Fig. 2C).

The resettlement of the area after the end of uranium mining was not fully successful, however. The process was decelerated by both internal and external (regional factors). The internal mesoregional factor is represented by the foundation of the protected landscape area Slavkovský les (Forest) in 1974 (Fig. 2C and 2D). The regional factors include the total transformation of settlement structures resulting in the concentration of the population into basin areas, which focused on open-cast brown coal mining and on the industrial sector (Fig. 3A). The deficit in post-war resettlement can only partly be seen from data about land use structure (Fig. 3D), because they do not give the comprehensive information about relative extent of land use and spatial pattern at a level of individual cadastres. In spite of these limits, the graphs in the map show a slightly larger decrease in the extent of permanent cultures and meadows in Prameny, Rovná and Nová Ves in contrast to other basic territorial units, which were not affected by military and mining activity, and represent or are located nearer to the mesoregional centers.

The developmental trends after 1989 were influenced by the transition process, which is – among other factors – characterised by the increasing role of social capital in regional development, and therefore these trends accentuated the differences in the developmental potential of microregions that were gained during the previous period (cf. Hampl, 2003). This is documented in the Tab. 1, Fig. 2C and Fig. 3 with the data after the first ten years of the period of transition. The effects of delaying the resettlement process is shown in the municipalities of Prameny, Rovná and Nová Ves, i.e. those in the highest parts of the Karlovarská vrchovina Highland (representing the center of the classic periphery) and those mostly

affected by post-war depopulation, military activity and mining. These municipalities contain a higher ratio of population younger than 65 years and the lowest number of native inhabitants.

Statistical data shows a population increase in the municipality of Prameny. On the other hand, the qualitative indicators show growing differences between the outer perimeter municipalities and the municipalities of Prameny, Rovná and Nová Ves. As expected, the municipality of Prameny and other rural municipalities within the inner perimeter attain a high unemployment rate and the highest rate of the population commuting to work (Tab. 1). Two of these municipalities deal with extraordinary developmental problems, i.e. with very high public debt (Prameny) and a high rate of unemployment in the economically active ages between 15 and 65 (Rovná).

4.2 Landscape regeneration at a local scale

The study area at a local level in both time horizons, as assessed from aerial images, was composed of a relatively compact matrix of pastures, meadows and surrounding patches of forest vegetation. However, in the first time horizon the land cover and land use structure differed because no pastures and meadows were used for agriculture due to military activity. The major changes in horizontal landscape structure are visible in forest vegetation and in linear anthropogenic transformation (off-road tracks).

The forest vegetation follows the same pattern that was already apparent in the 19th century, so that most changes were within the individual enclaves of forests, and only a few enclaves originated from after 1952, including the one in the former location of Čistá town. The typical process was forestation of forest-free patches within the forest enclaves, resulting in increasing continuity of forest vegetation cover. However, the process was already detected on aerial photos from 1952, showing

