BRNO AND ITS SURROUNDINGS: A LANDSCAPE-ECOLOGICAL STUDY

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Abstract

Authors used historical maps from the period 1760 to 2005 for the study of spatial development of the city of Brno and its surroundings (Czech Republic). The City of Brno is the second largest urban agglomeration in the Czech Republic. Historical topographic maps are very useful source of information for the landscape-ecological studies of such urbanized and rural landscapes. Digital processing of maps in GIS milieu enables a high-quality assessment of changes occurring in the landscape. An interesting result of the study is the fact that in spite of the location of the region under study within the hinterland of the city of Brno, 60% of the territory shows stability in the monitored time interval. Multiple land use changes were observed on the peripheries of the urban agglomeration. Less stable are also floodplain landscapes.

Key words: city of Brno, urban landscapes, impact of the city development on landscapes in its hinterland, use of historical maps in landscape-ecological studies in GIS environment

1. Introduction

The Department of landscape ecology at VÚKOZ is engaged with the development of Czech landscape in the last 250 years on the basis of studying data contained in large-scale digitalized historical topographic maps in GIS milieu. Since the second half of the 18th century the Czech landscape has experienced a great transformation due to the exceptional sprawl of residential landscapes, rural landscape changes due to raabization, the first and the second agricultural reform and collectivization of agriculture in the 1950s as well as in consequence of changes induced by developing recreation. Certain problems in studying the landscape development are seen in the contents of these topographic maps whose keys were originally largely meant for military purposes.

2. Methodology

Color topographic maps of the 1st and 2nd Austrian military mapping designed in a scale of 1: 28 800 and surveyed in the second half of the 18th century and in the first half of the 19th century were acquired from the Austrian Military Archive in Vienna and scanned in the Laboratory of geoinformatics at J.E.Purkyně University in the town of Most. Maps of the 3rd Austrian military mapping from the second half of the 19th century in a scale 1: 25 000 were procured for a part of Czech territory in color originals and for a part of the territory in black & white copies from the Map Collection of Charles University and digitalized by the authors at governmental Agency for nature protection and landscape conservation of the

CR and at VÚKOZ Brno. For the period of the First Czechoslovak Republic (1918-1938) the Czech Military Geographic and Hydrometeorological Office in the town of Dobruška lend maps for a part of the Czechia in the form of reambulated paper maps of the 3rd Austrian military mapping in a scale 1: 25 000, maps of Czechoslovak military mapping from the period between the 1st and 2nd World War in a scale 1: 20 000 and reambulated military maps on a scale 1: 75 000 that were digitalized by the authors at VÚKOZ Brno.

Color military topographic maps S-1952 and S-42 for the period after World War II and their gradual renewals lend by a body of the Czech Ministry of Defense in the town of Dobruška were digitalized by the authors in a scale of 1 : 25 000. The Basic map of the Czech Republic 1: 10 000 with raster graphic was used for year 2005 (Czech Office for Surveying, Mapping and Cadastre Prague).

The content of digitalized maps is further processed by the authors in GIS milieu with using ArcView 3.3, ArcGIS 9.1 SW. The information obtained from the historical maps is further complemented with literary data.

3. Landscapes in the city of Brno and its surroundings

In this study the authors dealt with the development of urbanized landscape in the city of Brno and with the development of suburbanized and rural landscape in the city surroundings. The area of study is in the North delimited by a line connecting the villages of Malhostovice in the West and Ruprechtov in the East, in the West connecting the villages of Malhostovice in the North and Ořechov in the South, in the South connecting the town of Rajhrad in the middle and the village of Milešovice in the East, and in the East by a line connecting the village of Milešovice in the South and the village of Ruprechtov in the North (Fig.1). The surveyed territory occupies an area of 759.60 square kilometers. There are 5 towns and 59 communes in this territory whose population was 461 417 inhabitants (2005).

Urbanized area of the statutory City of Brno is situated in the western part of the surveyed territory in a typical location on the boundary between highlands of the Bohemian Massif (Brněnská vrchovina Highland) and lowlands and hilly lands of the Carpathians (Dyjsko-svratecký úval Graben and Vyškovská brána Gate). The geomorphologic situation had an essential if not decisive influence on the town location and on the development of urban area. The historical core of urban landscape spreads in the northernmost part of the Dyjsko-svratecký úval Graben and in grabens and horsts of the Bobravská vrchovina Highland, their foundation being formed largely by igneous rocks of Proterozoic Brno Massif, and in the East along the margins of the massive Drahanská vrchovina Highland consisting mainly of Devonian and Carboniferous sediments. Elevations with steep (partly fault) scarps provided a favorable defensive position (Špilberk Hill 288,8 m a.s.l.) while the system of depressions (mostly grabens) cutting through the Bobravská vrchovina Highland enabled an easy entry into the Bohemian Massif as may be documented by currently important road and railway communications that utilize the system of depressions (KREJČÍ 1993, p. 131).

Suburban landscape spreads both in radial directions through depressions of the Brněnská vrchovina Highland to the North up to town of Kuřim (Fig.1), and in the southern direction through the northern part of the Dyjsko-svratecký úval Graben up to the satellite town of Rajhrad (Fig.1).

Rural landscape is typical of the north-eastern section of the studied area, particularly of managed forest landscapes in the Drahanská vrchovina Highland and of the Carpathian

parts in the north-eastern reach of the Dyjsko-svratecký úval Graben and in the south-western section of the Vyškovská brána Gate.

A mean annual air temperature in Brno is 8.7 °C and means annual precipitation amounts around 490 mm. The southern reach of the studied area is dominated by warm landscapes while medium warm landscapes prevail in the northern highland section. The entire territory is drained into the Morava River and especially into the watershed of the Svratka R. and its left tributary Svitava R. Characteristic features has the drainage of karst landscapes in the southern part of the limestone Moravian Karst. Natural disasters such as tornadoes of May 26th, 1830 and October 13th, 1870 (Mendel 1870) or floods (e.g. 1799) affected Brno and its surroundings during the period of study.

There are numerous immediate relationships and feedbacks between the city and its surroundings (hinterland). First of them were location relationships to the near precincts (e.g. city water supply through a conduit from the locality Mlýn pod Puhlíkem on the Svratka R. Race directly below the Petrov Hill - see Fig 2). Relationships with more distant surroundings were developing later (e.g. supply of the city with underground water from the town of Březová nad Svitavou 1913 or from the Brno dam lake on the Svratka R. (Fig.1), and later on from as far as the Vír dam lake on the Svratka R. 1988. Links affecting the neighborhood of settlements were coming to existence concurrently. Sewage water from the City of Brno is discharged after having been purified in sewage water treatment plant back into the Svratka R. south of town of Modřice (Fig.1). The trail of polluted air from Brno spreads in the direction of prevailing NW winds up to town of Slavkov (Fig.1). The network of paths and later on roads and railways leading up to the Brno traffic junction influenced the settlement pattern development.

4. Developmental stages of landscapes in Brno and its surroundings

Urban landscape in Brno started to gradually develop at the beginning of the 11th century from a settlement at a ford across the Svratka R. at the place of the today's Staré Brno (Old Brno – see Fig.1)). A new town was founded on a green field at a higher elevation on the gentle sloping Bobravská vrchovina Highland (SVITÁK 1995, p. 197). A castle was founded on the Špilberk Hill by the Premyslids in about mid-13th century. King Wenceslas I bestowed Brno town privileges in January 1243.The new town circled itself with fortifications whose existence is documented as far back as 1243-1247 (Fig.2).

