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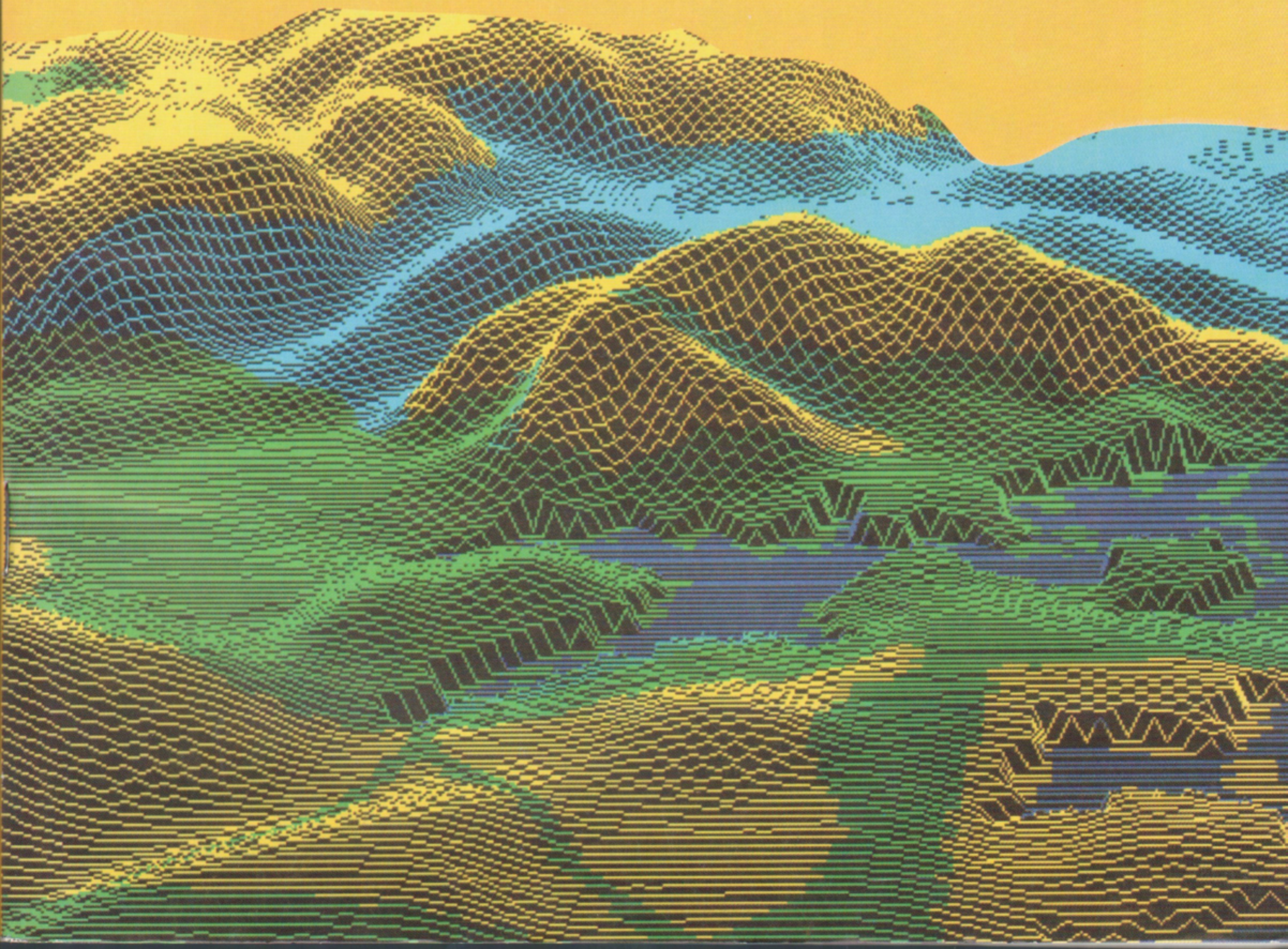

Owing to lateral erosion on outer side of the bends, the right bank which is composed of eolian sands is more than 7m high, very steep and without any vegetation (the locality is named "Loose sands").

Photo: K.Kirchner, V.Nováček

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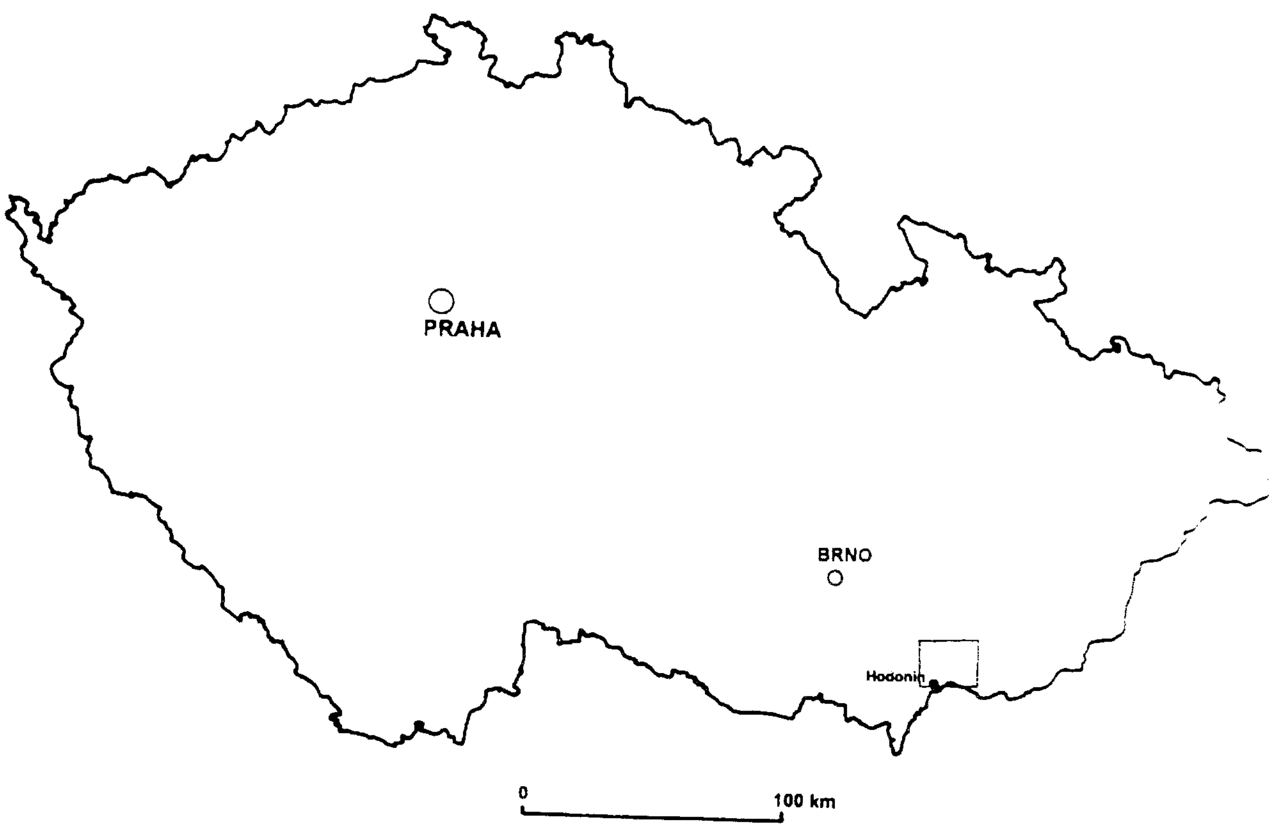
A SET OF GEOGRAPHICALLY ORIENTED MAPS (on example of the map sheet 34-22 Hodonín, scale 1:50 000)

Vítězslav NOVÁČEK

A scientific and research project E 5.5 "Inventory, record and evaluation of ecosystems in the Czech Republic" was launched within solution of the "National Environment Programme" which was coordinated by the then Federal Ministery of Environment. Former Geographical Institute, Czechoslovak Academy of Sciences (GGÚ) signed a "Contract on Project Solution" within this project in the fourth quarter of 1992, with Czech Institute for Nature Protection (ČÚOP) in Prague, proper activities of the former GGÚ consisting in solution of a partial subproject "Situation record and geographical evaluation of biotopes in the Czech Republic". Coordinators of the project were Jan Lacina and Vítězslav Nováček.

In compliance with the above contract, an area of interest was dealt with, which was defined by a map sheet of the basic map of the Czech Republic, sheet 34-22 Hodonín, at the scale of 1:50 000 on the basis of a bilateral agreement with ČÚOP Prague. A rela... extensive and complex physico-geographical resea... led to proposals of methods for landscape invento... elaboration of the first versions of methodolog... creation of individual map sheets illustrating ... physico-geographical characteristics of the give... Results of these efforts included for example a ... matic map of the given area, whose author is ... Quitt, inclusive the accompanying methodolog... The topoclimatic map illustrates three func... planes of the issue: energy balance, air flo... vertical stability of temperature stratification. T... provides a complex view of topoclimatic processe... curing within the ground and boundary atm... layers. A map of relief types and some format... also made by a following collective of authors: ... Ivan, Karel Kirchner, Vítězslav Nováček - who a... authors to the accompanying text which can se... methodological procedure to design the proc...



The map of relief types and some formations illustrates fundamental geomorphological characteristics of the given area which is situated in six basic relief types (from flat uplands on flysch with remains of platform formations through to flat hilly lands on eolic sands). Some relief types were monitored in the area under study at the same time. The terrain survey as well as a study of aerial and cosmic materials and other available cartographic and text documents revealed altogether 25 specific relief types (from areas suffering from landslips, over side erosion through to anthropogenic formations of the relief). In 1992-1993, the geomorphological project was partly funded also from the grant ordered at the Czech Academy of Sciences "Anthropogenic transformation of the relief and possibilities of its evaluation". Part of the set of thematic maps is also a map of area utilization, whose author is Vítězslav Nováček who also prepared the text section. The map of area utilization points out possibilities of using image data provided by the SPOT satellite in order to detect spatial distribution of individual landscape elements and components. Besides the natural (physico-geographical) background, the utilization of areas is a major physiognomic element of contemporary landscape, resulting physiognomy of the area under study being defined by natural framework and spatial distribution of products of human activities. Three basic functional types came into existence in the area of interest during historical development, which are defined by spatial structure of area utilization as follows: 1-technical forms, 2-agricultural forms, 3-forest forms.

After the Federal Ministery for Environment of the former Czechoslovak Federative Republic had been abolished, many projects of federal character were closed down. These reasons as well as insufficient funds were main causes why the project was never properly finalized, being terminated with creation of the first version for methodology "Record of the status and geographical evaluation of biotopes in the Czech Republic" (44 pages of text and map author's originals). This version was handed over to the client and stored in archives of the former GGÚ. Thanks to apprehension of the management from the Institute of Geonics, Czech Academy of Sciences, Brno Branch Office, the set of thematic maps was decided to be published in 1993-1994. Partial knowledge gained in the course of the project will be made use of for solution of the grant project "Transformation of South Moravia border landscape", registered at the Grant Agency of the Czech Republic, which was launched in 1994.

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Corrigendum

Number 1/1994 of Moravian Geographical Reports brought a faulty informations in enclosures to the article J.Kolejka-V.Nováček: Maps of natural landscape types and land use in the Czech Republic. Actual scale of appendicies No.1 and No.2 is 1 : 1 250 000. The copyright bearer of the original map for appendix No.1, which was modified by J.Kolejka, is Austrian Institute of East and South-East European Studies (Emil Mazúr was the author). We apologize to our readers for the oversight.

GEOMORPHOLOGY OF THE HODONÍN TOWN SURROUNDINGS

Antonín IVAN - Karel KIRCHNER - Vítězslav NOVÁČEK

Abstract

Landforms of the Hodonín surroundings (map sheet Hodonín 34-22 at the scale of 1:50 000) are very complicated. In a very interesting erosional and accumulation relief with important renewable and non-renewable resources different economic activities (mainly agriculture) led to many environmental problems and conflict of interests. This is the reason, why the presented geomorphological map of relief types and selected forms puts an emphasis on both direct and indirect relief tranformations. The main geomorphological unit of the area is the Dolnomoravský úval (Graben) which originated in the NW part of the Vienna Basin, bordered by flysch horsts of the Bílé Karpaty (Mts.) and Kyjovská pahorkatina (Hilly land). Special attention is paid to the Morava river floodplain, wind-blown sands and man-made landforms.

Shrnutí

Geomorfologie okolí Hodonína

Reliéf listu geomorfologické mapy Hodonín (34-22) 1:50 000 je velmi složitý. V erozně-denudačním a akumulačním reliéfu vede využívání obnovitelných i neobnovitelných zdrojů spolu s dalšími ekonomickými aktivitami k mnoha geoekologickým problémům a četným střetům zájmů. Tyto skutečnosti se odrážejí i v mapě typů reliéfu a vybraných tvarů. Dominantní geomorfologickou jednotkou v daném prostoru je Dolnomoravský úval vzniklý na struktuře sz. části Vídeňké pánve. Je lemován flyšovými hrástěmi Bílých Karpat a Kyjovské pahorkatiny. Zvláštní pozornost je věnována údolní nivě Moravy, eolickým pískům a antropogenním tvarům.

Key words: Dolnomoravský úval (Graben) as a part of Vienna Basin, geomorphological mapping, floodplain of the Morava river, wind-blown sands, man-made landforms.

1. Introduction

The territory of map sheet Hodonín (34-22) at the scale of 1:50 000 is situated in southeastern Moravia at the border with Slovakia. From geomorphological and geological point of view it is a contact area of the Pannonian Basin composed of mainly Neogene and Quaternary sediments and Outer West Carpathians consisting of Cretaceous and Paleogene flysch. In this typical agriculture area of low to medium altitude, there are many valuable renewable and non-renewable natural resources together with a very favourable climate and fertile soils, of which some are being mined at present and are of considerable value for economic use. The important strategic position of the area as well as existing and planned international traffic lines (including the proposed Danube - Elbe - Oder canal) is yet more significant after disintegration of former Czechoslovakia in 1992. Thus, the Hodonín district with its rural landscape is characterized mainly by very intensive and productive agriculture. Other economic activities, such as industry, water management and tranport are also important and contribute to high economic standard. No wonder that recent development is also accompanied by many conflicts of interests and serious environmental problems. Moreover, Hodonín as a district town is situated quite eccentrically in the SE corner of its administrative territory and now it is also a frontier town direct on the border with Slovakia. The present landscape is deteoriorated by activity of man and therefore the middle-scale geomorphological mapping of the area at the scale of 1:50 000 is intended to gather all data about direct and indirect anthropogenic relief transformations, significant for improving of present situation. In our opinion, together with a land-use map of the same scale, the geomorphological map facilitates an insight to the spectrum of present geoecological problems of the area.