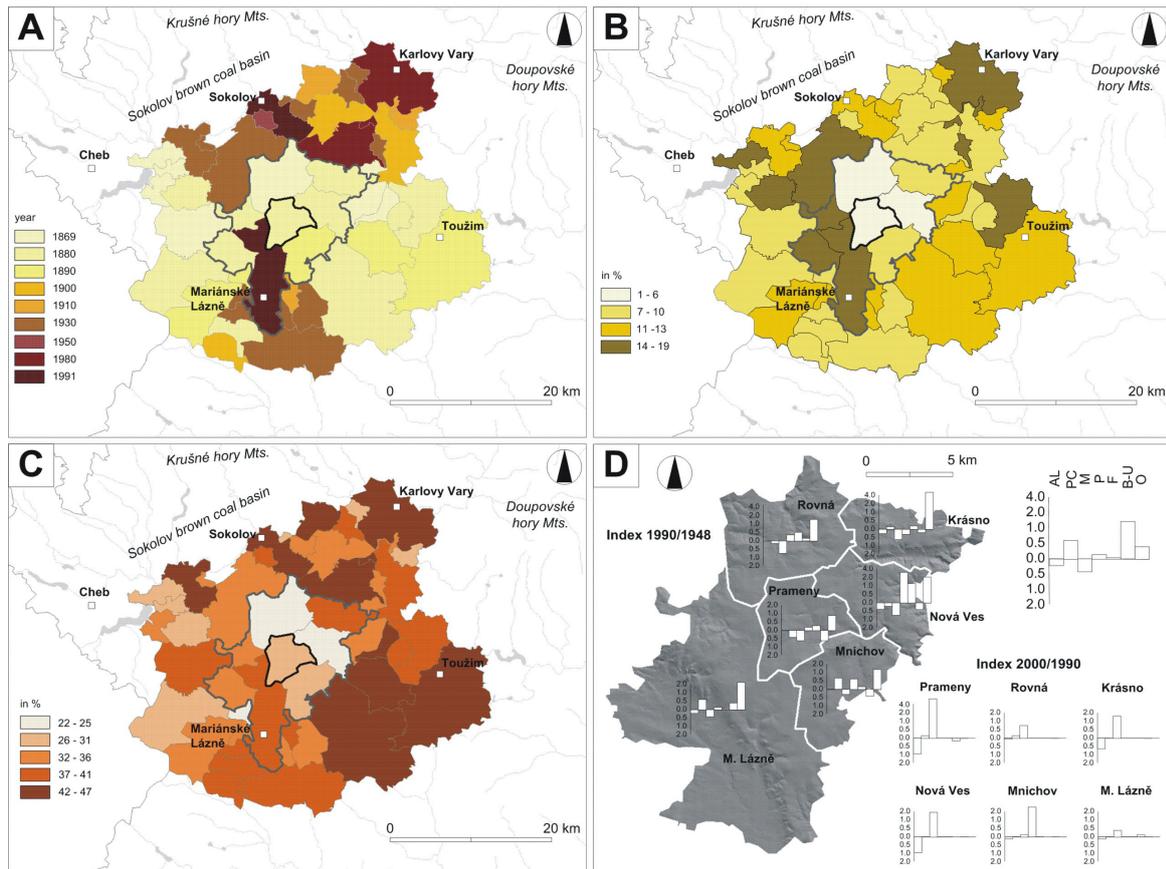


Fig. 3: Population, economic and land use characteristics of the study area A – year of maximum population, B – number of inhabitants older than 65 years, C – number of native inhabitants (black line delimiting the municipality of Prameny, grey line delimiting the inner perimeter), D – index of change in selected land use categories in years 1990/1948 and 2000/1990 (AL – agricultural land, PC – permanent cultures, M – meadows, P – pastures, F – forest land, B-U – built-up area, O – other areas). Data: Collective, 2005a; Bičík, Kabrda, 2007

forest strips of different age, and therefore, this process cannot be directly attributed just to the end of military activity. The total area of fully-grown forest increased by 62 percent between 1952 and 2007, while the area of young forests decreased by 10 percent.

The density and character of off-road tracks represent an important factor, which influences soil quality. The major effect of off-road vehicles is compaction of the soil, although the level of compaction also depends on soil moisture, vegetation and parent material (Becher, 1985). In locations with high slope inclination, the off-road traffic frequently causes disturbance to vegetation and acceleration of sheet erosion. The comparison of the density of off-road tracks in the years 1952 and 2007 is shown in Fig. 4, which documents local concentrations of tracks created by military activity. The average density of off-road tracks, expressed as a number of pixels (5m^2 in size), decreased from 1,239 per km^2 in 1952 to 618 per km^2 in 2007. The highest density of tracks in 1952 was 7,743 pixels per km^2 and 2,865 per km^2 in 2007, and the number of sampling fields without any off-road tracks doubled from 1952 to 2007. The spatial pattern of off-road tracks

in 2007 was absolutely different from that during the military activity. The new pattern was quite uniform, reflecting the structure of pastures and meadows in the area. Besides the off-road tracks, we identified new drainage ditches, some of them connected with a system of ponds (see next to mining facility in the Fig. 4, year 2007) built in the location of 19th century mills. The local impacts of military activity are represented by trenches as well as total destruction of Čistá town, but the impacts of recent training for bomb attacks on non-forested surfaces are almost not visible.

The relics left behind by mining include two different types of transformation; modifications to the original surface along the Cínový potok Brook, which are typically collapse depressions and accumulation levees caused by tin mining (Fig. 5A), and secondly, the relics of medieval mining and uranium mining in the 1950s. The relics after historical mining are apparent as artificial constructions (Fig. 5B), and subsurface systems of mine drifts (Kaláb et al., 2006, 2008). The relic left by uranium mining is represented only by a dump pile; its effects are much more apparent in social indicators (limited development of the area in times of uranium mining).

5. Discussion and conclusions

The present research of the study area gives a concrete opportunity to discuss several questions from a geographical perspective. In our case study, these questions are:

- are there some differences in the persistence of effects of disturbances caused to the social and natural (ecological) subsystem of a landscape?
- is it possible to ascribe the peripheral (marginal) position of the area located in a center of the former MTF only to military activity and uranium mining, or to other reasons as well? And within both of these questions,

- what qualities can be ascribed to landscape transformations after the end of military activity and to persisting relics after military activity and mining?