In the 14th century, the area delimitated by the fortifications was approximately 36.4 ha. From the 13th century the town core was accessible through five gates (see Fig.2) – Brána Běhounská (1252), Brána Židovská (Jewish -1261), Brána Brněnská (1269), Brána Měnínská (1296), Brána Veselá (1340), and through so called wickets (Branka –see Fig.2) for pedestrians that were linked to local and distance roads. From the Běhounská Gate (in the North – Fig.2) a road ran to the Veveří Castle and another one was a distance royal road to villages of Královo Pole (Fig.1) and Černá Hora and further to the North on to Bohemia (a so called Trstenická stezka trail). From the Židovská (Jewish) Gate in the SE a road was running to the East to a ford across the Svitava R. (near Zderad's column) where it forked into a road heading to village of Měnín (Fig. 8) and further to the South on to the Danubian Basin, and a road running to the North-East to towns of Vyškov and Olomouc (VERMOUZEK 1974, p. 144). From the ford across the Svitava River in Old Brno two roads ran to the SW to town of Znojmo and to the West to town of Jihlava. Roads played an important role for Brno linkages with its near and remote hinterlands as well as for the development of cultural landscape. They were surrounded by fields and there were new

settlements and special-purpose structures (e.g. coaching inns) emerging on them. The transportation ties of Brno were considerably reinforced by the royal decrees of 1333 and 1338 stipulating that roads from the Danubian Basin to the North would not lead through the village of Měnín (see Fig.8) but rather through the city of Brno (VERMOUZEK 1987, p. 89).

It is estimated that in 1365 Brno had approximately 520 houses and a population ranging from 5 000-11 000 persons. Suburban villages had approx. 470 houses and 3 500 inhabitants. The town impact on the beginning suburban agriculture showed as early as at that time. The wet and sometimes inundated Svratka R. floodplain to the S from downtown (near villages of Křídlovice and Nové Sady) was suitable for the establishment of vegetable gardens which supplied the town with fresh vegetables and fruits. The town hinterland was a good place for growing vine, hops and for keeping honey bee. Vineyards were on the southern slopes of the Žlutý kopec Hill, the Červený kopec Hill, and the Kraví hora Mt., on the slopes of the Špilberk Hill below the castle, the Palacký vrch Hill, on the south-western slopes of Černá Pole, in the villages of Jundrov, Soběšice, Juliánov, Líšeň, Židenice, Řečkovice and on the Hády Hill (424 m a.s.l. – see Fig.1). Interestingly, grapevine was doing well in Brno and its surroundings even during the Little Ice Age. The vineyards were considerably damaged by Swedish Armies during the Thirty Years' War (1643, 1645).

War events in the 15th century harmed namely Brno suburbs. In 1442, the records speak of only 353 houses. Vineyards were damaged too. Bohemian-Hungarian wars caused another decrease of houses to 319 in 1477. Number of houses increased to 364 in 1509 (KUČA 2000). Of course, the population decreased during wars, too (Tab. 1.).

Tab. 1.: Population development in the Brno centre and in adjacent neighbourhoods. Figures in bold letters are data on the number of inhabitants inside the fortifications including suburbs which showed a dynamic development. Compiled by P. Mackovčin according to K. Kuča 2000.

Year	Houses	Inhabitants	Municipal suburb	Non-municipal suburb
1365	520	8 400		
1442	353	5 500		
1509	364	4 600		
1619		**5 500**	Yes	
1748	503			
1763		**7 805**	Yes	
1770	440	**14 972**	Yes	
1775	537			
1780		**13 908**	Yes	
1786	556	8 551	745 houses/10460 inhabitants	
1834	582	12 236	417/9003	961/17 272
1846	578	13 850	425/9707	991/21 797
1850		46 000		
1869	2 287	73 771	Yes	Yes
1875	534			
1880	2 292	82 660	Yes	Yes
1890	2 665	94 462	Yes	Yes
1900	3 047	109 346	Yes	Yes
1919		131 500		
1930	5 273	146 140		
1950	6 021	144 445		

The first water supply system was built already in 1414 for utility water and fire extinction water from the Svratecký náhon Race below the Petrov Hill (Fig.2), leading through the today's Denisovy sady Orchards to water house on the Petrov Hill and supplying water to public fountains on town squares. At that time, water was already considerably polluted in the Svratecký náhon Race (Mühlbach) which diverted from the Svratka R., leading across the today's Mendlovo náměstí Square (Fig. 2) and opening into the right Svitava R. side channel near the village of Dornych. Water from the Svratka R. water conduit was filtered only very coarsely. Drinking water was supplied by private and public wells. In 1492, a so called "long bridge" was erected in Old Brno in the place of the original ford across the Svratka R. to which distant roads were heading from city of Vienna and towns of Jihlava and Znojmo. The Svratka R. bed being rather widened at the crossing point, the bridge required a considerable length. Moreover, the floodplain was considerably wet.

The quality of drinking water in wells was gradually worsening with the city development and due to human activities. Therefore, a decision was made in 1520 to build a conduit for drinking water from springs at the foot of Kraví hora Mt. (so called Cimpl – near to the western border of the downtown). Springs were originally feeding a so called Městský potok Brook flowing through the today's Údolní Str. towards the Veselá Gate, to the Dolní trh Market Place (the today's Náměstí Svobody Square), the Kobližná Str. and Cejl where it opened into the Svitava River (JORDÁNOVÁ, SULITKOVÁ 1991). In 1545, a water conduit was constructed from a spring near the pond "am Gassperk" in the village Královo Pole (see Fig. 1), which was used until 1913. Unlike the existing historical data on water supplies, data on sewage water drainage are missing.

Although the number of Brno inhabitants stagnated in the 15th and 16th centuries, some relief changes were occurring in the historical core. Data about the thickness of backfills in the historical core differ. It is well possible that the thickness of backfills ranges at some places between 5-10 m (VERMOUZEK 1974a, p. 346; HÁLOVÁ-JAHODOVÁ 1975). However, the backfills were rather used to raise the terrain in front of town fortifications in the sporadically inundated and wet river floodplains.

The number of residents in the historical town core was 5 500 in 1619. During Thirty Years' War, Brno became the capital of Moravia in 1642 but its near and remote surroundings were considerably devastated during the war events in the 17th century. Prince Gábor Netulen burnt down suburban parts of Brno in 1623. Swedish Armies caused a considerable damage to landscapes in the wide surroundings of Brno during their expeditions in 1643 and 1645. Landscapes around Brno were devastated also during the invasion of Turks and Tartars who invaded the region up to Brno in 1663. The war events affected the Brno hinterland also in the first half of the 18th century during the Silesian wars, especially during the Prussian siege of Brno in 1742. The invasions evoked further fortification works in Brno. In 1748 (Theresian cadastre) the town had 503 houses and palaces.

The map of the 1st Austrian military mapping from 1763-1773 illustrates Brno as a sizeable baroque fortified town in the northern-most section of the Dyjsko-svratecký úval Graben on the slope of the Bobravská vrchovina Highland at an average altitude of 220 m surrounded with bastions and linked with the fortress on the Špilberk Hill above the town (288,8m a.s.l.). Construction of the baroque fortification reduced the number of town gates of which only the Brněnská Gate and the Židovská (Jewish) Gate retained their original function. In 1774-1776, a ring road was constructed around the external town fortifications, which enabled a transit through Brno without having to pass the historical core. In 1770, Brno had approximately 440 houses and palaces and 14 972 inhabitants. The numbering of

Brno houses was accomplished in 1775 and their number reached to 537. Distance (imperial) roads springing from the town gates were constructed to the South to Vienna (1727), to the Northeast to town of Olomouc (1740), to the West to Jihlava (1752) and to the North to Svitavy (1752). The town was bordered with villages with rural landscapes stretching in the southern and eastern directions. Rivers to the South of Brno anastomozed and freely meandered in sporadically inundated floodplains covered with grasslands and floodplain forests. The Svitava River opened into the Svratka R. beneath the village of Dolní Heršpice. The two rivers were interconnected by means of a race near the village of Komárov. The Svitava R. Race turned from the Svitava R. on a weir at Radlas and opened into the Ponávka River on the crossing of today's Vlhká and Skořepka streets. The Ponávka R. discharged itself into the right arm of the Svitava R. in the vicinity of Olomoucká Str. and there were numerous ponds in its valley north of Brno. In the southern surroundings of Brno, there were pond systems in the rural landscape such as near towns of Modřice and Rajhrad (the Dunávka R. valley), villages of Kobylnice (the Zlatý potok Brook valley) and Milešovice (the Mlýnská dolina Valley). The northern and particularly the north-eastern surroundings of the city of Brno were dominated by managed forest landscapes with small rural settlements.