2. Basic features of relief and geological structure

Surroundings of Hodonín belong to parts of Moravia with the lowest altitude (mostly 170- 250 m a.s.l). They are situated in a broad shallow depression of the Dolnomoravský úval (Graben), from geological viewpoint a part of intermontane depression of the Vienna Basin. The graben is the only NW marginal part of the huge Pannonian Basin wedged between the Western Carpathians and Eastern Alps. The Moravian part of the basin with its longer NE axis is paralell with the bend of the

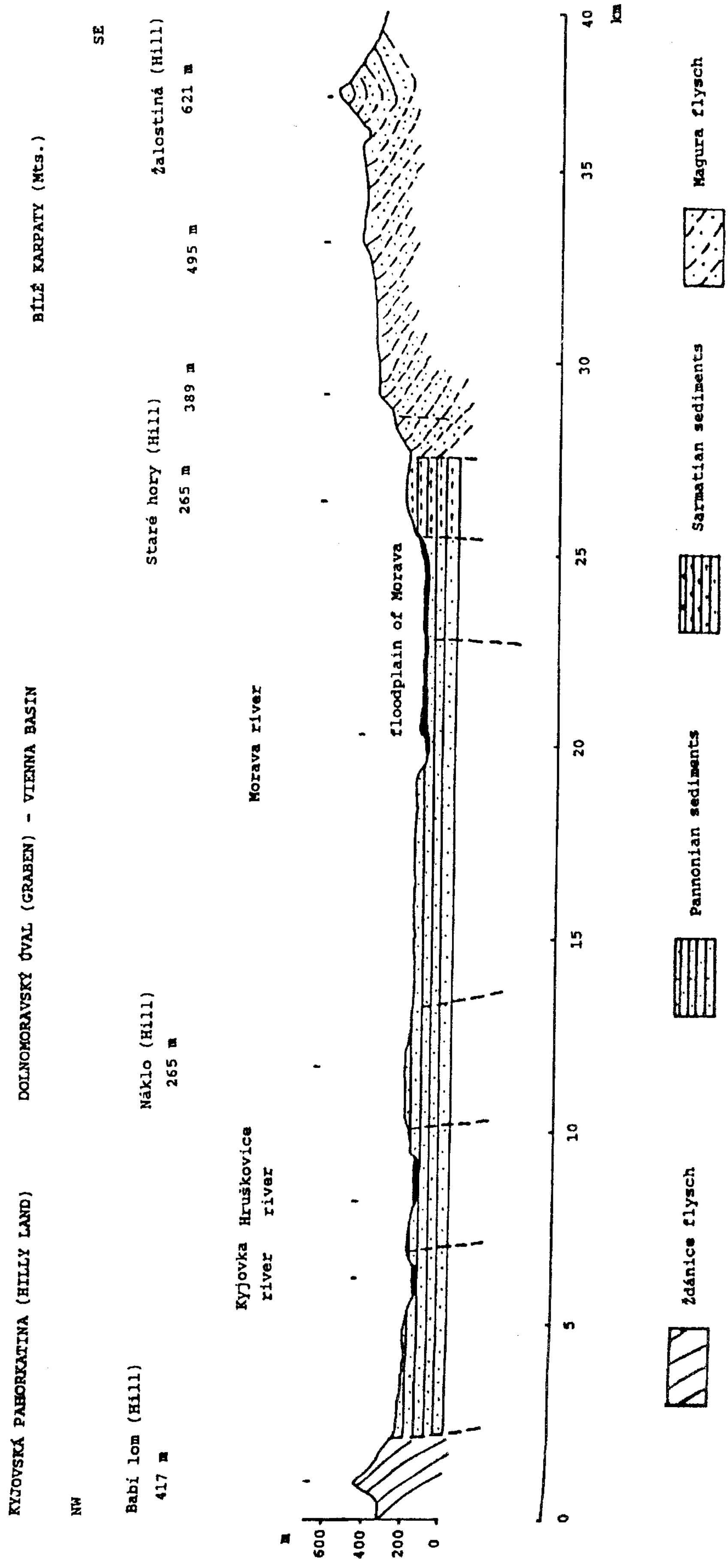

Fig. 1. Profile across the Dolnomoravský úval (Graben)

West Carpathians and is bordered with flysch elevations, namely by the Bílé Karpaty (White Carpathians Mts.) on the SE and Kyjovská pahorkatina (Hilly land) on the NW. The axis of Dolnomoravský úval (Graben) is followed by river Morava, the major watercourse of Moravia flowing to the SW and also an important left tributary of Danube. In Slovakia the part of Vienna Basin is Záhorská nížina (Lowland) and in Austria, the Östliches Weinviertel and Marchfeld, each of them having specific landscape features. Boundaries of the Dolnomoravský úval (Graben) coincide with margins of the Vienna Basin only in the East, while there are great differences in the West.

3. Morphostructures and relief development

3.1 The Dolnomoravský úval (Graben) as a part of the Vienna Basin

The paleogeography and structure of the Vienna basin is exhaustively explained by R.Jiříček and P.H.Seifert (1990) and by H. Hamilton, R.Jiříček, G.Wessely (1990). Very complex evolution of the basin started already in the Lower Neogene in connection with thrusting of the Magura nappe composed mainly of Paleogene flysch (Pyrenean or Helvetic phase). Very important was also the Savian phase at the beginning of Neogene which created not only the younger Ždánice nappe (NW of the Magura nappe) but also a forerunner of the present Vienna Basin. In the present form, the Vienna Basin is a pull-apart type structure originated in Middle Miocene (L.H.Royden, F.Horváth, B.C.Burchfiel, 1982) and filled with Neogene and Quaternary sediments. Configuration of the basin was controlled by the course of pre-Neogene structural lines (T.Buday 1963).

In the opiniom of Z.Roth (1975), the Magura nappe was an erosion (subaerial) thrust, rapidly denuded into low relief in altitude of 200 - 400 m, which corresponded to the "Augensteinlandschaft" (e.g. H.Riedl 1977) of the Eastern Alps. This is partly confirmed by Lower Miocene basal sandstones and conglomerates resting with angular unconformity on folded flysch structures both in southern part of Bílé Karpaty (Mts.) and on the bottom of the Vienna basin (A.Ivan 1980). It is possible, that also the Nesvačilka Graben continued far southeastwards, probably into the Inner Carpathians. This is also indicated by the presence of a depression in surroundings of Kobylí and Čejč situated on the crossing of the Nesvačilka Graben and NW marginal fault (Bulhary - Schrattenberg fault system) of the Vienna Basin. In our opinion, faults of the Nesvačilka Graben also control tne SW end of the Bílé Karpaty (Mts.) and their brachyanticlinal closure. The basin functioned as a piggy-back structure and its Lower Miocene filling is moderately folded. According to Z.Stráník et.al.(1993) " the presence of Karpatian sediments below the nappes and at their fronts indicates submarine nappe movements during Karpatian sedimentation".

Thus, the most dynamic changes occurred in Karpatian and Badenian. First, in connection with extension of the Pannonian Basin the Vienna Basin was reshaped and opened due to left-lateral strike-slipa faults as a pull-apart basin accompanied by rapid subsidence and sedimentation (L.H.Royden, F.Horváth, B.C.Burchfiel 1983). According to Z.Roth (1980), amplitude of the lateral movements along the system of west marginal Bulhary - Schrattenberg fault was about 80 km. Second, during the short stage of Karpatian (17.5 -16.5 m.y, with some uncertainty, see D.Vass, K.Balogh 1989), maximum rate of sedimentation 22 cm per 100 y. took place in the basin (D.Vass, K.Čech 1989). Third, thrusting of the Magura nappe over the younger Ždánice nappe as well as the Ždánice nappe over Karpatian (in southern Moravia) or Badenian sediments (in northern Moravia) during the Styrian tectonic phase was finished. L.Pospíšil, T.Buday and O.Fusán (1992) define the neotectonic movements in West Carpathians as Sarmatian - Quaternary, following the latest folding and overthrusting". Thus, from this point of view, the Vienna Basin is not a neotectonic structure. As to geomorphology, the problem calls for a more detailed discussion. Moreover, the issve is complicated by radial and longitudinal migration of orogenetic phases (R.Jiříček 1979).

The bottom of the basin as well as bordering horsts on the NW and SW are composed mainly of folded Magura flysch. A dense pattern of normal synsedimentary faults segmented the basin in many fault blocks (Fig. 1). In the deepest part of the basin, thickness of Neogene sediments is about 5 000 m. The sediments are mostly marine, but also deltaic, limnic and fluviatile.

3.2 The Bílé Karpaty (Mts.)

The Bílé Karpaty (Mts.) to the NE of the Vienna basin consist of flysch of Bílé Karpaty unit, which is a partial nappe of the Magura nappe (however, see M.Potfaj, 1993) with broad folds (E.Menčík 1969). In their NW part, their contact with the Vienna Basin is formed by a series of step like faults distinct in present topography mainly on the territory of Slovakia. The lowest foot blocks are composed of or partly covered with Miocene sediments. This is also the case of the lowest fault step in Moravia south of the town of Strážnice. The foot step (Sudoměřice step) is situated between the Strážnice and Skalica faults trending to SW (T.Buday et al. 1963b). The flat erosion surface of the step is in the altitude of 260 m and about 100 m above the floodplain of the Morava river. The Skalica fault between this block and a more uplifted block (Žerotín, 322 m) is remarkable by rectilinear course, flat facette and shalow saddle at the foot. The SW part of Bílé Karpaty (Mts.) named the Žalostinská vrchovina (Highland, according to the highest point Žalostinná 622 m) is characterized by subdued forms on low to medium resistant flysch sediments and thus without the rock forms. Inversion of the relief, as compared with other flysch areas suggests a deep level of denudation. Generally gentle slopes prevail even in the highest part of the Žalostinská vrchovina (Hillgland) with many shalow landslides (outside the map). Characteristic are also accumulation fans of left tributaries of the Morava river and also low river terraces (J.Demek, M.Vilšer 1957, A.Zeman et al.1980; D.Minaříková 1982).

3.3 The Kyjovská pahorkatina (Hilly land) and its contacts with the Dolnomoravský úval (Graben)

The Kyjovská pahorkatina (Hilly land) NW of the Vienna Basin is more complicated, composed of the Magura nappe (but here its Rača unit has rather a different internal structure in comparison with the Bílé Karpaty unit), partly of the younger Ždánice nappe. However, a great part of the Kyjovská pahorkatina (Hilly land) consists of unconsolidated Neogene deposits accumulated originally in the Vienna Basin. Their present position is due to neotectonic uplift.

The thrust line between the Bílé Karpaty nappe and Rača nappe is buried by Miocene sediments of the Vienna Basin. On the other hand, the thrust line of Rača nappe (and at the same time of the whole of Magura nappe)) over the younger flysch of Ždánice nappe north of the Kyjov town is a surface feature (not on the map) complicated by normal or strike-slip faulting. Towards southwest (SW of Kyjov) this line coincides with the Bulhary- Schrattenberg fault, i.e. NW marginal fault of the Vienna Basin (Z.Roth 1980). Here the Paleogene - Lower Miocene flysch of the Ždánice nappe is in contact with unconsolidated Pliocene sediments of the Vienna Basin.

Structure of the frontal part of the Magura nappe is very complex and addition to NE trending anticlinal and synclinal zones, also younger cross faults of NW - SE direction are important, continuing also into the northernmost part of Vienna Basin (J.Dornič, J.Kheil 1963). The most important cross disturbance is the Boršice fault.

The intensively folded and faulted flysch of the Rača unit crops out on the surface only in the northern part of the map sheet (E of Kyjov). Here, on uplifted blocks, the weak Pannonian sediments were denuded and flat buried relief (planation surface ?) in the altitude of above 300 m was exhumed. However, the southern part of the uplifted block consists only of Pannonian sediments and between the small town of Bzenec and the village of Vlkoš ends with a gentle slope of about 100 m high. This WNW - ESE running slope faces the low accumulation relief of the Dolnomoravský úval (Graben) on eolian sands. Foot of this marginal slope of the northern part of the Kyjovská pahorkatina (Hilly land) is followed by the brook of Syrovinka, right tributary of the Morava river. In our opinion, the slope is of tectonic origin.

In the western surroundings of Kyjov the topographic contact between the Kyjovská pahorkatina (Hilly land) and the Dolnomoravský úval (Graben) is less distinct. Very gradual transition into higher relief is in weak Pannonian sediments in the altitude of 200 - 260 m. In this subdued relief, the important NW marginal fault (Bulhary - Schrattenberg) of the Vienna Basin runs contacting the Pliocene sediments and Paleogene flysch of the Ždánice nappe. Higher parts of this hilly land consist of untypical flysch (rather a molasse). Rests of the erosion surface truncate the folded structures of the nappe approximately in 320 m. The highest point of the hilly land, Babí lom (417 m) composed of Paleogene conglomerate protrudes above this surface.

Boundary of the Kyjovská pahorkatina (Hilly land) between the towns of Kyjov and Hodonín runs in a very shallow valley of the small rivulet of the Kyjovka flowing southwards to the Morava river.

4. Some landforms of the Dolnomoravský úval (Graben)

1. The most remarkable feature of Dolnomoravský úval (Graben) is a ring structure situated between Hodonín and Bzenec delimited by a broad floodplain of the Morava river on the East and its small right tributaries, Syrovinka on the N and Kyjovka on the W and SW. The structure developed on intensively faulted Neogene deposits (Ratíškovice - Bzenec blocks, T.Buday et al.1967) but these sediments (Pannonian and Pontian) crop out only in its highest SW part (the hill Náklo 265 m). This higher relief corresponds probably to the Vacenovice elevation composed of Neogene sediments and flysch of Rača unit. In flysch rocks the search for oil and gas was succesful long ago (see e.g. E.Menčík 1962).In this part of structure also Pannonian lignite is mined (the Dubňany seam).
2. However, the structure is also the largest area of wind-blown sands in the Czech Republic and this presents great interest both for geologist and geomorphologist. Although extensive literature exists (F.Vitásek 1942; J.Pelíšek 1943, 1968; M.Dlabač, M.Plička 1959; P.Havlíček 1980; P.Havlíček, A.Zeman 1986; A.Zeman et al.1986; D.Minaříková 1982), the problems of origin of eolian sands and formation of dunes are not fully understood. The greatest thickness occurs in northeastern part of the structure between Rohatec (village) and Bzenec (small town) up to 35 m. Here the sands are also intensively mined. A very difficult problem consists in relation of the wind-blown sands to floodplain sediments of the Morava river. Between the town of Strážnice and the largest sand pit the floodplain is only 2-3 km wide (in

comparison with more than 5 km upstream between the towns of Bzenec and Veselí nad Moravou (see profiles in P.Havlíček, A.Zeman 1986 and in P.Havlíček 1977). In a relatively short reach between the road from Strážnice to Bzenec and the village of Rohatec, the Morava river flows in a natural meandering channel (K.Kirchner, V.Nováček 1994). Owing to lateral erosion on outer side of the bends, the right bank which is composed of eolian sands is more than 7 m high, very steep and without any vegatation (the locality is named "Loose sands") .It is apparent, that before channelization, the floodplain was in process of widening also upstream of the road from Strážnice to Bzenec. Whereas in the profile at Strážnice only Neogene sediments are present under the floodplain deposits (P. Havlíček 1977, fig. 1b), in the profile at Veselí nad Moravou (5 km upstream) the fluviatile sandy gravels are underlained also by fluviolimnic sandy clays or clayey sands of Mindelian age (c.f. P.Havlíček, fig, 1a). These Lower Pleistocene sediments, some ten meter thick, fill deep depressions in Neogene sediments. Thus, thick Quaternary sediments (referred to by Z.Kouřil 1970, but without a more precise specification) in boreholes in the floodplain near its west margin composed of eolian sand are probably also of Lower Pleistocene age, but with regards to recent westward shift of the river, another explanation is cannot be excluded.

Although the continuous cover of wind-blown sands accumulated mainly in Uppermost Pleistocene, many individual dunes are probably of Holocene age (see F.Vitásek 1942). The longitudinal dunes (mostly of NNW-SSE direction) and also crescentic dunes occur mainly among the villages of Rohatec, Vacenovice and Moravský Písek. In the past, deforestation of territory activized eolian processes. Original deciduous woods (local name Dúbrava means the oak forest) were substituted with pine in the last century.

But eolian sands are known also from other parts of the Dolnomoravský úval (Graben), in adjacent part of Slovakia (Záhorská nížina Lowland, D.Minaříková 1973), and from small dunes in the floodplain of the Morava river. It is interesting that extensive area of eolian sands in the Záhorská nížina (Lowland) is on the left side of the Morava river, opposite than sands in the area Hodonín - Bzenec. Importance of fault tectonics in the Záhorská nížina (Lowland) is evident (D.Minaříková 1973) and is also proved in adjacent part of the floodplain of the Morava river (e.g. V.Baňacký 1993).

As regards isolated eolian sands in the floodplain, the main problem is again their relation to fluvial sands and gravels. According to P.Havlíček and A.Zeman (1986), the wind-blown sands are everywhere underlained with river sands and gravels. The authors suggest that the end of eolian accumulation was in the Uppermost Pleistocene or at the beginning of Holocene. Dune formation started probably in braiding floodplain and its microrelief was important.

3. The Hradiště Graben. The narrow Hradiště Graben is a northeast promontory of the Vienna Basin and the Dolnomoravský úval (Graben). Only its small southernmost part situated NE of the between Bzenec and Veselí nad Moravou is shown on the geomorphological map. The graben originated by downfaulting of flysch of the Rača nappe. Bordering uplifted structures are the Hlucká pahorkatina (Hilly land) on the E and Kyjovská pahorkatina (Hilly land) on the W . The graben is filled with Upper Miocene, Pliocene and Quaternary deposits (J.Dornič, J.Kheil 1963; P.Havlíček 1986). But some sediments originally believed to be Pliocene have recently been redated as Quaternary (see P.Havlíček 1986). Together with longitudinal faults continuing from the main parts of Vienna Basin also the cross faults of NW-SE direction were important in formation of the graben. This applies especially to the Boršice fault between the villages of Boršice and Uherský Ostroh. The cross faults are apparent in the adjacent part of the Kyjovská pahorkatina (Hilly land) where Pliocene sediments are preserved on uplifted blocks. Their high position is due to post-Pliocene uplift (E.Menčík, V.Pesl 1961). Almost a whole bottom of the graben is occupied by wide floodplain of the Morava river. Up to now, only in this part of the Dolnomoravský úval (Graben) the high river terraces have been described (P.Havlíček 1986). On the other hand, below the floodplain deposits of Würmian to Holocene age, the fluviolacustrine sediments (Mindel) occur. With this correspond also anostomosing channels of the Morava river, well preserved to the NE of Moravský Písek.