At first, our research showed, that physical disturbances to the area caused by military training were almost totally buried by new features connected with agricultural activity in the past 50 years. The length of off-road tracks has decreased and has changed its spatial pattern. In the present-day, the area is utilized for extensive agriculture, which causes no local disturbances, the traffic load on off-road tracks is low and episodic and forest enclaves

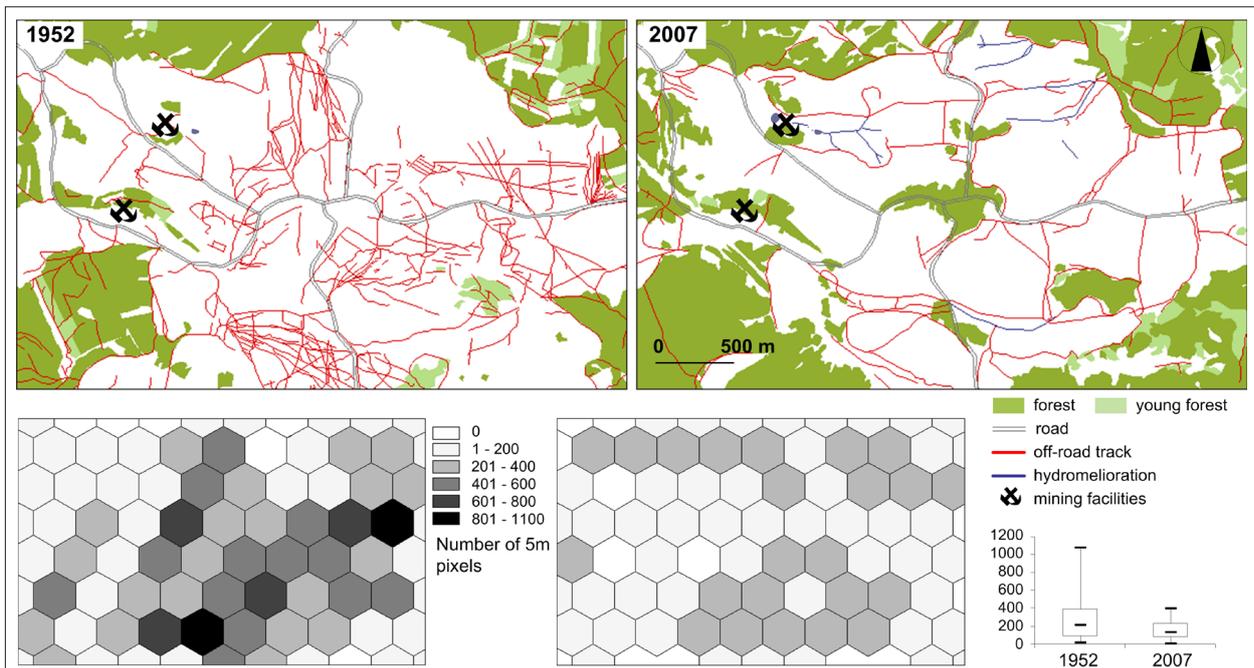


Fig. 4: Comparison of off-road track density and forest vegetation cover in years 1952 and 2007. Below: spatial pattern of off-road track density in sampling net (the rectangles have a similar area as the maps above them), box-plot with statistical distribution of off-road tracks within the sampling hexagons.

Data: aerial photos VGHMŮř Dobruška, GEODIS Brno, a.s.



Fig. 5: A – surface relics after tin mining at the Cínový potok brook; B – Entrance to the upper deck of medieval mine drifts (Photo K. Kirchner)

are continuous. The relics left behind by mining and military activity are limited to the local vicinity and include collapse depressions, mining facilities, drifts and trenches. The importance of a set of mining facilities (e.g. national technical monument Důl Jeroným Mine) and post-mining features, which could represent anthropogenic geomorphosites of regional significance (Reynard et al., 2009), led to intensive geotechnical research of the locality (Kaláb et al., 2006), the aim of which is to contribute to the foundation of an outdoor mining museum. In contrast, the social environment seems to be much more affected by former activities and the inner perimeter of the study area still holds a peripheral to almost marginal position. This position is not an absolute result of military activity and mining, however. To explain the situation, we can apply the concept of path-dependency (e.g. Boschma, Lambooy, 1999), which implicitly showed its relevance in studies of other peripheral borderland areas of the Czech Republic (e.g. Koutský, 2005; Rumpel et al., 2009; Vaishar et al., 2011). The regional application of the path-dependency concept to the study area can be understood in two ways:

1. dependency on the natural environment with prevailing orientation on agricultural production and with a long-term population deficit,
2. following the post-war depopulation trends, which were only accelerated by military activity and uranium mining.