In the set of colored maps from the 2nd Austrian military mapping in 1838 is unfortunately missing the color sheet illustrating the town core of Brno. Therefore, the authors had to use for the urban landscape a black & white copy of the map from 1839 on a scale of 1:14 000 (Fig.3). The Brno historical core is on the map still surrounded with the fortifications but it is obvious that demolition works had already started on most town gates, on the mediaeval inner fortification wall (taken down completely in 1858-1863) and on the backfilling of town moats. Instead of them, there is for example a train station of the railway track from Vienna, which was finalized in 1839. Other railway lines were constructed to the towns of Svitavy (1849), Zastávka (1853), Přerov (1869) and Tišnov (1885). The construction of the track to Zastávka in the Rosice-Oslavany coalfield reinforced the relationships of the coalfield with Brno. The track substituted for the former coal transportation to Brno by carters, leading also to increase coal mining and to the emergence of a mining landscape with numerous spoil heaps between settlements of Zastávka and Oslavany. A considerable intervention into the landscape was the construction of a railway track from Brno to Svitavy with 10 tunnels in the deep incised valley of the Svitava R. between Brno and the town of Blansko.

Brno experienced a boom of industry and trade. Symptomatic for the development of this type of Czech urbanized landscape is the fact that industrial works were rising directly in the town or in suburban villages in a close vicinity to housing areas. The surface area of suburbs was increasing. Settlements immediately adjacent to the town were changing into industrial suburbs. As early as in 1813 there were 23 textile (wool) manufactories in Brno. Large machine works were erected directly amidst the housing areas such as První brněnská strojírna on the Svitava R. bank (1872), Vaňkovka (1864) and machine works Královopolská strojírna (1889) in the valley of the Ponávka River.

The map from the 2nd military mapping shows quarries on the Červený kopec Hill and the Žlutý kopec Hill where Lower Devonian red-brown sandstones and conglomerates were mined of which a number of public buildings were constructed in the city. The rock extraction was also taking place in the localities of Švédské šance Hill, Stránská skála Hill and Hády Hill. Loam pits of brickworks are plotted for example in Old Brno, Úvoz and Veveří Street.

In 1850, Brno was annexed 32 villages of its hinterland (e.g. Špilberk, Augustian area, Dolní Cejl, Horní Cejl, Malá Nová Str., Červená Str., Hráze, Příkop, Josefov, Radlas,

Zábrdovice, Kožená Str., Novosady, Silniční Str., Křídlovice, Jircháře, Pekařská, St. Anna precincts, Křížová Str., Úvoz, Staré Brno, Hlinky, Polní Str., Vídeňská Str.) which resulted in urban landscape enlargement and the Brno population reached 46 000. From the annexation of near suburbs in 1850 the industrial development of Brno and numerous independent surrounding villages proceeded forward at a rapid pace with their mutual approximation. Gas lighting and tram were introduced in the town in 1847 and 1869, respectively. A specific urban climate started to develop. In 1875, the numbering of houses by streets was accomplished. Brno had 534 houses to the date. Southern outskirts of the town in the Svratka River flood plain below Old Brno showed an extensive area of suburban agriculture (gardening). The growth of urban landscape is documented on Fig. 4.

At that time the municipal water conduit from the Svratka R. Race beneath the Petrov Hill was not sufficient any longer and the town bought the Kamenný mlýn Mill with a weir on the Svratka R. In 1872 a new waterworks was built which drew water from the Svratka R. above this weir and purified the water in Pisárky. The new water supply made it possible to increase the number of municipal fountains.

The most conspicuous change for the rural landscape in the southern surroundings of Brno was the Austrian agrarian reform (so called raabization) and drainage of a large number of ponds in this period. Their floors were used to grow sugar beet. The number of ponds and their size on the Ponávka R. was considerably reduced (compare Fig. 3 and 4). Even the large Modřický rybník pond fed with water from the Bobrava River was drained. A map from 1838 indicates that preserved large ponds were the Žatčanský rybník on the Cézava R. and the Sokolnický rybník on the Sokolnický potok Brook (Dunávka – Fig. 3). Channel regulation of the Svratka and Svitava rivers was launched in 1848. During the regulation their confluence was moved southwards to the village Přízřenice. Farming land area increased also in the managed forest landscape on enclaves adjacent to rural settlements (Fig. 3). The land use map in Fig. 3 shows floodplain forests and meadows preserved in the floodplains.

Maps from the 3rd Austrian military mapping in 1876 show a rapid sprawl of the Brno urban landscape after the demolition of town fortifications (Fig. 3). The fortifications were usually replaced by public buildings and green sites (Koliště) that formed a new town ring. The taking down of the fortification belt facilitated a town sprawl nearly in all directions. The town was expanding radially with the construction works taking place particularly in the grabens and depressions of the Brněnská vrchovina Highland. The urbanized territory sprawled southwards along Vídeňská Str. and eastwards along streets Cejl, Křenová and Dornych. Machine and textile works were built beside dwelling houses.

The growing size of suburbs at a turn of the 19th and 20th centuries and their changing to urbanized landscape with industrial operations resulted in their promotion to towns: Královo Pole on August 6th, 1905 (see Fig.1) and Husovice on March 5th, 1912. In 1880, the town core had a population of 82 660 persons living in 2292 houses, Královo Pole had a population of 4427 living in 352 houses, and Husovice a population of 3531 living in 279 houses.

The set of maps from 1876 still includes the quarries on the Červený kopec and Žlutý kopec Hills. Brickworks in Úvoz, Veveří and Červený kopec Hill were enlarged. A quarry with a limekiln can be found e.g. in Ochoz and near Březina in the Moravian Karst. Sandpits in Juliánov, Maloměřice (KREJČÍ 1993, p. 166) and Lesná started to grow. Iron ore mining landscape is marked out southwards of Rudice (Fig.8).

An important landscape-forming and ecological change in rural landscape in this period was the continuing drainage of ponds and their conversion to arable land (including the above mentioned large fish ponds Žatčanský rybník and Sokolnický rybník – see Figs. 3

and 4), as well as the ploughing of riverine and valley floodplains. Floodplain forests were nearly completely felled out; large permanent grassland surfaces were ploughed. This is most obvious in the broad floodplains of the Svratka and Svitava Rivers in the Dyjsko-svratecký úval Graben (Fig. 4).

The fact that there was no map work coming to existence in Czechoslovakia between the wars (1918 -1938) makes unfortunately the monitoring of landscape development in that period rather complicated.

It is known that the city was annexed other 23 neighbouring villages pursuant to a law issued by the National Assembly in the independent Czechoslovakia in 1919 on the integration of these communes with Brno; cadastral municipalities annexed to the town were Juliánov, Židenice, Husovice, Maloměřice, Obřany, Královo Pole, Medlánky, Řečkovice, Žabovřesky, Komín, Kamenný Mlýn, Jundrov, Kohoutovice, Bohonice (Bohunice), Líškovec, Horní Heršpice, Komárov, Černovice, Slatina, Dolní Heršpice, Přízřenice and Vejvanovice (Brněnské Ivanovice), which greatly increased the area of urbanized landscape. The cadastral area of Brno increased from 1815 ha to 12 376 ha, i.e. nearly seven times, and this is how an extensive urban territory of Velké Brno (Great Brno) came to existence. The number of Brno inhabitants increased to 237 559 (1921) and reached 300 000 in 1937.