5. Anthropogenic relief transformations

In the southern Moravia and especially in the Dolnomoravský úval (Graben) traces of very ancient settlements have been evidenced. In the floodplain of the Morava river even three significant centres of Great Morava existed in 8th and 9th century, namely Mikulčice (about 10 km S of Hodonín), Staré Město in Uherské Hradiště (in middle part of Hradiště Graben) and Pohansko, south of the town of Břeclav near the junction of rivers Morava and Dyje .

Although anthropogenic influences in the present landscape are innumerable, most direct and indirect anthropogenic transformations of the relief (ATR) have originated in this century.

Exploitation of oil and gas as well as underground mining of lignite have only relatively a small impact on the landscape. Oil and gas were found not only in Neogene sediments,but also in flysch. The most productive structures of oil and gas were found mainly in Badenian and Sarmatian (T.Buday et al. 1961). On the territory of geomorphological map the thickness of Neogene sediments is limited and important deposits are only those of Hodonín and Vacenovice. At present, deep parts of the basin and its basement (including the buried Bohemian Massif) are explored. South of Hodonín the former gas deposit Hrušky is used as a reservoir for imported gas.

Lignite deposits are widespread in the surroundings of Hodonín, but their mining is very limited at present. The lignite is of Pannonia age. The present state of research and reserves has been published by B.Krejčí (1979), B.Krejčí-S.Žídková (1987) and B.Michálek (1987). Two lignite seams are the Kyjov seam, mined mainly at the NW margin of the basin and the Dubňany seam. The underground mining of lignite is complicated by fault tectonics and underground water. Impact of the mining on the landscape is relatively weak.

In the Vienna Basin there are also other great resources: building and ceramic materials, clays, sands, loess and sandy gravels there. Many pits and open mines exist there. In the past, there were many mining places there (see J.Kalášek 1950) but after the revolutionary change of 1948, especially small pits were closed and filled with municipal waste. At present, the wind-blown sands are intensively mined mainly west of Strážnice with undesirable aesthetic impact (K.Kirchner, V.Nováček 1991).

Soil erosion also presents a serious problem, especially in the area composed of weak Pliocene sediments (Kyjovská pahorkatina - Hilly land). This is often apparent in thin incomplete soil profiles (R.Schwarz 1950). Intensive processes of gully and rill erosion during thunderstorms were studied in detail by O.Stehlík (1953) in the surroundings of Bzenec. In the past, many slopes were terraced. Many of these forms are product of unintentional long term evolution and have not any impair effect on the landscape. However, in the 70 s, the large areas were terraced insensitively as emergency drive with the use of heavy machines. In some cases the impact was terrible.

In the last century, the greatest changes were made in floodplains, namely those of the Morava river. As in other areas, the study of floodplains in South Moravia shows that great thickness of fine-grained floodplain deposits was in connection with deforestation, agriculture and changes of hydrological regime in the Middle Ages (e.g. E.Opravil 1983). Many subfossil soils occur in floodplains of the Dolnomoravský úval (Graben) (P.Havlíček 1977,1980; P.Havlíček, M.Smolíková 1994).

The prevailing part of the flooplain was deforested and changed into meadows and pasturelands. With the exception of a short reach downstream of the road from Strážnice to Bzenec, the Morava river was channelized and even the canal for transport of lignite to Otrokovice was built by fa Baťa in the 40 s. After World War II, the meadows were gradually transformed into arable land with necessary destruction of floodplain micrforms. Due to the use of heavy machines in agriculture, surface of the flodplain was very rapidly nivellized, perhaps in less than 20 years (A.Ivan 1980).

Because the Morava river is the only larger river in the Czech Republic without any important dam, danger of periodic floods still exists. In the geomorphological map special attention was given to direct anthropogenic transformations and these are very distinct in the floodplain of the Morava river.

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Explanations to the map - Appendix No.1

RELIEF TYPES

1. Gently undulated highland composed of flysch, with remnants of planation surface
2. Dissected hilly land composed of Neogene sediments with preponderance of slopes
3. Foot hills composed of Neogene sediments with remnants of planation surface and discontinuos cover of eolian and slope sediments
4. Undulated hilly land composed of Neogene sediments with extensive planation surface
5. Undulated hilly land composed of Neogene sediments with discontinuos cover of Quaternary sediments
6. Undulated hilly land composed of wind-blown sands

SELECTED FORMS

7 - Knobs
8 - Landslide area
9 - Tectonic lines along foot of slope
10 - Great gullies
11 - Active lateral erosion
12 - Low river terraces
13 - Alluvial cones
14 - Floodplains
15 - Shallow floodplain depressions filled with swamp deposits
16 - Less distinct oxbow lakes
17 - Well distinct owbow lakes
18 - Distinct dunes
19 - Area strongly affected by man
20 - Area of underground mining of lignite
21 - Active mines
22 - Inactive mines
23 - Active open mining of sand
24 - Small active sand and loam pits
25 - Small inactive sand and loam pits
26 - Dumps of waste
27 - Setting pits
28 - Dikes
29 - Channelized watercourses
30 - Agricultural terraces
31 - Deep road cuttings changed in gullies

OTHERS

32 - Significant view-points
33 - Distinct landforms boundary
34 - Undistinct landforms boundary

Explanations to the fig.

1 - Ždánice flysch
2 - Magura flysch
3 - Sarmatian sediments
4 - Pannonian sediments

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TOPOCLIMATIC MAP AS A BASIS FOR ATMOSPHERE PROTECTION AND REGIONAL DEVELOPMENT OF THE LANDSCAPE

Evžen QUITT

Abstract

A detailed topoclimatic map, sheet 34-22 Hodonín, at the scale of 1:50 000 illustrates the most significant processes which take place in the lower part of atmosphere boundary layer and in the atmosphere layer immediately adjacent to the active surface. It is therefore an important source of information about primary interactions between topography of the terrain, character of the active surface, and socio-economic activities - and as such, it is an integral part of the set of environmental maps.

Shrnutí

Topoklimatická mapa jako základ ochrany ovzduší a regionálního rozvoje krajiny

Podrobná topoklimatická mapa list 34-22 Hodonín v měřítku 1:50 000 zobrazuje nejvýznamnější procesy odehrávající se ve spodní části mezní vrstvy ovzduší, ale i ve vrstvě atmosféry bezprostředně přiléhající k aktivnímu povrchu. Je tedy významným zdrojem informací o základních interakcích mezi reliéfem terénu, charakterem aktivního povrchu a socioekonomickými aktivitami. Je tedy významnou součástí v souboru map životního prostředí.

Key words: topoclimatic map, atmosphere boundary layer, ground layer of the atmosphere, system of geographical information

1. Introduction

Importance of topoclimatic mapping as a basic source of data for atmosphere protection has lately considerably increased with breakthrough of information science and particularly in consequence of rapid development of geographical information systems. Various thematic documents (geobotanical, biogeographical, hydrogeological, pedological, aerial or satellite photographs) inspire to the export of results from these surveys at assessing possibilities of rise, duration and intensity of processes occurring in the ground- and lower parts of atmosphere boundary layer, which is the fundamental scope of topoclimatic maps. On the other hand, these documents are also a primary and irreplaceable source of information at building information systems for atmosphere protection.

At setting up area plans of all hierarchic categories, and especially at decision-making by stateadministration authorities, it is necessary to be familiar with the whole complex of processes taking place in the ground- and lower parts of atmosphere boundary layer.

It is namely these processes which to decisive extent participate not only at distribution of air pollutants but also at the character of wind field, humidity, distribution and thickness of snow cover, and at many other climatic characteristics whose knowledge is essential in order to be able to evaluate conditions for regional development or atmosphere protection of the area. Long years of experience from topoclimatic mapping in the Czech Republic and countries of Central Europe gained by the former Geographical Institute, Czechoslovak Academy of Sciences resulted in a knowledge that an information system for atmosphere protection must be built up, which would further provide efficient support to the process of decision-making. Quantification of topoclimatic processes will make it possible to evaluate their effects on for example dispersion potential of atmospheric admixtures directly in the atmosphere layer which is most dangerous to health status of the population, damage to landscape natural components or depositions of foreign substances in ecosystems.

Thus, with such a topoclimatic map, designers and state administration authorities get in their hands an important document for setting up area planning projects, for decision-making at protection of air, regional development of the landscape and dwelling environment. These documents serve particularly:

a) to work out area- and regional plans for extension of heat or gas supply systems and to assess individual stages at the transition from small air pollution sources towards utilization of clean energy which would not mean any load to environment,

b) to up-date technologies of existing boiler houses,

c) to evaluate possibilities of situating new small and medium-sized point sources of air pollution opened into the lower part of atmosphere boundary layer,

d) to assess effects of localization of sources of annoying odours,

e) to assess localization of dumps for communal and industrial wastes,

f) at specifying newly projected tracks for high voltage lines,

g) as a basis for correction of dispersion studies in point, line and planary sources of air pollution,

h) at planning localization of stand-by parking places, large train stream railway systems,

i) at evaluating danger to population after failures of chemical plants, nuclear plants and incinerators of industrial and communal wastes,

j) to assess routes for newly projected or reconstructed line sources of air pollution (motor ways, roads, railways) with costs for their operation and maintenance,

k) to judge possibilities for utilization of solar radiation as non-traditional and environment-friendly energy source as well as its efficiency,

l) to judge possibilities for utilization of wind energy as non-traditional and environment-friendly source of energy as well as its efficiency,

m) to evaluate possibilities of landscape utilization for recreation, sports and agrotourism,

n) to set up price maps of landscape and dwelling environment.

The topoclimatic map together with information system registers help to explain processes occuring in anthropogenically exploited part of atmosphere, local differences in depositions of heterogeneous substances, to suggest methods of their solution or to recommend additional verification of the terrain, which can distinctly assist to precise results and provide necessary information on accuracy of the information.

2. Contents of the detailed topoclimatic map

The topoclimatic map, sheet 34-22 Hodonín, at the scale of 1:50 000, elaborated within the scope of the project E5.5 "Inventory, record and evaluation of ecosystems in the Czech Republic" defines four categories of the climate dominating in the lower part of atmosphere boundary layer.

2.1 Climate of plains (blue colour in the map, explanatory note 1)

Flat relief with differing height of up to 50m . 16km^{-2} has a vague influence on the structure of atmosphere boundary layer. Under the weather of radiation type and with vortex flow, action of thermic effects prevails, ie. that of temperature contrasts between individual kinds of the active surface. This means that intensity of turbulent flow is largest in supra-adiabatic section of the day, being negligible in the inversion day section, ie. at night. Dynamic displacement of the flow is limited to the ground- or lower parts of atmosphere boundary layer. It is formed behind small obstacles such as houses, trees, shrubs and the like on the active surface. Atmospheric vortices are mainly of small spatial scale: radius of curvature r=1 to 102 m and duration t=1 to 102 sec. Recorded is also low wind vector variability with height, high rate of dispersion of atmospheric admixtures. Significant influence of air flow structure is exhibited by vortex movements risen via thermic turbulence. Wind vector above the ground layer does not differ significantly from gradient flow and is supposed to be identical with it at the height of about 500 m.

2.2 Climate of uplands (ochre colour in the map, explanatory note 2)

Hilly relief with differing height of up to 50-150m. 16km^{-2}shows a distinct influence on the structure of atmosphere boundary layer. Dynamic causes to the rise of vortex flow are markedly affected by broken topography, which overlaps with the influence of small obstacles such as buildings and forests on the active surface. Thermic causes to the formation of vortex flow are still affected mainly by temperature contrasts between individual types of active surface, ie. by management of received energy. Signs of confluence and difluence of flowlines begin to show in the lower part of atmosphere boundary layer. This means that wind vector is already markedly affected by terrain relief in both vertical and horizontal direction, which results in variable values of atmospheric admixtures dispersion. Flow direction in the ground layer is often markedly distinguished from gradient flow, both directions coming to congeniality at elevations beyond 500 m above the surface.

2.3 Climate of hilly lands (brown colour in the map, explanatory note 3)

Topography of hilly lands with heights from 150 to 300m . 16km^{-2} exhibits a pronounced influence on the structure of atmosphere boundary layer. Thermic causes to the formation of vortex flow consists not only in different management of received solar energy in subsurface layers but also in radiation balance of differently inclined slopes and their different aspects. Higher values of linear momentum flow (convection) distinctly influence the air flow. The favourable inclination facilitates formation of anabatically conditioned microcirculation which makes the component of flow thermic displacement very efficient under radiation type of the weather. In contrast to the climate of uplands, action of the flow dynamic displacement is more apparent. Phenomena of flowline confluence and difluence are to be seen within the entire lower part of atmosphere boundary layer. Atmospheric vortices often acquire radius of curvature r=103 to 104m with duration t= up to 103sec. This indicates that wind vector is distinctly affected by relief, which leads to considerable deviations from gradient flow. Similarly, values of dispersion of atmospheric admixtures are many times very variable, too. The local differences in rate of active surface heating by solar radiation cause considerable vertical exchange of air masses. Participation of turbulence effects of thermic character at vortex flow is very significant, particularly in situations with lower wind velocities and under the clear weather. Effects of mechanical turbulence prevail at higher wind velocity values.

2.4 Climate of indented small flat relief forms (yellow colour in the map, explanatory note 4)

In this category, thermic causes to flow displacement consist mainly in temperature contrasts between individual types of the active surface. However, many times they coincide with dynamic flow displacement affected by topography surrounding the indented formation. In vertical direction, wind vector is to considerable extent influenced by the character of immediately adjacent relief rather than by the indented formation itself. Atmospheric vortices are mostly those of small spatial scale, radius of curvature r= 1 to 10^2m, duration t= 1 to 10^2sec. Low values of atmospheric admixtures dispersion are recorded at more frequent stable stratification with suppressed vertical component of turbulence. With regard to the surrounding upland relief which forms cool air-collection area and to the small area of accumulation space of the proper concave formation, we presume mean incidence of short-term weak temperature inversions. Low angle of superelevation with surrounding relief results in effective radiation decreased by as much as 2%.

Other ten categories formed climate of the ground layer of atmosphere, affected mainly by character of the active surface and its parent rock. In addition to the climate of fields and meadows, we defined the climate of forests, urbanized and water areas. In principle, the climate of fields and meadows has been classified by thermal conductivity of parent rock. Energy flows which cause heating of atmosphere ground layer as well as evaporation are namely influenced -besides global radiation- mainly by thermal and water status and properties of the parent rock. Differences in albedo in grass cover and cultural plants are great, too. However, they depend on growth stage of the vegetation cover throughout the year as well as on type of the cover.

2.5 Climate of fields and meadows with parent rock of low thermal conductivity (inclined black hachure in the map, explanatory note 7)

Low thermal conductivity parent rock is characterized by a tendency toward extreme surface temperatures under radiation type of the weather, and thus also by significant influence on vertical movements in the atmosphere. At a favourable inclination, these surfaces support rise and development of catabatic and anabatic processes. There are high maximum and low minimum temperatures here, accompanied by low relative as well as absolute air humidity. Increased production of cool air is a predestination of these areas for significant support of radiation type ground inversions. The following structure of heat flows can be expected under radiation type of the weather by midday: conductivity heat flow G=20%, turbulent heat flow H=60%, latent heat flow E=20%.

2.6 Climate of fields and meadows with adequately humid parent rock and normal thermal conductivity (without hachure in the map, explanatory note 8)

Climate in question is that of areas with common climatic status in the atmosphere ground layer and structure of heat flows under radiation type of the weather by midday, which is as follows: conductivity heat flow G=30%, turbulent heat flow H=40%, latent heat flow E=30%, and with normal predispositions to occurrence of inversions, catabatic and anabatic processes.

2.7 Climate of fields and meadows with adequately humid parent rock and high thermal conductivity (with inclined hachure in the map, explanatory note 9)

Climate in question is characterized by reduced temperature maxima and higher temperature minima under radiation type of the weather. Approximate heat flow structure by midday is as follows: conductivity heat flow G=40%, turbulent heat flow H=20%, latent heat flow E=40%.

2.8 Climate of fields and meadows with adequately humid parent rock and extremely high thermal conductivity (dotted screen in the map, explanatory note 10)

Areas with parent rock of extremely high thermal conductivity can be distinguished by high values of latent heat flow. Heat flow structure under rariation type of the weather by midday is as follows: conductivity heat flow G=40%, turbulent heat flow H=10 to 20%, latent heat flow E=40 to 50%. Usual records show higher evaporation and increased probability of fogs, maximum and minimum air temperatures are significantly lower and usually increased, respectively.