References:

- ANDERSON, A. B., WANG, G., FANG, S., GERTNER, G. Z., GÜNERALP, B., JONES, D. (2005): Assessing and predicting changes in vegetation cover associated with military land use activities using field monitoring data at Fort Hood, Texas. *Journal of Terramechanics*, Vol. 42, p. 207–229.
- BALATKA, B., KALVODA, J. (2006): Geomorfologické členění reliéfu Čech. *Kartografie*, Praha, 79 pp.
- BALEJ, M., ANDĚL, J., ORŠULÁK, T., RAŠKA, P. (2008): Development of environmental stress in the northwestern part of Czechia: new approaches and methods. *Geografie*, Vol. 113, No. 3, p. 320–336.
- BALEJ, M., ANDĚL, J. (2010): Political changes and consequences of their actions for land cover in the Czech Republic after 1989. *Geografický časopis*, Vol. 62, No. 3, p. 201–220.
- BALEJ, M., RAŠKA, P., ANDĚL, J., CHVÁTALOVÁ, A. (2010): Memory of a Landscape – a Constituent of Regional Identity and Planning? In: Anděl, J., Bičík, I., Dostál, P., Lipský, Z. [eds.]: *Landscape Modelling: Geographical Space, Transformation and Future Scenarios. Urban and Landscape Perspectives*, Springer-Verlag, Berlin-Heidelberg, p. 109–123.
- BECHER, H. H. (1985): Compaction of arable soils due to reclamation or off-road military traffic. *Reclamation and Revegetation Research*, Vol. 4, p. 155–164.
- BIČÍK, I., KABRDA, J. (2007): Land use changes in Czech border regions (1845–2000). *AUC – Geographica*, Vol. 42, p. 23–52.
- BIČÍK, I., KABRDA, J. (2008): Databasis of long-term land use changes in Czechia (1845–2000). http://lucc.ic.cz/lucc_data [last visited February 10, 2011]
- BOSCHMA, R. A., LAMBOOY, J. G. (1999): Evolutionary economics and economic geography. *Journal of Evolutionary Economics*, Vol. 9, p. 411–429.
- BRZOSKA, M., KINGMAN, K., WULF, H. (1995): Paper 1 - Demilitarization and conversion. Bonn International Center for Conversion, Bonn.

The acceleration of these trends caused the delay in resettlement of municipalities located in the center of the former MTF. In this respect, it can be concluded that the peripheral (marginal) position of the study area was not a new result of military activity and mining, but on the contrary, the location and intensity of these activities was induced by the former peripheral position of the area (cf. Hampl, 2003). Moreover, the path-dependency concept seems still to be valid for the area and it is very difficult if not impossible to “change the path”, as was shown by the developmental problems of the municipality of Prameny and Rovná, regardless of whether it was using internal or external incentives.

To summarize, the paper has shown the physical and social effects of military activity and mining on a peripheral landscape in the Czech borderland, and has discussed the persistence of these effects as well as their dependency on the long-term development of the study area.

Acknowledgements

The research was supported by research projects: Prognosis of spatiotemporal changes in stability of mining area of the technical cultural monument Důl Jeroným in Čistá (GA ČR 105/09/0089), The fate of the Czech post-industrial landscape (GA AVČR IAA300860903) and Czech borderland after Schengen: a distinct, oscillating and/or transit area? (GA AVČR IAA 311230901).