Many quarries became abandoned such as those on the Žlutý kopec Hill and the Stránská skála Hill. The limestone quarry on Hády Hill was considerably extended and supplied limestone to Maloměřická cementárna cement works, becoming a landscape element visible from distance. The brickworks in Old Brno, Úvoz and Veveří Street were abandoned; the loam pits of brickworks on the Červený kopec Hill and in Černá Pole were enlarged.

The original iron ore mines southwards of Rudice (Fig.8) were converted into pits to extract foundry sands and coloring earths.

Changes occurred in the rural landscape in consequence of the first Czechoslovak agricultural reform (1920) which mainly affected feudal estates. The railway corridor from the town of Břeclav was widened (1935) and a shunting yard was built. Municipal and rural settlements were developing. Housing resources in Brno went through extensive modernization. The housing estate of Adamov with a new arms factory acquired an urban character. An airport in Brno-Slatina was built in the eastern outskirts of Brno on the Tuřany terrace.

The first water conduit bringing to Brno drinking water from the Cretaceous sediments at the town of Březová nad Svitavou was constructed in 1913. The blocking of yielding springs in the Svitava R. valley near Březová resulted in a decreased discharge in the Svitava River. A feedback required the construction of a new dam on the Křetínka R. – tributary of the Svitava R. near the town of Letovice in order to enhance the discharge. Thus, new relationships of Brno with relatively distant landscapes were coming to existence. New water works were built in Pisárky with a plant to treat water from the Svratka River above the Kamenný mlýn Mill. After the Brno dam on the NW edge of the city (see Fig.1) was accomplished in 1940, the water works started to treat drinking water also from this valley reservoir.

After the Munich dictate in 1938, works were launched on the construction of an express way Breslau (now Wroclaw) – Vienna, which was however stopped in the following years of World War II. The route is still visible in the terrain with incomplete bridges, incisions and cut-offs from the village of Syrovice in the South in the northern direction through Brno-Bosonohy, Brno-Bystrc, Jinačovice – Moravské Knínice (see Fig.1). The construction of railway track from Brno to the town of Havlíčkův Brod was started in this time; the construction was however disrupted during World War II and completed only in 1954.

The period of the city prosperity was disrupted by World War II (1939-1945) and the urbanized landscape suffered a considerable damage during the war events. A factory was erected in the war time on a green field in Brno-Líšeň and a large machine operation in Kuřim (which were however severely damaged by alliance bombing in 1944). The Brno water dam on the Svratka River was constructed in 1936-1940 for the purpose of which the village of Kníničky had to be abandoned and its population moved into a newly built Kníničky situated in the Jinačovický prolom Graben (Fig.1). Other communes were annexed to Brno in 1944.

The set of maps from the war period 1943-1945 shows the increasing share of arable land in the rural landscape south of Brno, namely the ploughing of riverine plains. The maps depict the coming to existence of recreational landscapes for individual recreation (esp. settlements of summer houses and cottages – so called tramp settlements).

The village of Líšeň was annexed to Brno on the January 1st, 1944 (Fig.1).

War damages in 1944-1945 affected every other house in Brno where 1 120 houses were totally destroyed and 12 610 buildings were largely damaged (HÁLOVÁ-JAHODOVÁ 1975, p. 18). First postwar years were therefore devoted to repair and renovation of both housing resources and industrial operations. The new construction started with so called 2-year reconstruction plan 1946-1948 The urbanized landscape was now growing at a very mild pace.

In 1950, Brno had 299 099 inhabitants who lived in 30 637 houses (see Tab.2).

Tab. 2 Development of houses and inhabitants within the administrative boundaries of Brno. Compiled by P. Mackovčin according to K. Kuča, 2000 and according to the Statistical Lexicon of municipalities in the Czech Republic 2005.

Year	Houses	Inhabitants
1850		71 749
1869	6 396	104 977
1880	7 066	120 122
1890	8 535	145 782
1900	10 807	176 645
1910	14 450	216 709
1921	15 866	237 659
1930	23 780	283 972
1946		290 476
1950	30 637	299 099
1961	31 097	324 173
1970	32 130	344 218
1980	33 851	371 463
1991	36 327	388 296
2001	37 051	376 172

A new set of Czechoslovak military color topographic maps (System 1952) was published in 1952-1955 (Fig.5). The set of maps shows the post-war stagnation of rural settlements but also the growth of Brno urbanized landscape at the cost of fields, gardens and orchards, and the developing recreational landscape around the Brno dam lake.

The first prefabricated block of flats was built in Brno in 1957 according to Dutch model. In 1958, the construction of prefab housing estates was launched, which considerably changed the size and the character of Brno urban landscape. In just a few years, whole city neighborhoods emerged on a green field – essentially independent of the historical town core. Silhouettes of large prefab housing estates on elevations around the historical core

such as Lesná (1962-1973), Vinohrady, Nový Lískovec are conspicuously evident from many sides.

The map from the 1950s illustrates extensive recreational landscapes, especially settlements of summer houses and garden colonies both within the urban landscape and on its margins (see Fig.5). Also forests in the vicinity of the urban agglomeration are widely used for recreation.

Transport landscapes within the urban space are formed by passenger and goods railway stations. The significance of Brno as a traffic junction was enhanced by the construction of transportation corridors (IV and IVb corridor TEN).

The map from the 1950s shows an extensive loam pit with brickworks on the Červený kopec Hill in Brno-Štýřice. The extraction was however gradually downsized and a larger part of the mined out pit was built up with dwelling houses. The extraction of loam pit in the town of Modřice continued. Mining in large sandpits on the Tuřany river terrace between Brno-Černovice and Brněnské Ivanovice was gradually suppressed and the sandpits were filled with communal waste.

Other five communes were annexed to Brno. In 1957, the Brno (Kníničky) dam lake recreation area was annexed to the town, which included cadastres of villages Bystrc, Kníničky, Rozdrojovice, Moravské Knínice, Chudčice and Veverská Bitýška with the Veveří Castle. To the date of the July 1st, 1960 Brno was annexed the remaining parts of village of Bystrc and villages of Kníničky, Holásky, Mokrá Hora and a part of Moravany called Nové Moravany (DŘÍMAL-PEŠA 1973). In 1971, the town was enlarged by other 8 municipalities.

Grasslands nearly disappeared from the river and valley floodplains (Fig.5 and 6).

After 1989, Brno experienced the creation of urban developmental zones such as the Czech Technology Park, the Southern Centre (brownfield) and the Černovická terrace (greenfield) on the Tuřany river terrace. A developmental zone started to emerge also in the town of Modřice. The Brno airport on the Tuřany river terrace to the E from the city was transformed to an international airport (see Fig.6).

On the other side the extent of brownfields in the City is growing due to liquidation of factories (mainly textile and machinery factories) and demolition of old department houses. Land that has been used is now abandoned (derelict land) and now awaits some new use. Brownfields are commonly found in old industrial zones, particularly in the inner city around the main railway station, around the Svitava R. and in Královo Pole where land has been made vacant by factory closures. Brownfield site s are commonly occupied by derelict buildings and favored for dumping rubbish (e.g. the Southern Centre). The example for redevelopment is area of the former Machinery Factory Vaňkovka near the main railway station. The brownfield was changed into shopping park. During the redevelopment were preserved constructions interesting from the technical and architectural point of view. But the redevelopment was very expensive (over 1 billion of crowns). The redevelopment may be also complicated by the presence or potential presence of a hazardous substance, pollutants, or contaminants especially on sites of former dye-works on previous sites of the textile industry. Small brownfields can be also found in older residential neighborhoods (e.g. sites of abandoned or underused old workers colonies near the factories dating from the first phase of industrialization, and also in suburbs Husovice, Židenice) occupied by derelict buildings. In the year 2006 was registered 117 localities of brownfields.