Forest-covered surface is characterized by low total values of long-wave heat radiation. Compared with open terrain, less than a quarter of global radiation gets to the surface. The distinctly lower effective radiation reflects in lower values of mean diurnal air temperature. Height-related variability of wind vector is slightly increased in the ground layer, both catabatic and anabatic processes are markedly suppressed similarly as intensity of vertical movements in the atmosphere. Intensity of aeration in the ground layer is heavily reduced, temperature maxima are lower while temperature minima are higher, durability of snow cover is distinctly prolonged. Immediate evaporation from soil and transpiration of the lower herb layer in the forest are low with regard to poor offer of solar radiation and weak turbulent transmission. From the viewpoint of effects on energy and water balance, forest areas in the sample sheet of Hodonín topoclimatic map have been divided into coniferous, deciduous and floodplain.

2.9 Climate of coniferous forest (dark green horizontal hachure in the map, explanatory note 11)

This climate is typical of low albedo around 10%, heavily reduced effective radiation from the soil surface and the following approximate structure of heat flows under radiation type of the weather: conductivity heat flow G=25%, turbulent heat flow H=25%, latent heat flow E=50%. Anabatic and catabatic processes are severely suppressed, maximum air temperature values are reduced, minimum air temperature values elevated, slightly increased is also relative humidity, evaporation is lower. Snow cover durability is markedly prolonged, intensity of turbulent exchange is reduced over the whole year, interception of precipitations is significantly increased (up to 40%).

2.10 Climate of deciduous and mixed forests (yellow-green horizontal hachure in the map, explanatory map 12

This type of climate is characterized by slightly lowered albedo of around 20%, heavily reduced effective radiation from the soil surface, structure of heat flows similar to that of coniferous forests. Severely suppressed are both anabatic and catabatic processes. In summer, minimum air temperature values are increased, maximum air temperature values decreased. Influence of crown canopy disappears in winter, which reflects in changed structure of heat flows as well as in effect on maximum and minimum air temperature values. Compared with the open grass surface, snow cover durability is slightly prolonged. Interception of precipitations is about 20%, intensity of turbulent exchange is heavily reduced in summer, slightly reduced in winter.

2.11 Climate of floodplain forest (blue-green horizontal hachure in the map, explanatory note 13)

Floodplain forest with slightly reduced albedo of about 20%, structure of conductivity heat flows G=40%, turbulence H=10%, and latent heat flow E=50%, maximum and minimum air temperature values are reduced and elevated, respectively. Markedly increased relative air humidity relates to higher frequency of fogs.

Urbanized areas with vertically articulated active surface of building materials, intensive anthropogenic heat flow, many times also with polluted air. The active surface of urbanized areas has a great thermal capacity, ie. it accumulates thermal energy at the day time in order to radiate it at night. Increased turbulent heat flow is associated with pronounced increase in aerodynamic roughness of the active surface. Vertical component of flow velocity develops to the detriment of horizontal component, which -along with anthropogenic production of heat and overheating of dark urban surfaces such as roofs and roads - leads to distinctly increased convection. Apparent reduction of latent heat flow is the cause to low water content in the urbanized areas. Most water is namely being drained off the town by sewerage systems. Dominant factors of the urbanized areas are therefore seen in production of waste heat, differences in thermal conductivity and thermal capacity of building material, changes in water balance and changes in turbulent transmission. All this reflects density and height of housing.

2.12 Climate of urbanized areas with medium housing density (thin yellow vertical hachure in the map, explanatory note 14)

This climate is characterized by apparent anthropogenic heat flow in the winter period. Expected structure of heat flows under radiation type of the weather by midday is as follows: conductivity heat flow G=30%, turbulent heat flow H=50%, latent heat flow E=20%. Apparent is wind vector variability with height and rate of vortex flow $r=10^1$ to 10^2m with duration t=101 to 102sec. Air temperature maxima and minima are elevated, relative air humidity is lower than that in the open landscape. Snow cover durability is shorter.

2.13 Climate of densely built-up urbanized areas (thick yellow vertical hachure in the map, explanatory note 15)

This type of climate is distinguished by lower values of direct solar radiation and by distinct anthropogenic heat flow over entire year. Albedo amounts to 20-30%, effective long-wave radiation is significantly reduced due to atmosphere turbidity. Expected structure of heat flows under radiation type of the weather is as follows: conductivity G=20%, turbulent heat flow H=70% and latent heat flow E=10%. Variability of wind vector with height is very high, vortex flow values amount to $r=10^2$m and $t=10^2$sec. All this results in considerable vertical movements in the atmosphere. Intensity of aeration in atmosphere ground layer is very low. Both maximum and minimum values of air temperature are increased. Relative air humidity is decreased and evaporation is very low. Snow cover durability is distinctly shortened.

Water reservoirs exhibit typical energy balance following out of physical properties of water. Their influence on atmophere ground layer is given namely by size, shape, depth and turbidity of water in the reservoir. Solar radiation penetrates to certain depth in the water, reaching the bottom in riverine parts and in shallow reservoirs. This is why absorption of the radiation is distributed across a much greater space than in soil. Water area albedo is generally lower than in the majority of other surfaces. However, water heating is slower, which is given by its large-volume thermal capacity as well as by existence of turbulent flows. High values of latent heat flow play an important role in energy balance, being dependent on water surface temperature, saturation cofactor, and intensity of aeration in the vicinity of water table. In comparison with latent heat flow, turbulent heat flow above the water table is considerably smaller. From the viewpoint of flowing, water table roughness is namely very low, and this is why we can often record laminar flows here. Turbulent heat flow into the atmosphere above the water table is therefore considerably limited. Dominating factors which play the most important role at affecting topoclimate of water reservoirs and their surroundings include specific energy balance that is conditioned by depth, size and shape of the water reservoirs.

2.14 Climate of water reservoirs (thick blue vertical hachure in the map, explanatory note 16)

Small and shallow water reservoirs are typical of absorbing direct solar radiation within the entire vertical profile including the bottom. At the time of insolation, vertical profile of water temperature is thus influenced by partial increase of temperature near the bottom. Higher values of latent heat flow are caused by advection of unsaturated air from surroundings. Small size of the reservoirs facilitates higher intensity of turbulent transmission of water vapours. Turbulent heat flow values remain unreduced (as it is usual in water reservoirs) due to overgrowing of riverine parts as well as with regard to effects of contrasting temperatures of surrounding areas. Due to overgrowing and low depth albedo can be even greater than 10%. Reduced aerodynamic roughness of water table does not show in vertical flow profile due to small size of the reservoir. Significant diurnal fluctuation in water temperature values has only a negligible influence on air temperature with relative air humidity being slightly elevated.

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Explanations to the map - Appendix No.2

CLIMATE DOMINATING IN LOWER PART OF ATMOSPHERE BOUNDARY LAYER

1-climate of plains, 2-climate of uplands, 3-climate of hilly lands, 4-climate of small flat concave formations, 5-slopes with excessive insolation, 6-slopes with insufficient insolation.

CLIMATE DOMINATING IN ATMOSPHERE GROUND LAYER

7-climate of fields and meadows with parent rock of low thermal conductivity, 8-climate of fields and meadows with adequately humid parent rock and normal thermal conductivity, 9-climate of fields and meadows with adequately humid parent rock and high thermal conductivity, 10-climate of fields and meadows with adequately humid parent rock and extremely high thermal conductivity, 11-climate of coniferous forest, 12-climate of deciduous and mixed forests, 13-climate of floodplain forest, 14-climate of urbanized areas with medium housing density, 15-climate of densely built-up urbanized areas, 16-climate of water areas.

CLIMATE DOMINATING IN THE LOWER PART OF ATMOSPHERE BOUNDARY LAYER

1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	1	5	1	1	1
2	2	2	2	2	2	3-5	1-2	1-2	1-2
3	3	3	3	3	4	2-5	1-2	1-3	1-2
4	2	2	1-2	2	2	3	2	2-3	2
5	+1						-1		-1
6							+1	+1	

1-number of explanatory note in the map, 2-thermic causes of turbulence, 3-dynamic causes of turbulence, 4-size and duration of vortex flow, 5-wind vector variability with height, 6-confluence and difluence of flowlines, 7-dispersion of atmospheric admixtures, 8-duration of temperature inversions, 9-frequency of temperature inversions, 10-intensity of temperature inversions.

CLIMATE DOMINATING IN ATMOSPHERE BOUNDARY LAYER

1	2	3	4	5	6	7	8	9	10
7	1	1	3	2	2	4	1	2	3
8	1	3	2-3	3	2	3	2	3	3
9	1	3	2	3	2	2	3	3	3
10	1	4	2	4	2	2	3	5	3
11	1	2	2-3	3	4	2	4	2	5
12	1	2	2-3	3	4	2	4	4	4
13	1	4	2-3	4	4	2	4	4	4
14	3	3	4	2	4	4	3	2	2-3
15	5	2	5	1	5	5	5	1	1
16	1	5	1-2	5	2	2	3-4	5	-

1-number of explanatory note in the map, 2-anthropogenic heat flow, 3-conductivity heat flow, 4-turbulent heat flow, 5-latent heat flow, 6-size of vortex flow, 7-maximum temperature, 8-minimum temperature, 9-evaporation, 10-durability of snow cover.

CLASSIFICATION CRITERIA
1-absent, negligible, heavily reduced
2-weak, low, reduced
3-medium, normal
4-strong, high, reduced
5-very strong, very high, highly increased

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UTILIZING THE SPOT SATELLITE DATA TO SET UP A LAND USE MAP

Vítězslav NOVÁČEK

Abstract

Land use map is one of many possibilities to make use of data provided by the SPOT satellite in order to indicate spatial distribution of individual landscape elements and components. Resulting physiognomy of the area under study is defined by natural framework as well as by spatial arrangement of products of human activities. Proper content of the land use map is a result of integrating documents and data of various origin and content (false colour composites made of SPOT satellite three spectral zones, aerial photographs, topographical maps of different scales, terrain surveys). A map which is set up in this way is of areal character with individual phenomena and functional areas being plotted in colours. The empirically found physiognomic elements of landscape use illustrate spatial structure of the landscape from environmental point of view.

Shrnutí

Využití údajů z družice SPOT pro sestavení mapy využití ploch

Mapa využití ploch ukazuje na možnosti využití obrazových dat z družice SPOT pro zjišťování prostorového rozmístění jednotlivých prvků a složek krajiny. Vedle přírodního (fyzickogeografického) pozadí je využití ploch hlavním fyziognomickým prvkem současné krajiny, přičemž výsledná fyziognomie sledovaného území je určována přírodním rámcem a prostorovým rozmístěním produktů lidské činnosti. Specifickým typům přírodní krajiny v podstatě odpovídá výběr, kombinace a prostorové rozmístění tvarově a velikostně diferencovaných areálů forem využití ploch. V průběhu historického vývoje se v zájmovém území vytvořily tři základní funkční typy, jenž jsou definovány prostorovou strukturou využití ploch : 1. technické formy, 2. zemědělské formy a 3. lesnické formy. Vlastní obsah mapy využití ploch je výsledkem integrace podkladů různého charakteru (nepravě barevná syntéza pořízená z údajů snímačů družice SPOT, letecké snímky, topografické a tematické mapy různých měřítek, osevní plány a přirozeně i vlastní terénní šetření). Tímto způsobem zkonstruovaná mapa využití ploch má areálový charakter, kde jednotlivé objekty a funkční areály jsou barevně znázorněny. Takto vyčleněné fyziognomické prvky využívání krajiny charakterizují prostorovou strukturu krajiny z environmentálního hlediska.

Key words: false colour composite, interpretation of satellite imagery, environment, land use mapping

1. Introduction

The term "land use" is normally used to express external manifestation of utilizing geographical environment for economic activities of human society. Actual forms and methods of the land use are usually a compromise between natural properties of the given area and technical potentials, knowledge and capabilities of the man in the specific historical epoch. The actual information on spatial arrangement of individual components of landscape cover are considerably important for the whole range of decision-making processes which are necessary for general transformation of economy in the Czech Republic. At these decision-making processes, necessity of preserving the landscape complexes has to be taken to account, whose organization is near to natural environment optimum status. If the threshhold status has been exceeded, we speak of devastated areas whose original natural status can be restored only with difficulties.

Character of actual land use situation in the given region is best illustrated by data obtained from satellite carriers such as LANDSAT or SPOT, which are being processed and interpreted with consequent plotting into the map. On the basis of the hitherto experience and acquired knowledge it can be stated that the remote sensing methods are a.o. very efficient at monitoring and evaluation of lands, ie. at studying and characterization of spatial distribution of individual landscape elements and components. Apart from the existing natural (physico-geographical) background the land use forms one of the major physiognomic elements of contemporary landscape. Thus, the land use map can provide unambiguous and irreplaceable information about fundamental functional differentiation of the area under study.

When resolving the issue of landscape spatial structure organization it is useful to start with definition of a scheme of its description which would facilitate classification of the landscape sphere into a hierarchic system.

This means that it would be useful to set up a classification scheme of several stages which would correspond to different distinguishing standard. At present, we can meet with a whole range of land use and land cover classification systems which are rather similar as to their typological units. A classification scheme which was worked out by the EU Committee for the project "CORINE-Land Cover" has been considerably spread lately.

Two basic interpretation methods can be used at monitoring and evaluation of land use by remote sensing, which depend on the character of the used image information. If there are image data at our disposal, which have been recorded on floppy disc carriers, it is useful to process the information by means of computer interpretation methods employing a corresponding software. However, if we only have the image information in the form of a photograph (false colour composite), we should rather prefer a visual-analogous method of interpretation.

2. Methods to process and set up the map

A major task at creating the thematic land use map consists in allocation of proper thematic content to actually existing areas, ie. in defining the way of use for each individual area including its taxonomic classification. The given issue is well suited for very successful utilization of satellite data which are being processed into the form of false colour composites for visual interpretation. A properly set-up false colour composite makes it possible-in the case of visual interpretation-to assess the reality under study in a much more effective and complex way including a possibility of analyzing its spatial structure. This procedure is close to geographical approach to the landscape,representing a.o. a consistent method of how to use multispectral data. Proper implementation of the thematic land use map included imagery material which was obtained from the SPOT satellite on 2 May, 1990. Source data were acquired from the joint Czechoslovak-French remote sensing pilot project in two types: a false colour composite illustrated the area under study at the scale of 1:100 000 (see the colour twin sheet in the middle of the journal), visualized digital data at the original scale of 1:375 000 were at our disposal in all three SPOT satellite carrier spectral zones (channel 1: 500-590 nm, channel 2: 610-680 nm, channel 3: 790-890 nm). Positive copies were magnified to the scale of the resulting thematic map, ie. 1:50 000 for each of the spectral intervals by means of a specific photographic procedure. Basic map of the Czech Republic, sheet 34-22 Hodonín (scale 1:50 000) was used as a basis. However, due to excessive generalization, this map put some limitations on optimum use of information gained from the given area, which had been obtained in the course of relatively detailed terrain surveys, study of archive materials and evaluation of additional aerial and cosmic materials.

Basis for the thematic land use map created in this way was plotting of information obtained through false colour composite into the cartographical fundamental document, the decisive guide at delineating the boundaries being changes in colours of individual areas as well as all line elements indicated in the false colour composite inclusive the recognizable river network and water area images. The detected areas of individual objects were further precised by visual interpretation of individual black-and-white photographs of relevant spectral zones, with visual interpretation of large-scale aerial photographs being used in some cases, too. The first stage of setting-up the thematic land use map did not included any further support information of non-distance origin. The areas thus illustrated realistic situation in land use, documenting planary structure of the landscape to the date of scanning. Comparison of the areas with the basic map revealed a whole range of imperfect data, particularly in the illustration of areas with forest covers. Discrepancies were also found in the plotting of residential units namely those of urban types, in the course of road network (newly built roads are not plotted at all) as well as in the course of riparian line of water areas and streams (e.g. very distinct changes in meander shapes of the River Dyje near Strážnice).

In addition to the above information for correction, precision and actualization of the map, the illustration of land use areas provides new information not included in common maps. This relates in particular to the possibility of defining limits for forest species composition types and classification of agricultural lands by existing methods of their cultivation. After definition and plotting of land use areas for individual species, which was-to certain extent-a very labourious and time-consuming stage of creating the map by means of the above method, the next step consisted in filling the network of areas with thematic information which would characterize actual use of the given area. This information was evaluated on the basis of visual interpretation of false colour composite. The number of mutually different forms of land use that can be interpreted from FCC synthesis on the basis of empirical experience depends on resolution capacity of the synthesis by means of the scale, which also defines conditions for classification itself and consequently extent of the land use map legend. Three following basic categories of land use forms (see enclosure no. 3) were interpreted at the given scale of 1: 50 000 and defined for the land use map:

1 Technical forms of land use

2 Agricultural forms of land use

3 Forest forms of land use.

The first category included following forms of land use, which were detected within the space demarcated by the map sheet 34-22 Hodonín: built-up dwelling areas, built-up production areas, built-up recreational areas, areas with open-cast mines of mineral raw materials (sand pits, clay pits, open-cast quarries), devastated areas, spoil heaps, landfills, areas used for military purposes, roads, railways, field airports, water areas and water streams. The second category of agricultural land use forms includes arable land, meadows and perennial grass stands (in some cases with shrub vegetation), vineyards, fruit orchards, vegetable-growing areas, gardens and small land tenures. The third category of forest land use forms classifies: coniferous forests, mixed forests, deciduous forests and clearings.