- BRZOSKA, M., FRANKO, P., HUSBANDS, J. (2000): Paper 16 – Typology of military assets. Bonn International Center for Conversion, Bonn.
- COLLECTIVE (2005a): Statistický lexikon obcí ČR 2005. Český statistický úřad, Praha.
- COLLECTIVE (2005b): Historický lexikon obcí České republiky 1869–2005. Český statistický úřad, Praha.
- DEMARAIS, S., TAZIK, D., GUERTIN, P., JORGENSEN, E. (1999): Disturbance associated with military exercises. In: Walker, L. R. [ed.]: *Ecosystems of disturbed ground*. Elsevier, New York, p. 385–396.
- GAZENBEEK, A. (2005): LIFE, Natura 2000 and the military. European Commission, Environment DG, Luxembourg, 79 p.
- HAMPL, M. (2003): Diferenciace a zvraty regionálního vývoje Karlovarska: unikátní případ nebo obecný vzor? *Geografie*, Vol. 108, No. 3, p. 173–190.
- JONES, D. K. C. (2001): The evolution of hillslope processes. In: Higgitt, D. L., Lee, M. L. [eds.]: *Geomorphological processes and landscape change*. Blackwell, Oxford, p. 61–89.
- KALÁB, Z., KNEJZLÍK, J., KOŘÍNEK, R., ŽŮREK, P. (2006): Cultural monument Jeroným Mine, Czech Republic – Contribution to the geomechanical stability assessment. *Publs. Inst. Geophys. Polich Academy of Sciences*, Vol. M-29 (395), p. 137–145.
- KALÁB, Z., KNEJZLÍK, J., KOŘÍNEK, R., KUKUTSCH, R., LEDNICKÁ, M., ŽŮREK, P. (2008): Contribution to experimental geomechanical and seismological measurements in the Jeroným Mine. *Acta Geodynamica et Geomaterialia*, Vol. 5, p. 213–223.
- KOMÁR, A. (1993): Vojenský újezd Hradiště. *Geografie*, Vol. 98, p. 75–86.
- KOUTSKÝ, J. (2005): Mění se postavení původně periferních pohraničních oblastí, případová studie Euroregion Krušnohoří. In: Novotná, M. [ed.]: *Problémy periferních oblastí*. KSGRR, PŘF, Charles University in Prague, p. 123–129.
- KOVARÍK, D. (2009): Demoliční akce v českém pohraničí v letech 1945–1960. Ph.D. Thesis, MU, Brno.
- ILLYÉS, Z. (2010): Military activities: warfare and defence. In: Szabó, J., Dávid, L., Loczy, D. [eds.]: *Anthropogenic geomorphology*. Springer, Dordrecht, p. 217–232.
- POŠTOLKA, V. (1998): Revitalizace a nové využití bývalého vojenského prostoru Ralsko. *Geografie*, Vol. 103, p. 156–170.
- RAŠKA, P. (2006): Proměny kulturní krajiny Doupovska - specifický případ, nebo odraz obecnějších politických a sociálních změn? *Historická geografie (Supplementum I)*, p. 162–174.
- REYNARD, E., CORATZA, P., REGOLINI-BISSIG, G. [eds.] (2009): *Geomorphosites*. Verlag Dr. Friedrich Pfeil, München, 240 pp.
- RUMPEL, P., BORUTA, T., NOVÁK, D. W. (2009): Analýza příčin regionálních disparit v modelovém regionu Jesenicko v kontextu teorie regionálního marketingu. University of Ostrava, Ostrava.
- SEIDL, T., CHROMÝ, P. (2010): Problémy integrace marginálního území do regionálního systému: příklad Vojenského újezdu Boletice. *Geografie*, Vol. 115, No. 1, p. 44–63.
- SZABÓ, J., DÁVID, L., LOCZY, D. [eds.] (2010): *Anthropogenic geomorphology*. Springer, Berlin-Heidelberg, 298 pp.
- TOMÍČEK, R. (2000): Těžba uranu v Horním Slavkově. Okresní muzeum Sokolov, Sokolov, 294 pp.
- TOMÍČEK, R. (2006): *Historie Vojenského újezdu Prameny*. Krajské muzeum Sokolov, Sokolov, 181 pp.
- VAISHAR., A., DVOŘÁK, P., HUBAČÍKOVÁ, V., NOSKOVÁ, H., NOVÁKOVÁ, E., ZAPLETALOVÁ, J. (2011): Regiony v pohraničí (případové studie vybraných periferních regionů jednotlivých úseků českého pohraničí). *Studia Geographica* 103, ÚGN AVČR, v. v. i., Brno, 133 pp.
- WHITECOTTON, R. M., DARMONDY, D. R., PRICE, D. (2000): Impact of foot traffic from military training on soil and vegetation properties. *Environmental Management*, Vol. 26, p. 697–706.

Authors' addresses:

Mgr. Pavel RAŠKA, Ph.D.
 Department of Geography, Faculty of Science,
 J. E. Purkyně University in Ústí nad Labem,
 České mládeže 8, 400 96 Ústí nad Labem, Czech Republic
 e-mail: pavel.raska@ujep.cz

RNDr. Karel KIRCHNER, CSc.
 Institute of Geonics, Academy of Sciences of the Czech Republic, v.v.i., Brno Branch
 Drobného 28, 602 00 Brno, Czech Republic
 e-mail: kirchner@geonika.cz