The second Březová water conduit supplies Brno with drinking water from as far as the Bohemian Cretaceous Plateau and a sewage water treatment plant was built in the town of Modřice.

The surveyed area reaches to the Protected Landscape Area of Moravian Karst decreed in 1956 with a range of small-scale protected areas and natural parks of Podkomorské lesy Forests, Baba and Údolí Říčky.

Construction of a water conduit bringing to Brno water from the Vír dam lake on the Svratka River was commenced in 1988 with a part of the aqueduct being led in tunnels.

Renewed Czechoslovak color military topographic maps S42 from 1990/1992 document a considerable growth of the Brno urban landscape and the development of suburbanization in its surroundings. Further municipalities of town hinterland joined Brno in 1957, 1960, 1970 and 1980. In 1980, the town had a total population of 371 463 persons living in 33 851 houses. In 1965, the village of Šlapanice was bestowed town privileges and became a satellite town connected with the historical core of Brno by a trolley-bus line since 1954.

The map shows express ways D1 and D2 (constructed in 1969-1980) on the southern edge of the city, on whose crossing a typical transportation landscape came into being used by shopping parks Avion and other. The express way D2 was of a considerable significance for the location of the shopping park Olympia near the town of Modřice, and the four-lane speedway R53 played an important role in coming to existence of the shopping park Futurum.

In 1991, Brno reached the highest population in its history (388 296); in 2004, the population decreased to 369 299 persons. The number of inhabitants' decreases and a migration occurs from the town centre due to suburbanization (Tab.3). Examples of suburbanization can be town districts Brno-Ivanovice in the northern part of Brno with the shopping park Globus and Brno-Česká with the ongoing construction of the colonies of single family houses in the style of so called entrepreneurial baroque (suburbia), connected with the historical centre by a highway feeder. Suburbanization continues also by the construction of garden suburb estates in areas rather distant from the town core in the village Podlesí in the North. New suburban estates southwards of Brno emerged near Modřice, Přízřenice, Heršpice and Rebešovice.

Tab. 3 Population development in the surveyed territory. Compiled by P. Mackovčin.

Settlements	1880	1930	1950	1980	1991	2001
City of Brno	82 660	264 925	284 946	371 463	388 296	376 172
Small towns				12 783 (2)	13 710 (2)	20 117(4)
Villages	89 224	95 041	91 192	74 533	69 542	65 128
Total	171 884	359 966	376 138	458 799	471 548	461 417

The problem is the deficiency of vegetation especially in the inner-city areas. The City had 818.2 hectares of public green flats only in the 2005 (21.9 sq. m per inhabitant). Deficit of green flats is typical especially for industrial zones around the Svitava R. (Zábrdovice, Trnitá) and in the lowland southern parts of the City (Dolní Heršpice, Přízřenice, Chrlice – see Fig. 8).

Villages in the southern part of the studied region that were bestowed town privileges were Modřice in 1994 and Rajhrad in 2000, which however long kept its rural appearances. In 2003, Šlapanice became a town with extended competences. To the North of Brno, there is the industrial Adamov situated in a deeply incised Svitava R. valley, which was a bestowed town privilege in 1964. In the same year, town privileges were bestowed to Kuřim with an industrial zone on its periphery.

The contemporary landscape situation is showed on the digital raster Basic map of the Czech Republic 1: 10 000 from 2005 (Czech Office for Surveying, Mapping and Cadastre Prague) and on up to date aerial photographs.

Brno is an important traffic junction and a core of the integrated transportation system of the South-Moravian region the fact facilitating suburbanization of the town surroundings. The reconstruction of the IV railway corridor TEN was finalized in 2006.

The urbanized landscape recently exhibits a considerably increased number of cars and air-pollution due to their operation. There are problems with traffic jams. Due to obstructions the construction of highway R 43 is delayed and all transit traffic to the North has to pass through the City center. The rural landscape shows increased air-pollution due to the fact that the rise in price of natural gas has made many people living in rural areas return to local heating with solid fuels unfriendly to environment and to burning waste.

The grassland area (Fig. 6) has increased in some floodplains but not in the riverine floodplains of the Svratka and Svitava R. The number of unsuitably located structures (including large shopping malls) in floodplains is growing.

5. Quantitative assessment of landscape development

Digital processing of maps enables to make a quantitative assessment of landscape development for the last 250 years. With respect to the above mentioned problems with the quantitative assessment of maps from the 1st Austrian military mapping the authors have processed the information since 1840 so far.

It follows from Tab. 4 that urban built-up area considerably increased in the studied region since 1840 – from 5.05 km² (0.66%) in 1840 to 91.85 km² (12.09%) in 2005, which particularly applies to the urban landscape of the city of Brno. Rural built-up area doubled within the same period of time from 2.08% in 1838 to 4.49% in 2005.

Tab. 4 Land use changes in the period from 1838-2005

Land use	1838	%	1876	%	1955	%	1990	%	2005	%
arable land	381,69	50,25	419,26	55,20	404,67	53,27	331,8	43,68	307,13	40,43
permanent grassland	77,19	10,16	52,84	6,96	12,06	1,59	2,07	0,27	24,3	3,20
orchard	3,80	0,50	4,81	0,63	18,75	2,47	9,56	1,26	11,54	1,52
vineyard and hop-field	8,63	1,14	5,35	0,70	2,13	0,28	2,08	0,27	1,56	0,21
forest	263,64	34,71	249,98	32,91	255,21	33,60	261,71	34,45	260,99	34,36
water area	3,21	0,42	0,31	0,04	1,49	0,20	2,21	0,29	2,06	0,27
rural built up area	15,81	2,08	17,31	2,28	25,84	3,40	34,15	4,50	34,13	4,49
urban built-up area	5,05	0,66	7,86	1,03	34,01	4,48	87,28	11,49	91,85	12,09
recreational area	0,00	0,00	0,00	0,00	1,34	0,18	17,59	2,32	16,42	2,16
other	1,00	0,08	1,87	0,25	4,1	0,54	11,14	1,47	9,61	1,27
Total	759,60	100,00	759,60	100,00	759,6	100,00	759,6	100,00	759,6	100,00

The share of managed forest landscape has remained practically unchanged and ranges between 32 and 34%. Floodplain forests in the southern part of the studied area were

largely felled out. The share of arable land reached its maximum in 1876 (55.20%) and then started to decrease. Although the share of arable land in 1955 was 53.27%, it gradually fell to 43.68% in 1990 and 40.43% in 2005. Reasons to the decreasing size of fields were increased yield of field crops, inefficient soil cultivation in highland landscapes and the impact of built-up area.

The share of permanent grassland was decreasing from 10.16% in 1838 until 1990 (0.27%) when it started to slightly grow due to the downsizing of agricultural production in the period of Czech economy transformation to 3.20% in 2005.

The share of recreational landscapes began to grow after 1950 from 0.18% in 1955 to 2.32% in 1990. Then it dropped again due to the liquidation and building up of garden colonies in Brno.

The area of vineyards decreased from 1.14% in 1838 to 0.21% in 2005.

The share of other areas was steadily growing up to the current 1.27%.

The comparison of land use made it possible to quantitatively assess the land use stability in the landscape. Although the landscape in question is adjacent to the residential and industrial agglomeration and therefore exposed to heavy anthropogenic impacts, the analysis revealed that the landscape is used in a relatively stable way. This applies in a long-term span both to the managed forest landscape in the north-eastern part of the studied region in the Drahanská vrchovina Highland, and to the rural landscape in the southern and eastern part of the Dyjsko-svratecký úval Graben and in the Vyškovská brána Gate. Under stable use is also the urban landscape of the Brno city historical core and suburbs. Great changes in land use can be observed also in the alluvial landscape in which floodplain forests were first cut out in the 19th century. Then the meadows were ploughed and converted into fields at first, and later partly built-up with all negative consequences. At the latest stage of landscape development a part of floodplain landscapes were grassed again.