Nevertheless, some of the above mentioned land use forms could not be defined unambiguously and were classified only on the basis of visual interpretation of false colour composite recorded by individual spectral channels of the SPOT satellite, this being caused by proper spectral manifestation of some objects whose spectral properties were practically identical (e.g. permanent grass stands were plotted in a practically identical way as arable land covered with perennial fodder plants or in the case of newly established vineyards or fruit tree orchards the spectral interpretation was similar to that of bare land, etc.). This was due to the date of remote sensing (beginning of May) and to the course of vegetation development in the given year. This was the reason for us to strictly verify success of FCC visual classification, and this is also why extensive material was obtained mainly from individual agricultural plants in the form of detailed rotation plans and personal discussions with individual agronomists from agricultural establishments. Methods of direct terrain survey were used in cases when false colour composite objects which are difficult to classify were defined directly in the terrain on the spot. Documents of the District Authorities in Hodonín were used at assessing some specific land use forms such as at defining open-cast mineral mines, waste landfills etc.

A thematic land use map made like this is of areal character where individual monitored categories and functional areas are colour-plotted. Choice of means to delineate the individual land use categories in the given conception respects recommendations of the technical committee for land use mapping at the International Geographical Union (IGU).

3. Discussion and conclusions

The area demarcated by the map sheet 34-22 Hodonín occupies an area of approximately 440 square km (territory of the Slovak Republic not being included) with nearly two thirds of the territory being occupied by agricultural land use forms (five major forms have been identified on the basis of false colour composites). Forest forms of land use occupy hardly one third of the given area with four major forms indicated. Most numerous representation is that of the technical land use forms which do not represent large areas but their representation includes fifteen major forms in total. In some cases, the false colour composite synthesis facilitates interpretation of other land use forms, but their plotting in the map is no more realistic taking into account legibility, good arrangement and interpretation capacity of the map. The land use map which has been set up on the basis of the above procedure makes it possible to operatively up-date content of the map to the date of remote sensing or on the basis of annual up-dating provided that necessary supporting data are available. Advantage of a map which has been set up in this way consist in the fact that localized informations provided are independent of the static geodetical information system which relates to administration units. If a chronological series of these maps has been created, we can start assessing of dynamics of changes of some phenomena and processes in the landscape, differentiating and prognosing the areas also from the viewpoint of some aspects in their time and spatial development.

In addition, the land use map can provide the very valuable information about actual situation of the landscape sphere. Its application can be seen at all places of legal area-planning decision-making and at all places where the maps can serve a suitable basis for decision-making processes of administration bodies such as authorities of regional area development and environment protection at district councils. The land use maps belong to fundamental information layers at generating data files for geographical information systems (GIS). GIS creation and their up-dating by means of strictly made interpretation of remote sensing materials appears to be considerably effective both from the time point of view and in terms of financial funding. The above described method of land use map generation, which consists in visual interpretation of false colour composites appears useful particularly in cases when corresponding technical facilities for digital processing of image information are not available (ie. th whole system chain - from obtaining digital satellite data through to graphical output by means of large-size colour laser printer). The above mentioned procedure of land use thematic map generation has been based on human factor and makes full use of empirical experience of interpreter at assessing false colour composites. The used material gained by means of SPOT satellite scanners provides relatively acceptable results at the used map scale of 1:50 000. If other satellite records are to be used such as Landsat TM data or at interpretation of aerial multispectral photographs, some adjustments and corrections must be made since the Landsat TM data are of a much wider spectral engagement and false colour composites made of them facilitate more precise and more reliable interpretation of land use forms under study.

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Explanations to the map - Appendix No. 3

TECHNICAL FORMS OF LAND USE:

1 - built-up dwelling areas
2 - built-up production areas
3 - built-up recreational areas
4 - sand pits
5 - clay pits
6 - open-cast quarries
7 - devastated areas
8 - undermined areas
9 - waste dumps
10- waste landfills
11- military-affected areas
12- roads
13- railways
14- field airports
15- water areas and water streams

AGRICULTURAL FORMS OF LAND USE:

16- arable lands
17- meadows and perennial grass stands
18- vineyards
19- fruit-tree orchards
20- vegetable-growing areas, gardens, small land tenures

FOREST FORMS OF LAND USE:

21- coniferous forests
22- mixed forests
23- deciduous forests
24- clearings.

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A COMPUTER INTERPOLATION OF PRE-QUATERNARY SURFACE

Zbigniew GARDZIEL - Vít VOŽENÍLEK

Abstract

Computer applications in geology have come to modern research methods rapidly. Advantages of computer data processing have substituted manual procedures in geological investigation and mapping. The paper treats computer interpolation of the Pre-Quaternary surface from bore-hole data on the Polish geological map of 1:50 000 scale. The area under invastigation is situated in SE part of Poland. Using several kinds of data the procedure was carried out by simple software package SURFER available to be run on PC computers. Final results exhibit suitability for futher use of the presented procedure.

Shrnutí

Počítačová interpolace předkvartérního povrchu

Generování předkvartérního povrchu v prostoru Wisznice (JV Polsko) bylo provedeno v prostředí programu SURFER, který dovoluje zpracovávat digitální prostorová data na počítačích PC v rastrovém formátu. Při vlastním zpracování bylo použito interpolační metody Kriging. Současně bylo nadefinováno několik parametrů. Jejich hodnoty byly odvozeny od konkrétních rozměrů území Wisznice a pro jiné aplikace se samozřejmě liší (rozlišení rastru 245x266, tj. 212x212 metrů ve skutečnosti). Vstupní data (údaje ze sond a vrtů) byly rozděleny do třech kategorií podle podrobnosti. Finální předkvartérní povrch je výsledkem rastrových operací třech vygenerovaných povrchů a poskytuje kvalitní obraz o průběhu předkvartérního povrchu. Použití programu SURFER, hardwarové platformy PC a uvedených zdrojů dat tak umožňuje jejich efektivní použití v procesu geologického modelování povrchů.

Key words: Interpolation, Kriging, Pre-Quaternary surface, computers.

1. Introduction

Since the first years of computerisation the computer applications in geology have concentrated on modelling of surfaces, calculating their volumes and generating geological cross-sections at main frame computers. Several topics of computer data processing were investigated for implementation in geological research eg. data source, interpolation methods, model structures and their generating, algorithms for extracting principal geological features etc. One of the most powerful structures in geological applications is a digital elevation model (DEM).

The digital elevation model is a numerical representation of surface characteristics. DEMs have found a wide range of applications (Petrie, Kennie 1990). In geological and geophysical mapping they visualise surfaces and underground structures (Raper 1989). They also can provide information on visibility from a specific point.

2. Geological map as a data source

The beginning of 1950, the geological mapping of Poland was started at the scale 1:50 000. The first produced General Geological Map of Poland was published in 1954 and since 1967, the mapping has been carried out systematically (1,069 sheets, Regions of the Sudeten at 1:25 000). Thee maps are completed by a uniform method of 1975 (upgraded in 1991). The maps are published by State Geological Institute in Warsaw but there was a lot of institutions which took part in their compiling (universities, scientific teams, Geoprojekt etc.).

The content of one sheet consists of a multi-coloured map of surface formations, geological cross-section and explanations. The explanations involve geomorphological description of the region, characteristics of general geological formations, stratigraphy, tectonics, hydrogeology and geological history of the region. Small simple charts (both general geological and geomorphological chart at 1:200 000 scale, bore-holes, about adjacent sheets etc.) are added. The geological maps are a powerful source of geological, geomorphological and topographical information for both scientific and practical purposes. Data about lithology, thickness, genesis, stratigraphy and their distribution are available.

More than 80% of the area of Poland is covered by Quaternary sediments. That is why the general geological maps depict mainly the distribution of Quaternary deposits. Many of data sources including bore-holes, laboratory and geophysical analysis, were used in creating geological content of the map.

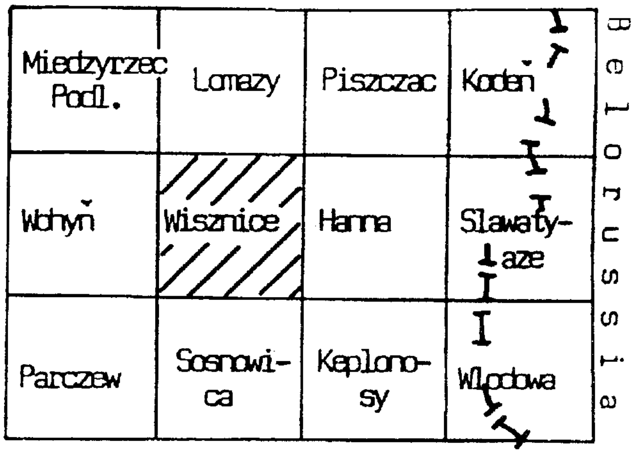

Fig.1. Wisznice - the area under investigation.

'hors demonstrated their approach based on com, nterpolation of Pre-Quaternary surface on the sh... of WISZNICE (642) - the General Geological Map of Poland using the software package SURFER. The studied area (Dolecki L., Gardziel Z., Nowak J. 1990) is situated in Eastern Poland (Polesie Lubelskie). Results of geological bore-holes and soil sampling were the main source of information. Another source consisted in archive materials concerning Quaternary surfaces. The Quaternary deposits cover mainly the sediments of Upper Createnous (Křída) or Tercier (Oligocene and Miocene). This is an erosional surface.

In the eastern part of the sheet Pre-Quarternary rocks reach the surface up to 120 - 135 meters a.s.l. in several places. They are divided by depressions of 100 - 115 meters and in 90 metres a.s.l. in W and NEN directions. These rocks also reach the surface in deep depressions in the SE corner of the sheet.

3. Computer platform and used methods

To execute a computer interpolation the PC platform and SURFER software package were selected of many available bases and programs (Reneé 1992).

The SURFER software package is produced by Golden Software, Inc. SURFER has been designed to generate contour maps and 3-D surfaces. For the purpose of geological modelling, SURFER offers good tools to calculate morphometric characteristics. It consists of six programs: GRID which is used to create regularly spaced grids, TOPO which is used to create contour maps, SURF which is used to create surface plots, VIEW which allows to see plot files created by SURFER, PLOT which is used to plot created plot files and UTIL which calculates the areas, volumes and residuals, produces cross-section information and converts the grid files.

SURFER creates a regularly spaced grid from both irregularly spaced data and from a user-specified function which is entered from a menu and calculated by SURFER. A regularly spaced grid is a rectangle made up of rows and columns. SURFER attempts to interpolate a Z value at the intersection of each row and column.

SURFER can specify the interpolation method used for creating a grid from irregularly spaced (X,Y,Z) input data. Unfortunately there is no interactive module for capturing the data from a tablet or a digitiser. The data have to be prepared outside SURFER, in PC ARC/INFO environment, and then handled by the GRID program. Interpolation methods used are based on inverse distance, Kriging or minimum curvature. Each algorithm has its advantages and disadvantages. Inverse distance is the fastest method but the Kriging method gives more accurate results in most instances. Since both Kriging and minimum curvature methods simulate trends, results will be more unpredictable in areas of missing data than when using the inverse distance method.

In our case when the Kriging method has been selected, SURFER would use the theory of regional variable technique. (The Kriging algorithm assumes an underlying linear variogram.). The Kriging method was used due to the fact that its advantages lay in using for the cases where a certain spatially oriented variability is assumed. It is recommended for use in regions with sporadic set of points or in extrapolation on the map margins. The Kriging method is highly recommended by most geological specialists for interpolation of geological data. The Kriging is used in cases when points are irregularly distributed and their density is sporadic.

Kriging is an interpolation method completed in economy geology within the assessment of variability of chemical elements and other geological elements eg. thickness of coal layers. The Kriging algorithm is based on a correlation between disappears in a certain distance. This construction is called a variogram which is a fundament of calculation procedures called Kriging (David 1977, Akin, Siemers 1988). Within SURFER the Kriging interpolation method is represented by a linear model (the Kriging can be represented by linear, quadratic or logarithmic models).

Using the Kriging method in SURFER program several parametres have to be defined. In addition, method

(Kriging is used) the most important parameter is resolution. It is applied within dimensions of grid-cell. The authors used the resolution of 245x266 (rows x columns) - that is 212x212 meters (4.2 mm on the map). This was limited by RAM capacity of the computer. Others important parameters are search (= Normal) and the nearest points (= 10).

4. Computer data processing

To find a suitable and powerful (efficient) data source for geological modelling the first and most important step is to build a representative data set. Many kinds of information can be used but each of them has a different level of plausibility and thus different suitability of their use. To apply the authors's experience, which would be easy-to-perceive by wide geological public, a geological map of 1:50 000 was used. The procedure is presented on the sheet WISZNICE (East Poland).

Three kinds of information about Pre-Quaternary surface are used in the data set:

1. data from bore-holes drawn on the geological map which reach Pre-Quaternary surface,
2. data from geological cross-sections drawn on the margins of geological map.

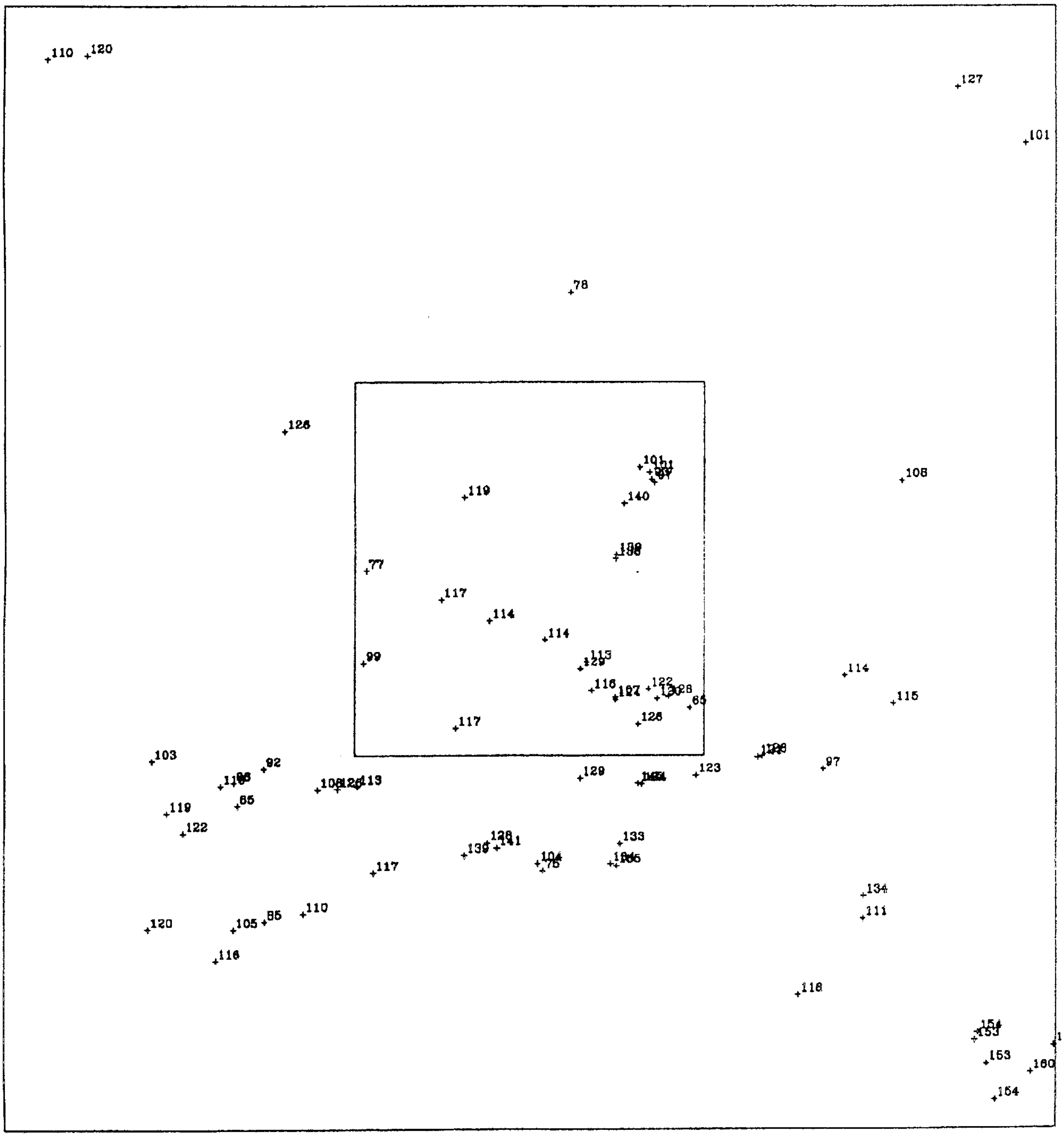

Fig.2. The first kind of data points and their distribution in Wisznice and adjacent sheets.

3. data from bore-holes drawn on the geological map which do not reach Pre-Quaternary surface.

Each of the above-mentioned kinds of data must be used carefully with respect to their plausibility. The first data involve exact indications about the bore-holes and depth of the Pre-Quaternary surface. Elevation of the Pre-Quaternary surface can be easily calculated and final value is used in the data sets. The Pre-Quaternary surface generated from this data set (surface A) exhibits on plausibility of the real surface due to lack of points in the data set (Fig.2). It avoids to create surfaces from data sets involving only this kind of data.

The second kind of data have been obtained from the geological cross-section drawn on the sheet. The Pre-Quaternary surface from the cross-section is a result of many factors based on the experience of geologists. Values of the surface under investigation were obtained by measuring from the cross-section and added into the data set. This second data set was used to generate the second Pre-Quaternary surface (surface B). This is more accurate than the surface A especially in regions passed by cross-sections.

To improve quality of the generated surface the third kind of data must be implemented into the data sets. Despite the fact that information of these data do not

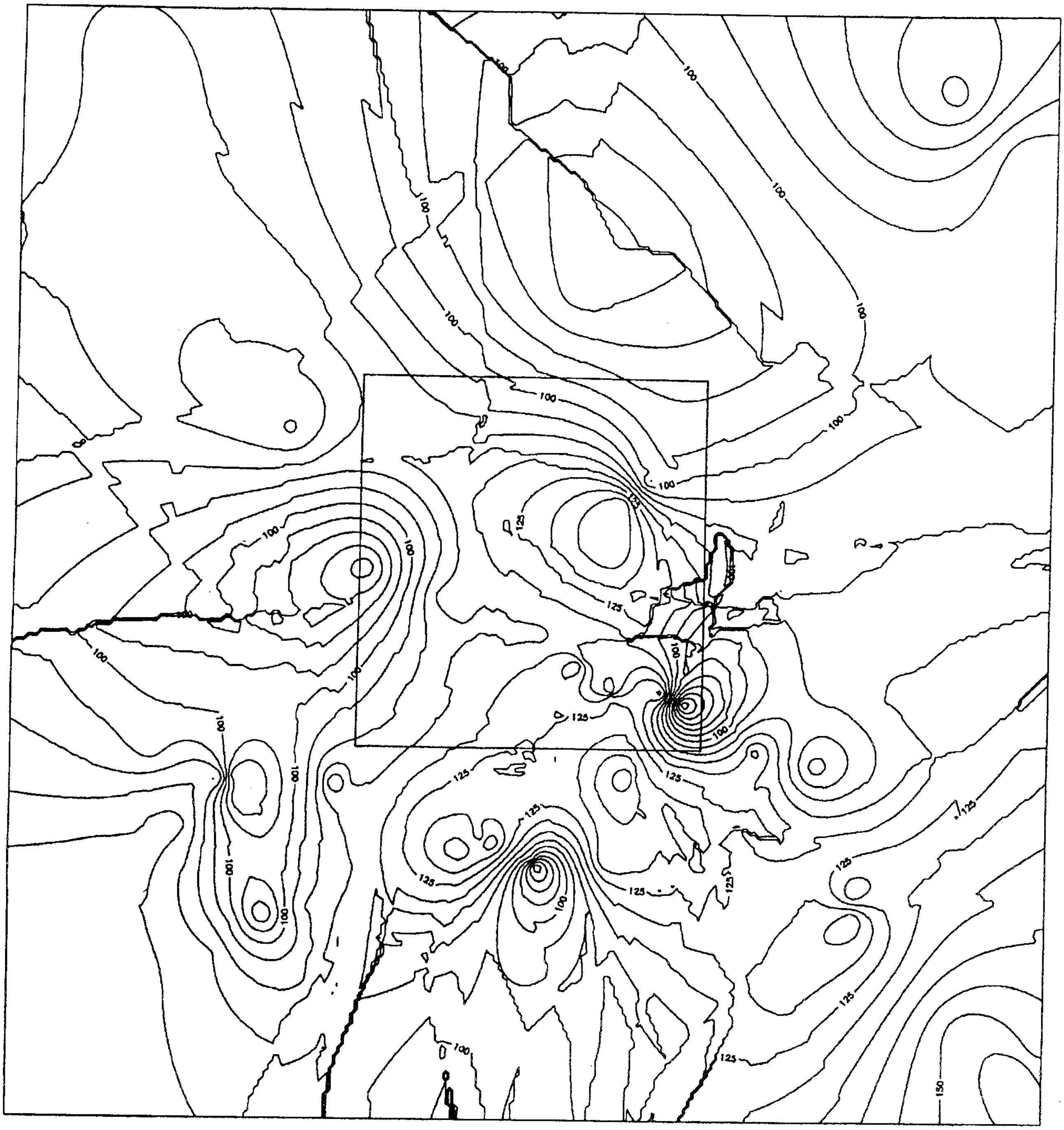

Fig.3. Surface A generated from the first data set.

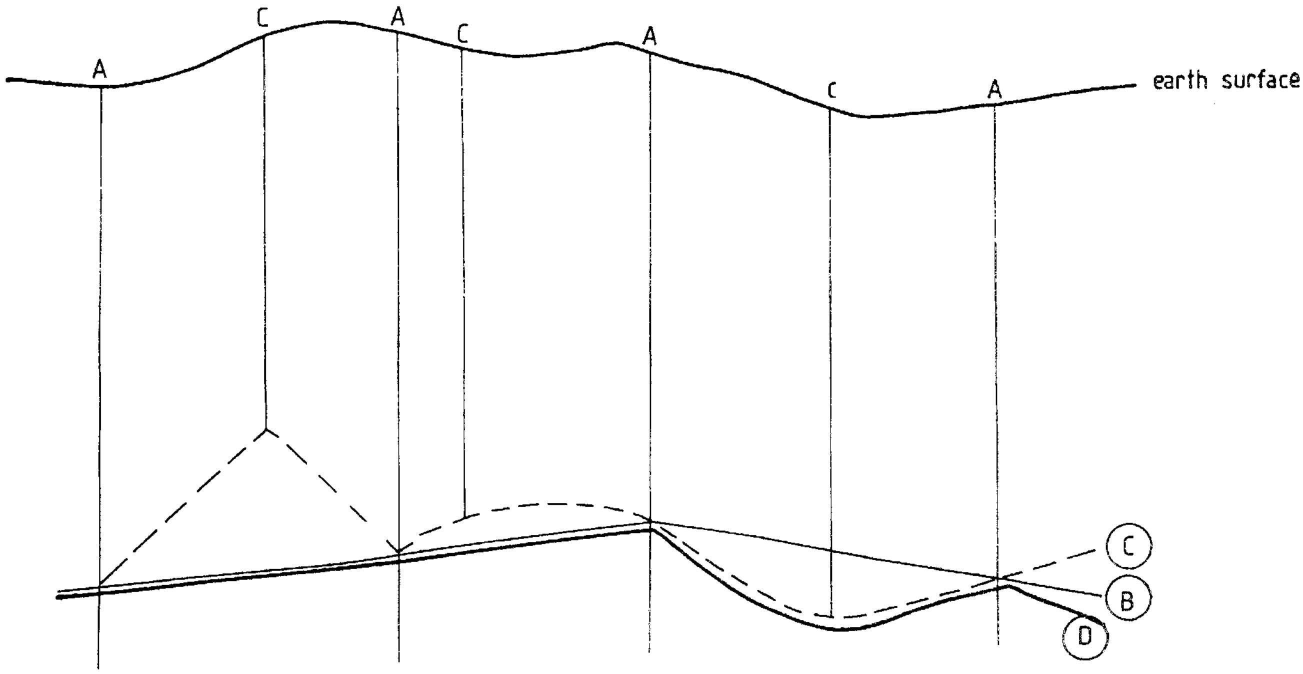

Fig.4. Chart of partial surfaces used for grid operation.
Explanation:
A - the first kind of data (from bore-holes drawn on the geological map, which reach Pre-Quaternary surface,
C - the third kind of data (from bore-holes drawn on the geological map, which do not reach Pre-Quaternary surface),
B - surface B generated from the second data set,
C - surface C generated from the third kind of data,
D - the final Pre-Quaternary surface.

involve exact values of the Pre-Quaternary surface (but only depth of the bore-hole stopped in Quaternary deposits). These data bring less important information about Pre-Quaternary surface but they can correct the generated surface in some places. To generate a new surface from the data set the included points of all kinds allow us to find areas where the first surface is not correct. Consider that the third surface is more complicated and involving mistakes. It is due to the fact that new data do not indicate the Pre-Quaternary surface but they are used like that. To obtain an acceptable surface a grid operation between all surfaces can calculate the third surface which is more accurate than the two previuos ones. The equation of operation can be expressed as following:

$$D = \min(B,C).$$

The principle of the operation is shown in Fig.3. The final Pre-Quaternary surface generated by the Kriging method (surface D) is shown in Fig.4.

In some cases where the areas without Quaternary deposits occur, it is recommended to extend the final data set by points limited all these areas without any Quaternary deposits (if they are present) - see fig.5. Then only area of Wisznice sheet is considered.

The final Pre-quaternary surface D is shown in fig.6.

5. Conclusion

The achieved digital Pre-Quaternary surface differs from manually made surface of authors of the sheet (Dolecki L., Gardziel Z.. Nowak J. in press). It comes from the fact that the computer approach is based on interpolation of exact values of documented points (which are irregularly spaced) whereas the map in press uses information from geophysical, geoelectronicl and other research. The greatest differences occur in the northern part of the sheet where there is a lack and bad distribution of points. This problem is not resolved by using points from adjacent sheets. It concerns mainly the W, NW, NE and E parts.

To obtain more accurate Pre-Quaternary surface from the computer data processing the authors recommend to extend the data sources (archive materials) of both studied and adjacent sheets. In addition it seems to be useful to carry out supplementary bore-holes or sonds in problem regions under study. The final result are designed in two-dimensional form to allow easy compare results with geological maps.

Computer implementation in geological modelling of surfaces is a complicated issue. It seems that the PC platform and program SURFER can be succesfully used to generate general images about the surfaces. How-

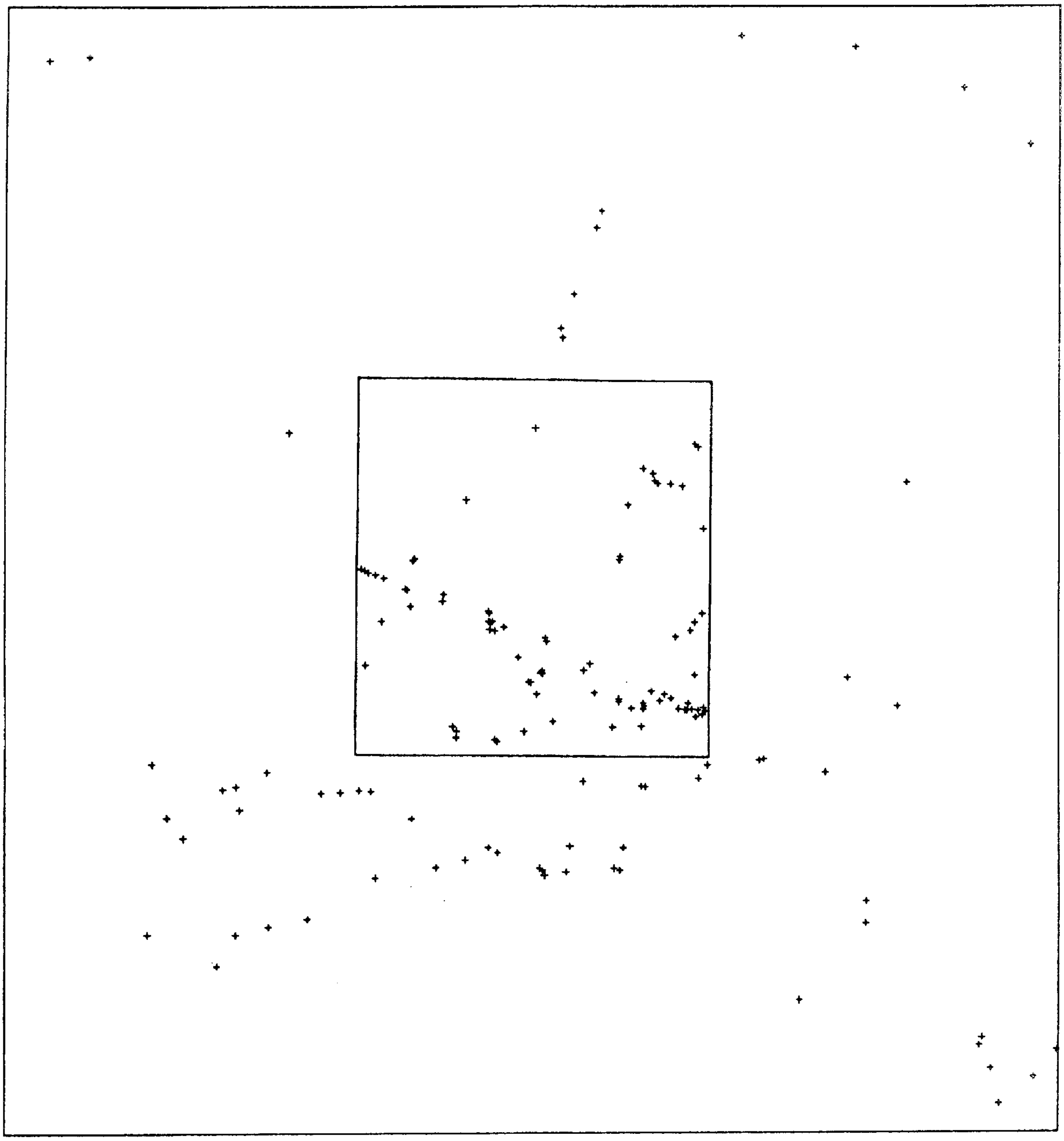

Fig.5. The final data set including all available information about Pre-Quaternary surface (144 points).

ever, their use must be carefully carried out and critically assessed. Of course that more powerful tools can be found on higher hardware platforms (workstations) but now their common using is not available everywhere that would be needed. Another topic to discuss is data availability. Because it is diffrent to find suitable source of digital geological data at present.

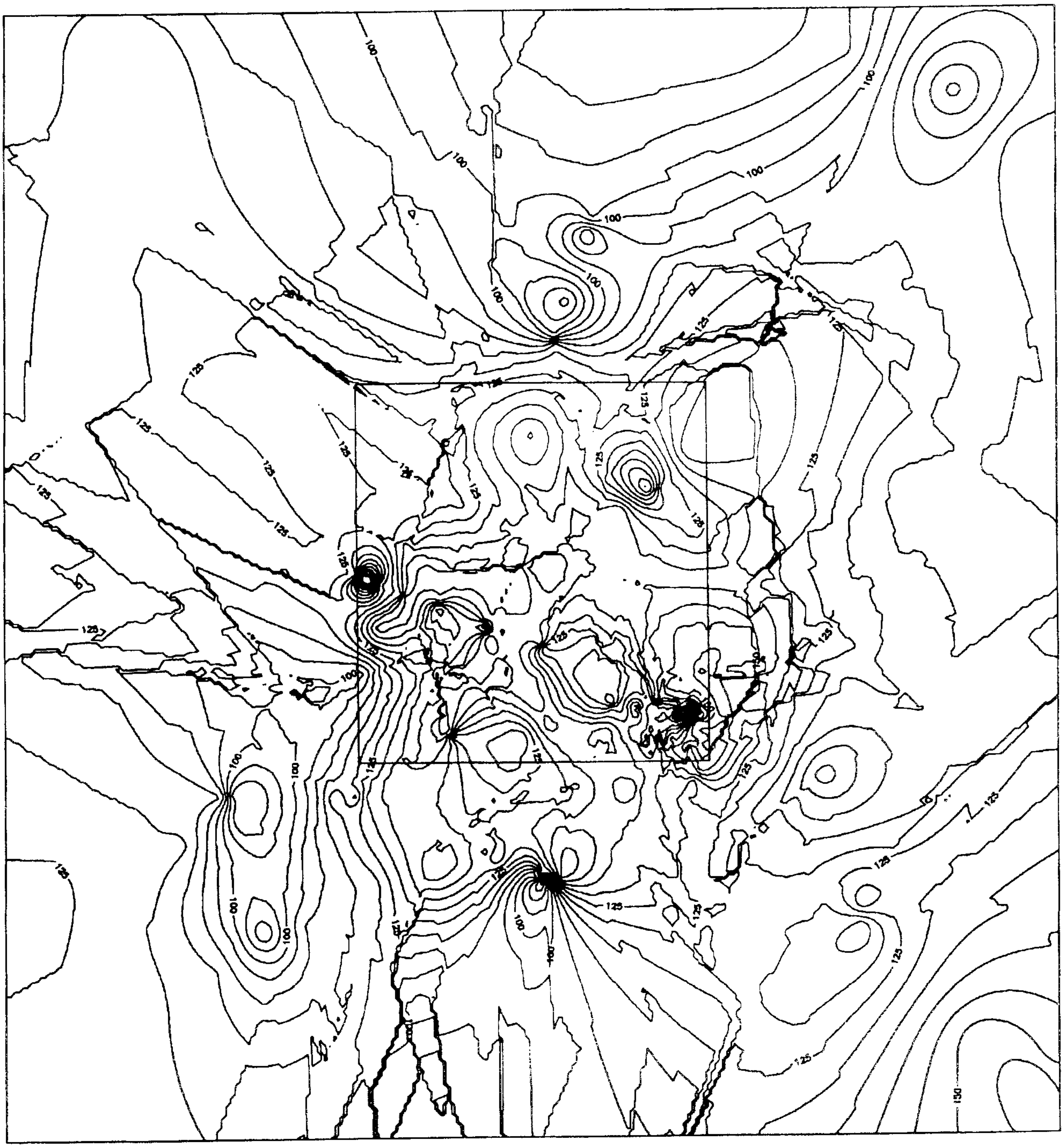

Fig.6. The surface D (D = min(B,C)) at Wisznice area and its surroundings.