6. Conclusion

Detailed topographic historical maps are an important source of information for landscape and ecological study into the development of cultural landscapes in the last 250 years. Digital processing of maps in GIS environment enables a high-quality assessment of changes occurring in the landscape. An interesting result of the analysis is the finding that in spite of the fact that the landscape in the studied region is situated within a hinterland of the large city, 60% of the territory shows stability in the monitored time interval. Multiple land use changes in the landscape were observed on the peripheries of the residential agglomeration. The landscape of riverine floodplains passed through significant changes.

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Fig. 1 The territory under study

Fig. 2 Georelief and the mediaeval town location

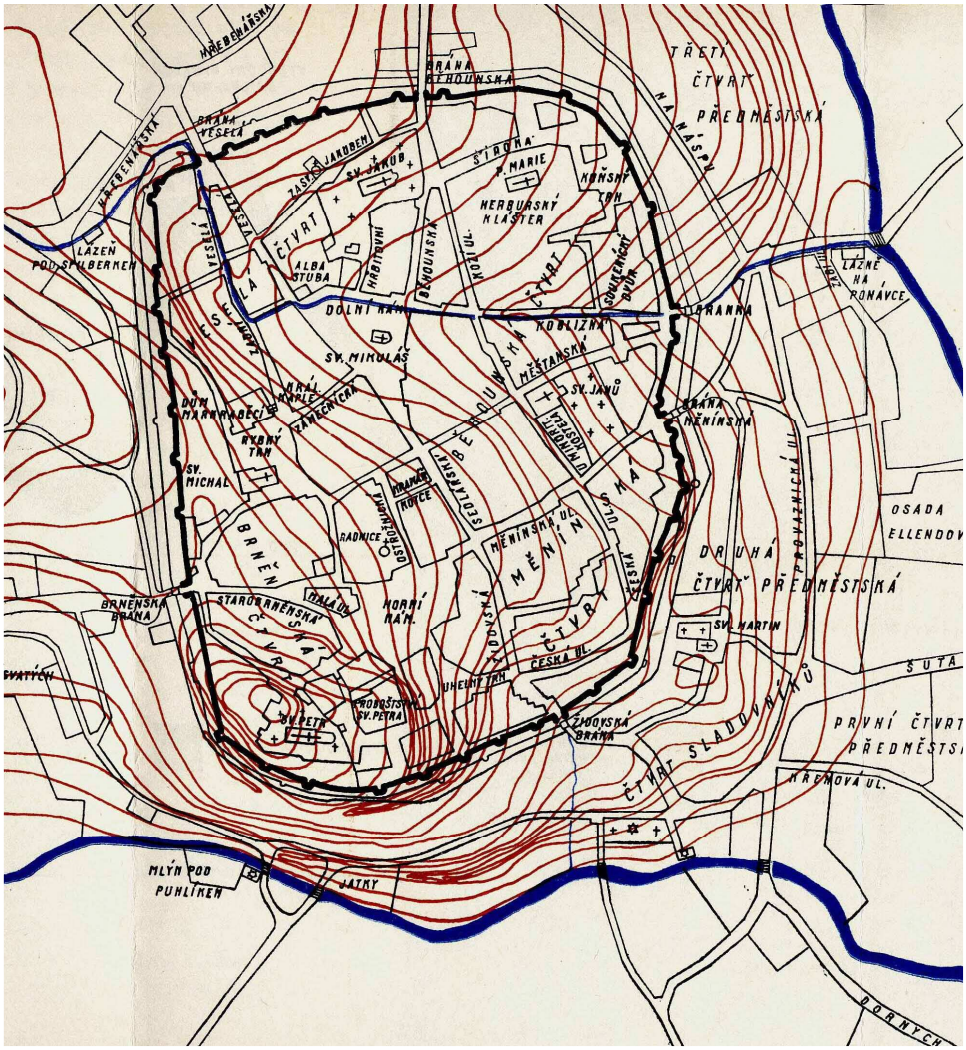