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NEW FINDINGS ON THE GEOMORPHOLOGY OF MORAVIA

Jaromír KARÁSEK

Abstract

New form of the Bachelor studies at the Faculty of Science, Masaryk University, in Brno has considerably stimulated professional activities of students who defend their bachelor projects already in the third year. They present results of their own research, which are in many cases remarkable and worth publishing. This paper presents main results of three bachelor projects in geomorphology. Each of these projects deals with either new findings on geomorphological conditions in the region under investigation or at least documents some facts known so far only empirically.

Shrnutí

Nové poznatky o geomorfologii Moravy

Nová forma bakalářského studia na přírodovědecké fakultě Masarykovy university v Brně značně přispěla k odborné aktivitě studentů, kteří již ve 3. ročníku obhajují tzv. bakalářské projekty. V nich předkládají výsledky svého vlastního výzkumu, jež v některých případech jsou přinejmenším pozoruhodné a zasluhují zveřejnění. V předloženém příspěvku jsou prezentovány výsledky tří bakalářských projektů z geomorfologie. Každá z těchto prací buď přinesla zcela nové poznatky o geomorfologických poměrech zkoumané oblasti nebo alespoň dokumentačně ověřila některé skutečnosti známé dosud jen z empirie.

Key words: bachelor project, structural control of relief, paleokarst, Miocene deposits, exhumation of forms, fault valley, fault-line valleys, rotational of scissors fault.

1. Southern Part of the Moravian Karst

Geomorphological research of selected forms in the surroundings of Brno built by diagenetic lithificied sediments dating back to the preneotectonical geological periods (Stránská skála, Babí lom and others) discovered correspondence of spatial orientation of some form elements with paleotectonic structural elements (J.Karásek 1991). This fact initiated investigation of interrelations between the structural elements and those of forms in the southern part of the Moravian Karst (L.Vašková 1993). Field measurements evaluated the values of bedding planes gradient and joints in outcrops and rock exposures. The same structural elements were evaluated from the viewpoint of their spatial orientation, i.e. direction of their dip. To find out the grade of mutual dependence of the structural elements and those of forms it was necessary to also measure slope gradients and to statistically elaborate the whole set of the carried out and derived measurements. The elaboration has resulted not only in a series of original geological cross sections (Fig.2) but also in the diagram presenting the percentual share of derived measurements of the direction of structural elements and those of form in the intervals of 5 (Fig.1).

Comparison of the diagram with main directions of tectonic disturbances known so far (e.g.K.Zapletal,1922-23,1927) results in the fact that there is a demonstrable relationship between the system of geologically investigated faults and the spatial orientation of joints. Nevertheless, there is no correspondence between the prevailing directions of joints and the prevailing slope gradients. Similarly, it can be stated that there is no statistically demostrable relation between the strike of strata and the direction of slopes (Fig.1).

Regarding this fact we can presume that the drainage pattern of the middle flow of the Říčka river is adapted to spatial orientation of structural elements only to a very small extent and thus it should be dendritic in the groundplan. In the case that some details are not taken into consideration, this presumption can be confirmed but there are evident detail deviations from the dendritic drainage, namely in the area NE of Líšeň (I.Veselý, 1974). Their analogy can be seen also on the line of the so-called Mokrá-fault in the sense of K.Zapletal (1922-23). On the basis of the hitherto known structural measurements we are not able to explain the deviations and solution of this problem will depend on further research.

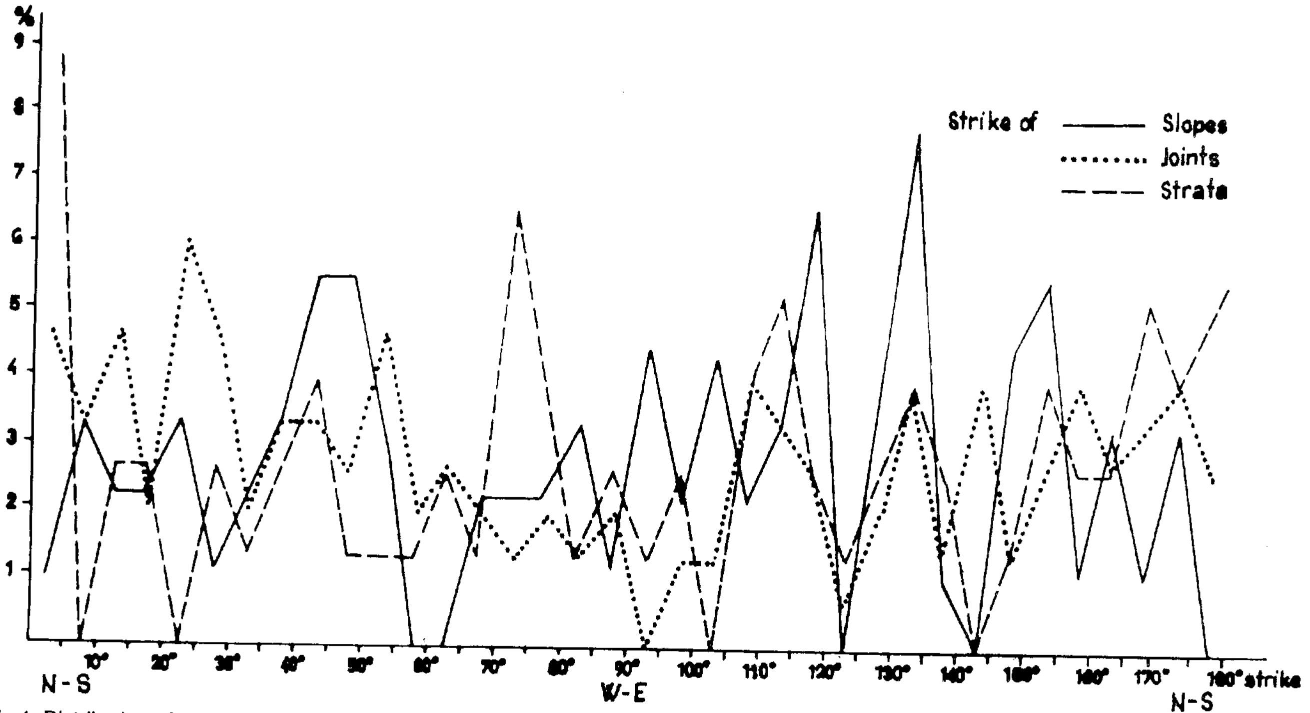

Fig.1. Distribution of relative frequences of the strike of structural elements (slopes, joints, strata) in azimuth intervals about 5 degrees (by L. Vašková, 1993)

2. The Rozdrojovice-Part of the Bobravská vrchovina (Highland)

Main mass of the Bobravská vrchovina (Highland) can be divided into parts that are separated from one another by water gaps. The nothernmost part is the Rozdrojovická vrchovina(*) (Highland) north of the water gap of the Svratka river inundated by waters of the Brno dam. It became the object of studies of the following bachelor project (Z.Máčka 1994). The author has come to very important conclusions, partly on morphostructural position of the Rozdrojovická vrchovina (Higland) and partly on manifestations of modelling processes.

a) The Rozdrojovická vrchovina (Highland) is - within the framework of complex main mass of the Bobravská vrchovina (Highland) - the only elevation whose western straight-lined and distinct bound does not correspond with a lithological boundary between the rocks of Brno Massif and permocarbonian deposits of the Boskovická brázda (Furrow). The morphostructural boundary of the Rozdrojovická vrchovina (Highland) is situated in the Rokytná-conglomerates of the Boskovická brázda (Furrow) and compared with the western bound of the southern Omická vrchovina (Highland) it is shifted approximately 500m to the West. However, the direction of both morpho- structural lines in question is identical (NNE-SSW).

b) The water gap of Kuřimka, which bounds the Rozdrojovická vrchovina (Highland) in the north, extends in the direction generally identical with the other water gaps of the Bobravská vrchovina (Highland) (WNW-ESE), but the gradient of its bottom is opposite (the direction of drainage towards WNW). Both these facts can be interpreted in casual nexus with neotectonic splitting of the eastern margin of the Bohemian Massif where the so-called "line of Labe" intersects with tectonical suture of the Boskovická brázda (Furrow) (compare A.Ivan 1974).

By the lithological boundary of the Brno Massif rocks and the Rokytná-conglomerates of the Boskovická brázda (Furrow),i.e.in the hilltop part of the Rozdrojovická vrchovina (Highland) there is a stripe of Devonian limestones, in places more than 500m wide (compare Z.Novák et al. l99l), extended in the direction corresponding with the western margin of the Rozdrojovická vrchovina (Highland). Resulting from the field research and from the studies of the unpublished archival documentation (A.Polák 1954), Z.Máčka succeeded in finding forms of at least two stages of karstification of these limestones. Quaternaire, and subrecent stage of karstification, respectively, is represented by karrens, sinkholes and small dry caves, one of which was already documented in the past (K.Kirchner 1991). What is more

(*) The name is not officially used as an oronymum, nevertheless, its application is logical with regard to the criteria common with detailed orographical division of the Bobravská vrchovina (Highland) (e.g. J.Demek et al. 1965).

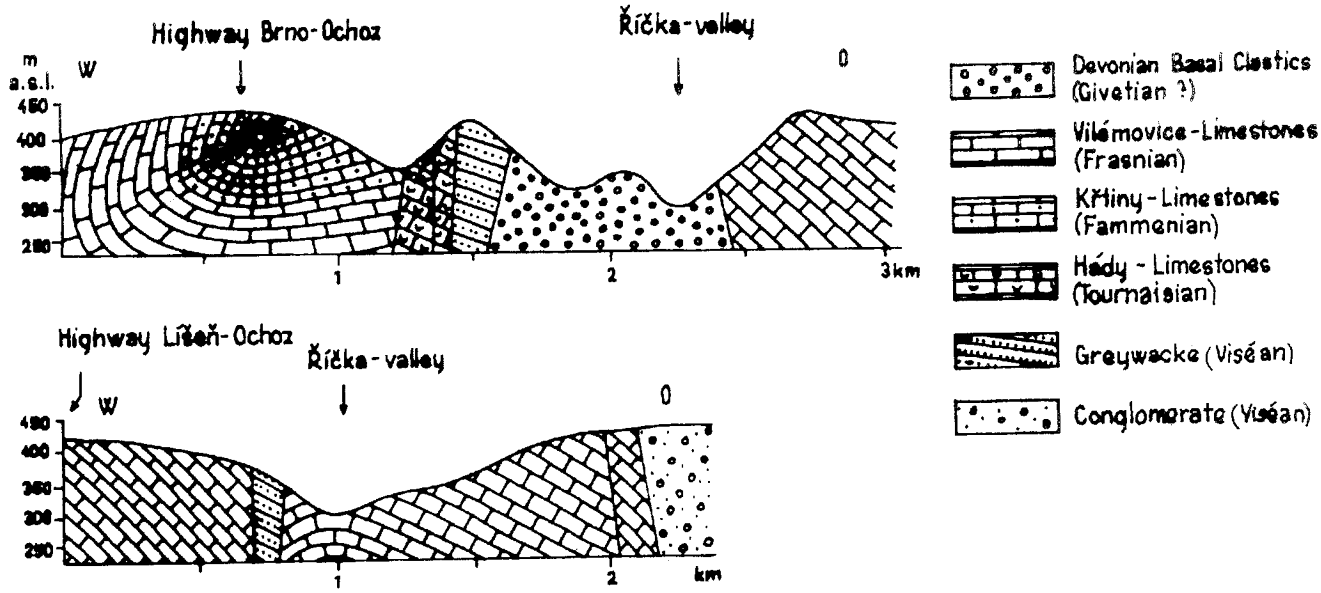

Fig.2. Examples of geological cross sections compiled after morphostructural measurements (by L.Vašková - 1993, stratigraphy by J.Dvořák in R.Musil et.al.1993)

interesting is the fact that the karstified Devonian limestones on the hilltop of the Rozdrojovická Vrchovina (Highland) are covered with Miocene deposits, presumedly with Badenian ones that are filling the caverns of Devonian limestone.

There is the only logical explanation of this fact that the karst caverns in limestones must have existed even in the period preceeding the Badenian transgression. It is then another verification of the existence of paleokarst by the western margin of the Bobravská vrchovina (Highland) (the preceeding evidence see P.Bosák et al. 1989).

The occurrence of Miocene deposits in the flat hilltop part of the Rozdrojovická vrchovina (Highland) at the elevation of about 400m above sea level (see Fig.3) is also worth considering from the paleogeographical point of view. One can argue for the opinion that in the period of Miocene transgression the area of the present Bobravská vrchovina (Highland) was covered with Miocene deposits and that the youngest regional levelling of the eastern margin of the Bohemian Massif dates back to the post-Badenian period. The existence of paleocaves almost excludes the possibility of Badenian transgression over the levelled surface (compare J.Karásek l988).

3. The Mikulov-Part of the Dolnomoravský úval (Graben)

The topographical position of the well-known paleontological locality of Kienberg near Mikulov (J.Tejkal 1955) evokes an idea of a fossil strand in the direction of transgression of the Upper-Badenian sea from the West. West of Kienberg we can find a flat, open field of a depression extending to the foothill of the Pavlovské Vrchy (Hills), the so-called Podmušlovská snížentina (Depression), which is a part of the Dolnomoravský úval (Graben) (J.Demek - M.Macka et al. 1970). There is an argument against the conception of the opposite direction of transgression, i.e. from the East, - a distinct offset of the flysch Milovická pahorkatina (Hills) (Vysoký Roh) towering over the level of the Podmušlovská snížentina (Depression) about 100m. From the geological viewpoint there is no doubt about the transgression of the Upper-Badenian sea from the east (e.g. P.Čtyroký in P.Havlíček et al. 1992). There is an evidence to prove it - conserved denudation relics of Upper-Badenian deposits in the hilltop parts of Vysoký Roh (Fig.4) in the roof of flysch. With this discrepancy between the topographical and geological situations deals another bachelor project (A.Petrová 1994), further to the early morphostructural study of the immediate neighbourhood (A.Ivan 1967).