Fig. 3 Land use in 1838

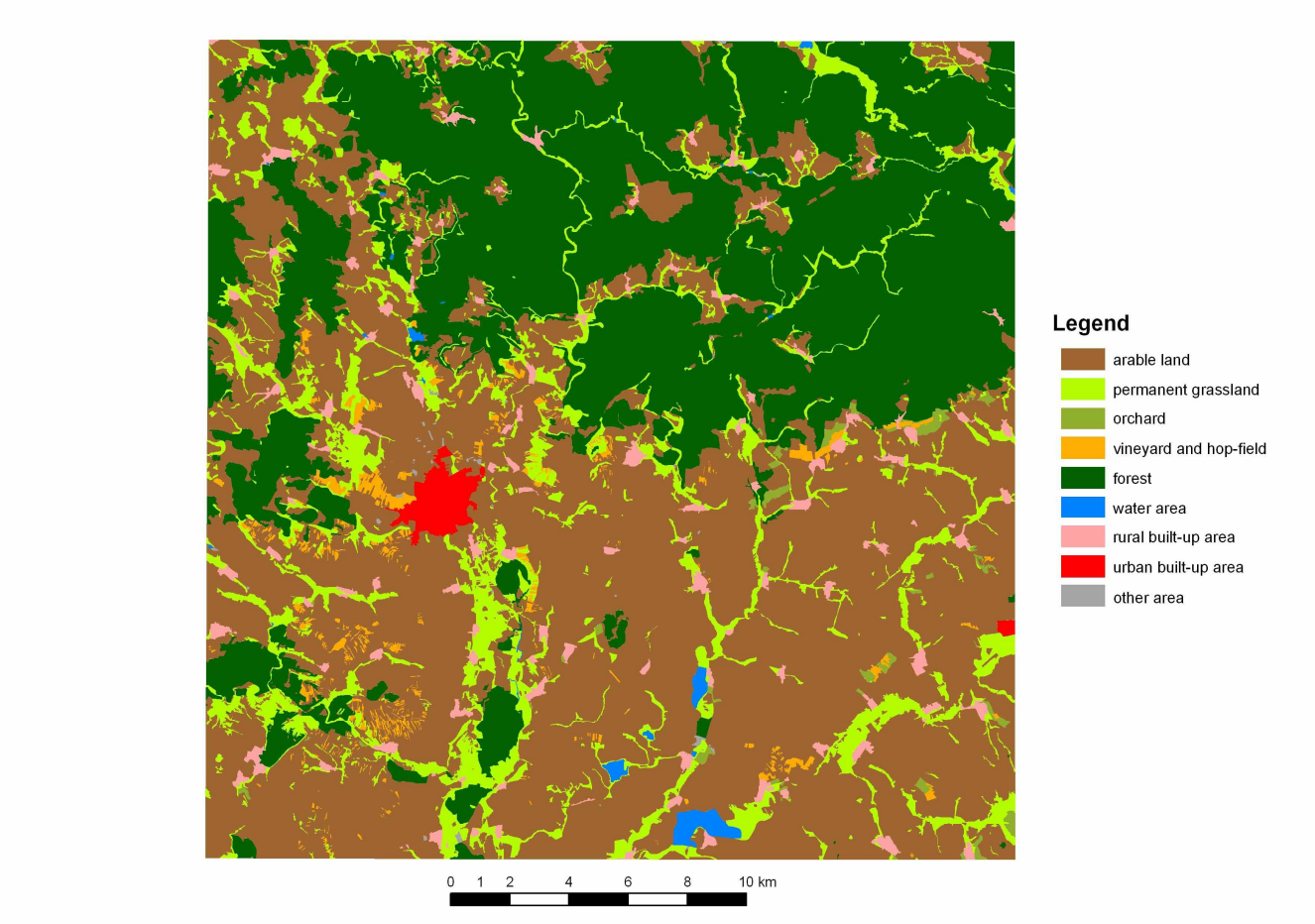

Fig. 4 Land use in 1876

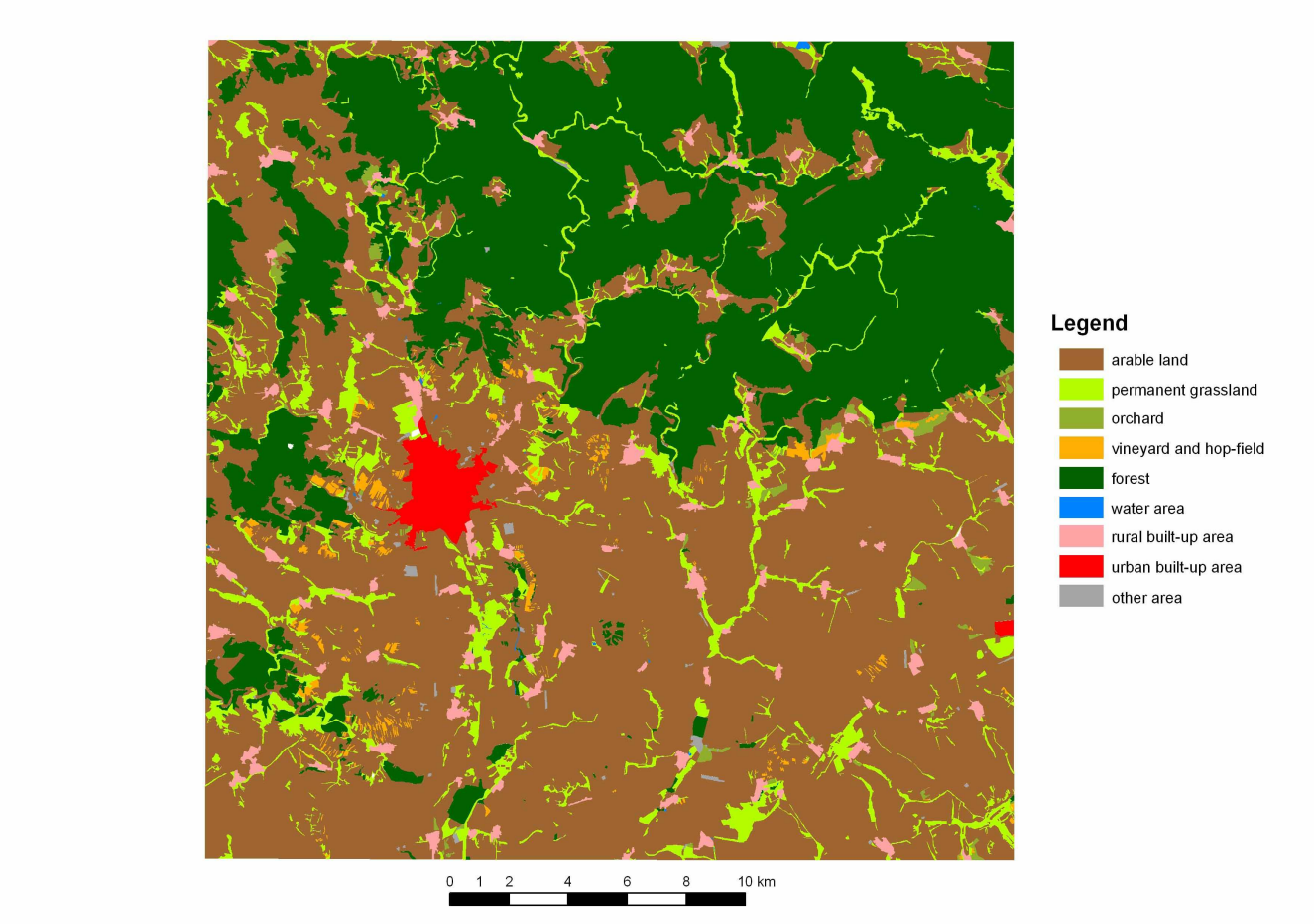

Fig. 5 Land use in 1955

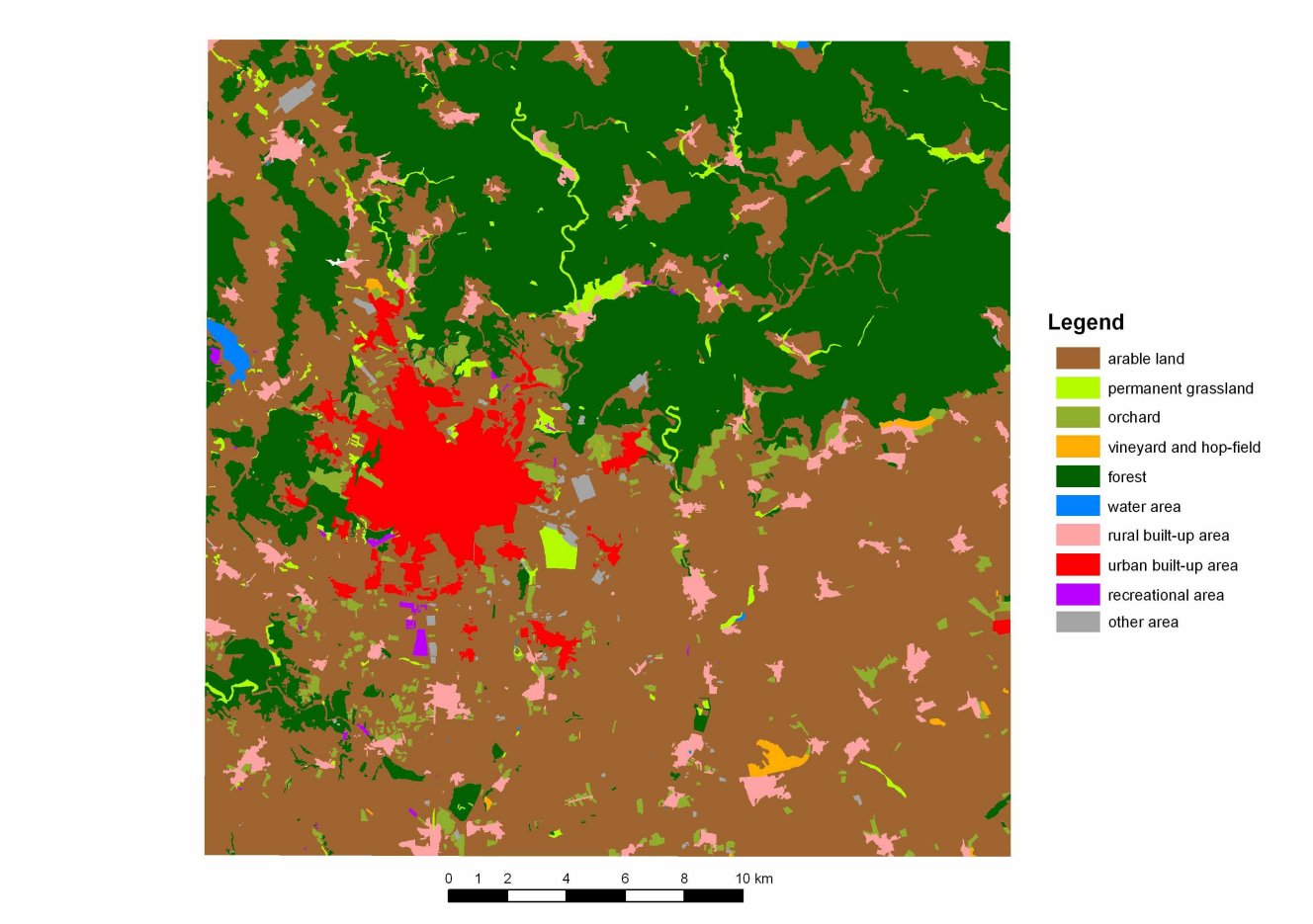

Fig. 6 Land use in 1990

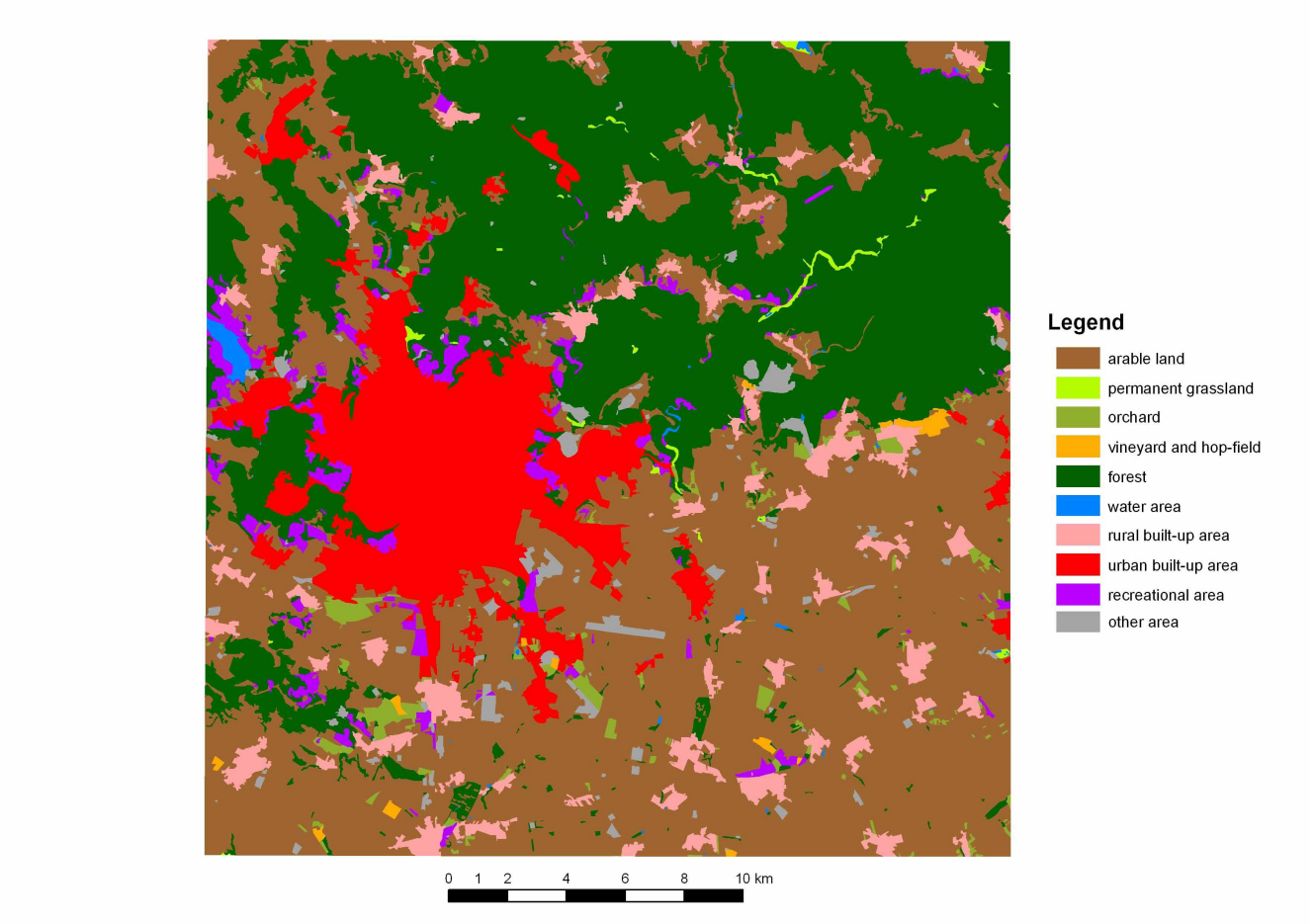

Fig. 7 Land use in 2005

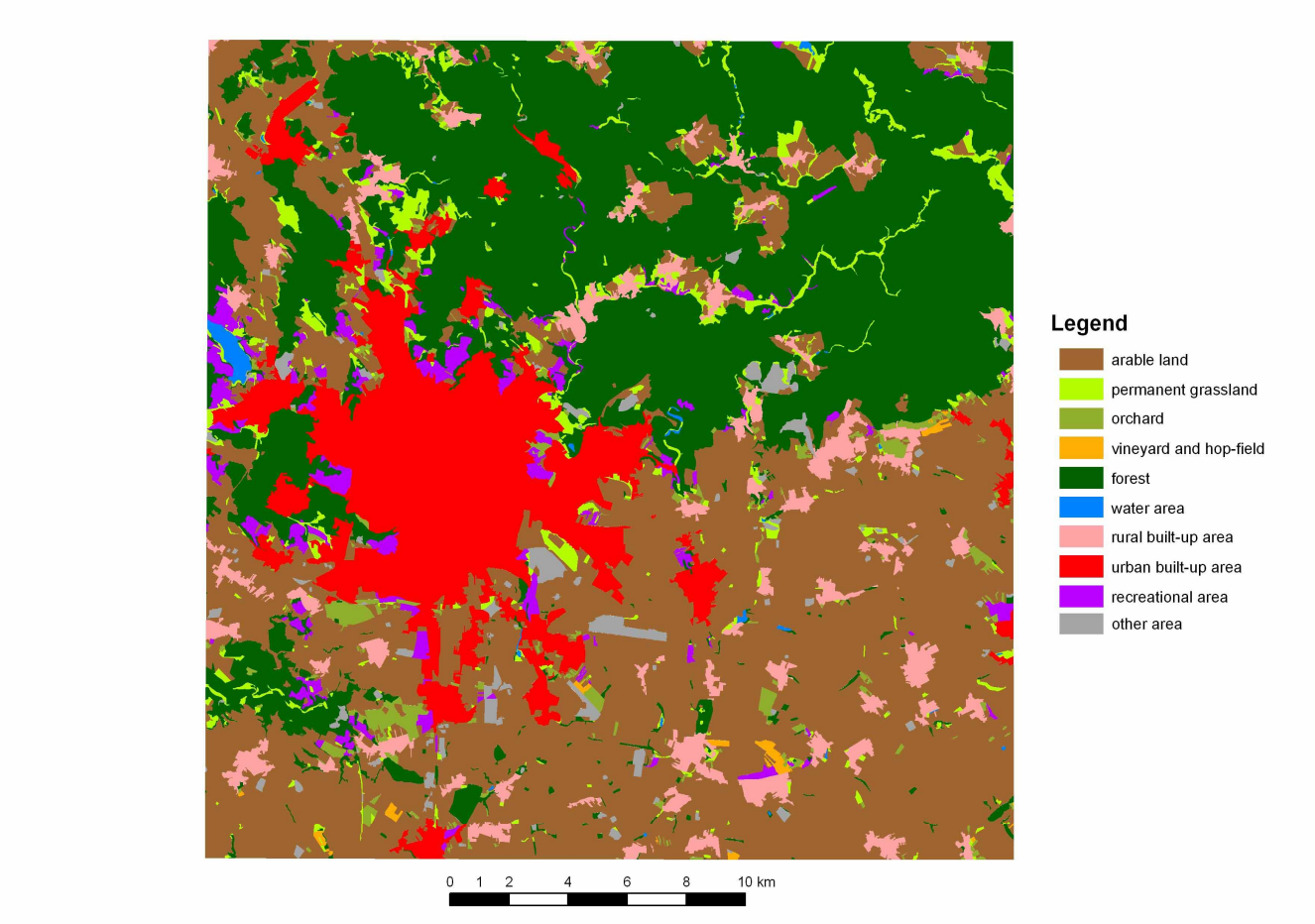

Fig. 8 Land use changes as plotted on five topographic maps from 1838, 1876, 1955, 1990 and 2005