The facts in question result in two possible interpretations.

a) The relief of the field here in the period of the Upper-Badenian transgression was generally similar to the present relief. We can say that the sea level was so high that it covered even the hilltop of the dominant Vysoký Roh. It would be necessary then to regard the present relief as a result of the post-Badenian exhumation.
Before we start to verify this hypothesis, it is necessary to draw attention to several facts already mentioned (A.Ivan 1967). For instance, angular unconformity between the Ždánice-Hustopeče flysch and the Upper-Badenian deposits may give evidence of the facts that the flysch surface was levelled before the Upper-Badenian transgression

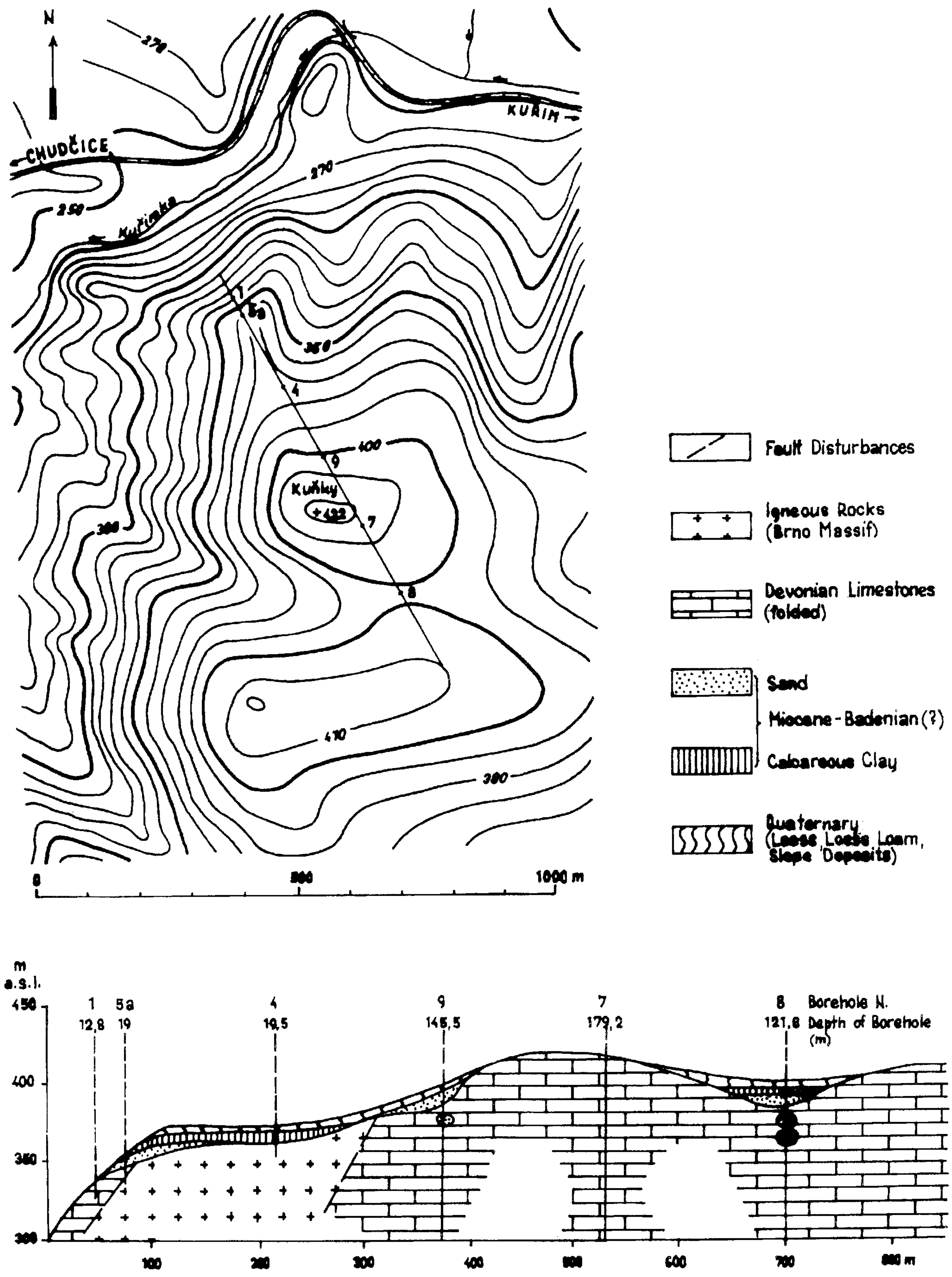

Fig.3. Morphostratigraphical situation east of Chudčice (modified from Z.Máčka, 1994)

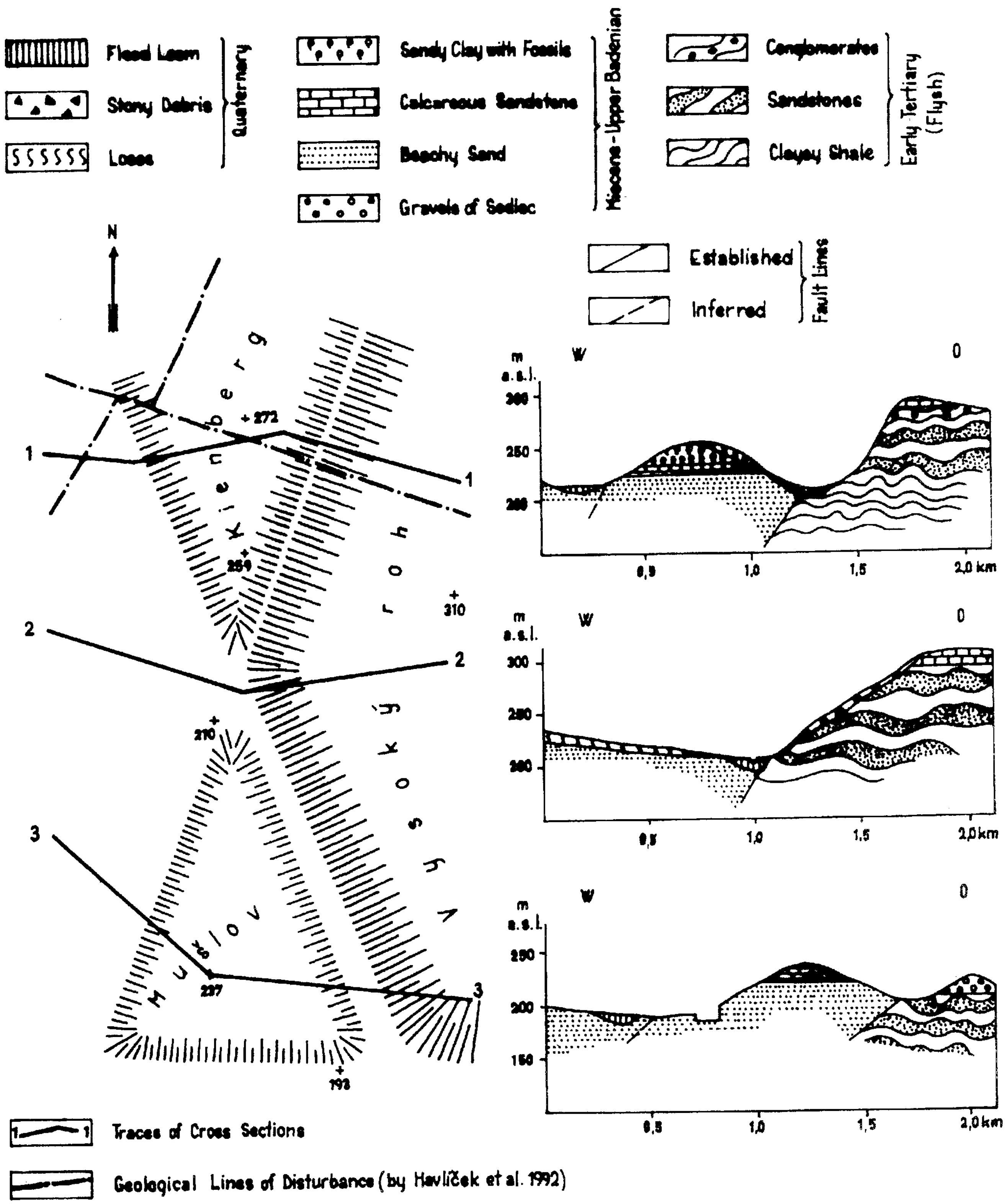

Fig.4. Morfostructural situation east of Mikulov (modified from A.Petrová, 1944)

("main levelling" in the sense of A.Ivan). The present levelled surface on the hilltop of Vysoký Roh 300-350m above sea level has its origin after regression of the Upper-Badenian sea because it truncates the Ždánice-Hustopeče series of strata and Upper-Badenian deposits in the same level (A.Ivan 1967,p.19).

Another important fact is the existence of two valleys in the Milovická pahorkatina (Hills) extended in the N-S direction but with different bottom gradient. They are separated from each other by a flat levelled surface and therefore A.Ivan considered them to be fault-line valleys. The continuation of the southern valley is to the NE from the community of Mušlov where it turns steep from the N-S direction to NNE-SSW and separates the offset of Kienberg from Vysoký Roh. The western slope of Kienberg is bounded by the valley of the Mušlovský potok (Brook) and by extension of its left tributary in the direction NNW-SSE. In the area of the ponds of Mušlov, the valley of Mušlovský potok (Brook) is connected in an acute angle with the valley bounding Vysoký Roh in the West so that the offset of Kienberg projects in a relatively sharp cusp. In the extension of the valley line of the Mušlovský Potok (Brook) to the SSE we can find a col by which the hill of Mušlov is separated as a satellite elevation from Vysoký Roh. The morphostructural independence of Mušlov from Vysoký Roh is evident partly by comparing absolute heights of crests of both elevations, partly by the fact that Vysoký Roh is built mainly of flysch while Mušlov (just as Kienberg) is built solely of Upper-Badenian deposits. The N-S fault found out by A. Ivan to the South from Milovice is then substituted to the NNW from Sedlec by a pair of faults bordering in the knot near Mušlovské rybníky (Ponds) (see Fig.4)

b) If we admit - in accordance with A.Ivan - that the surface of flysch was levelled in the period of Upper-Badenian transgression, then a different height of transgression plane of Upper-Badenian deposits (approx. 300m above sea level on Vysoký Roh and considerably less than 210m above sea level on Mušlov and Kienberg) is an unambiguous argument for post-Badenian displacements along fault lines of the NNE-SSW and NNW-SSE directions. In this case there are no fault-line valleys but real fault valleys in the sense of common classifications (C.A.Cotton 1948, W.D.Thornbury 1956, p.114).

This interpretation is in an apparent discrepancy with that of A.Ivan. The main Ivan's factographical argument, i.e. the morphological inexpressiveness of the fault between the northern and southern valleys on the water-divide to the south of Milovice is indisputable. No interpretational use was made of another Ivan's important finding concerning different or opposite manifestations of height assymmetry in the northern and southern valleys. This fact seems to give evidence for the interpretation that the NS section of the Milovice-fault may be regarded an axial rotational fault (see e.g. F.H.Lahee 1941, p.215 - "scissors fault", and J.Jaroš-J.Vachtl 1992, p.259) with a rotational axis in the area of the divide. Deflection of the Milovice-fault from the N-S direction to that of NNE-SSW to the North of Sedlec rather complicates this simple morphotectonic interpretation but it does not cast any doubt on it.

Doubts might probably result from the comparison of the course of tectonic lines recorded in this area during the geological mapping (P.Havlíček et al. 1992 - see Fig.4) and that of morphotectonic lines whose geological importance is evident from the enclosed geological profiles (Fig.4). The unambiguous interpretation of geological and morphological conditions in interrelations will probably still be under discussion. There will be a great obstacle to the final solution - an exceptional lithological variety of Upper-Badenian deposits. It is not clear whether this variety reflects heteropic facies or whether it is of lithostratigraphical importance.

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ENVIRONMENTAL GEOINFORMATION SYSTEMS AND POST-ACCIDENTAL TERRITORY MANAGEMENT (KYJOV TOXIC ACCIDENT CASE SITE)

Jaromír KOLEJKA - Jan POKORNÝ

Summary

A local purpose oriented GIS has been developed as a post-accident territorial management system for hazardous production/storage sites. The GEORISK Knowledge Base GIS is a common product of the Institute of Geonics, Branch Office Brno, and Masaryk University in Brno. The GEORISK GIS contains separate four sets of the text, legend and map data files and processed satellite image of the area under study. Each of the sets is composed of information about the selected component of natural environment, about behaviour of pollutants within the selected component, and about measures required in order to remediate the territory. The GEORISK system is a user-friendly tool, and the data sets and some files can be linked by simple operation of the mouse.

Shrnutí

Environmentální geoinformační systémy a pohavarijní řízení území (případ toxické havárie u Kyjova)

Lokální účelový geografický informační systém byl vyvinut pro potřeby pohavarijního řízení území v prostoru rizikových výrobních a skladovacích lokalit. Systém GEORISK vybavený expertní poznatkovou základnou je společným elaborátem Ústavu geoniky v Brně a Masarykovy university. Systém obsahuje čtveřice základních textových, legendových a datových souborů, doplněných pomocnými datovými a textovými soubory a družicovým snímkem velkého rozlišení pro orientaci v zájmovém území. Každý soubor obsahuje informaci o dané přírodní složce prostředí a o opatření na omezení důsledků pobytu polutantu v této složce. Ovládání systému je velmi jednoduché. Uživatel vyvolává postupně nebo podle potřeby jednotlivé informace pomocí menu a práce s myší.

Key words: GIS, environmental applications, toxic hazard

1. Introduction

Many failures of industrial plants, chemical warehouses and nuclear power stations , which occurred recently suggested that what is practically missing is the entire area documentation to detect pollution spread, migration of pollutants, operative and planned rescue measures in the landscape as well as prognoses on further development of contamination in the natural and anthropogenically differentiated landscape. Landscape is an active and at the same time also passive participant to the possible accident. With a whole set of its structural and dynamic properties it performs influence on primary and secondary distribution of pollutants, their migration, concentration and dilution. Documentation about such a landscape that could become subject to possible accidents should include not only factual material, guidelines on how to use it, possibly also software for real-time operative evaluation and modelling, but also proposals of localities for permanent and post-accident monitoring, or regionally differentiated measures. Operative utilization of these data cannot be thought of without application of geoinformation systems (GIS). GIS is understood as a system of humans, technical and organizational means making data collection, transfer, storing and processing to get territorial information (according to IGU, in Konečný, Rais 1985). In comparison to other information systems, the GIS treat localized data (Aelders 1980).

The experience gained so far on measures in the case of an accident often show how helpless the bodies of civil defense can be, how their activities can many times be inadequate and incompetent both at the time of immediate danger and particularly after the accident since there is neither sufficient plannary monitoring of area contamination nor possible forms of pollutant integration with environment. Rescue operations take long time because research in localities of these hazardous production plants or stores is usually made ex-post, which means that necessary area data are lacking with a few exceptions only corroborating the rule.

2. Application of GIS at environmental management

Environmental data are only exceptionally included in common territorial information systems at present time. Importance of these data markedly increases in GI systems concerned with management of natural resources or natural hazards. Definition of the "environmental data" can be considerably wide. What can generally be considered data on environment are informations which describe or assess actual or potential effect of human activities or rapid natural processes on life and work of the man, quality of environment, equilibrium in the landscape, and biodiversity.

The simpliest task of these environmental data is to be a part of a description block of data on the GIS-concerned area. In this case, the lump or multitemporal data can be products of inventory or environment monitoring, being stored in GIS as a documentation material (Smart 1986, Treitdal 1991, McDonald, Smith 1991). These cases of position of the environmental data in geoinformation systems include information on land use and its chronological changes, a.o. on localization of dumps, landfills or other sources of contamination to environment (transport arteries with traffic census), protected landscape areas, etc.

The data on environment become much more important in the GIS which are concerned with both simple and more complex assessment operations aimed at judging suitability or environmental risks in the areas of interest. In many a case, environmental interpretation of various data is used for thematic assessment of the area (Webster, Siong, Wislocki 1989, Estes, McGwire, Fletcher, Foresman 1987, Sauchyn 1989, Haber, Schaller 1988, Caron, Merchant 1986, Lamont 1991, McDonald, Smith 1991, SHasko, Keller 1991, Taylor, Ullman 1993, and others). The environmental data explained in this way serve at decision-making processes for environmental territorial management.

Key role is being played by environmental data in those geoingormation systems which are purposefully focused on integration of more environmental phenomena and their spatial and time modelling. This modelling is usually directed at development of some rapid processes and accidents, most frequently fires (fire management), spread of diseases in forest stands, forest succession etc. (Knutson, Douhan 1991, Wertz 1991, Van Wagtendonk 1991, Kessel, Beck 1991, McRae, Cleaves 1991, Polzer et al. 1991, Pamap 1993), possibly also at growth or decline in numbers of animals from certain areas at contamination of environment (Mueller 1991). Simulation models of the processes serve as a certain form of scientifically based prognoses of given phenomena. Another example of modelling can be a computer analysis of optimum land use or at least its stabilization or protection framework (Dick 1991, Kolejka 1992). For modelling purposes the environmental data must be selected and treated by specific methods and have to also be verified at random during their processing by comparing results from partial stages of modelling with empirical figures.

A special case of environmentally specialized geoinformation systems are information systems of national parks and other protected areas. Data stored in them can play informative, assessing, modelling and/or predication roles. However, the GIS on national parks can exhibit dominance of environmental data files only after several years of their building (Haskell 1991, ScotT et al. 1991, Okafor 1993).

3. Models of using GIS on the basis of territorial differentiation of risks

Risk status of individual sites in the area, or hazard for human beings to dwell in these sites, is a subject of some specialized territorial information systems. With regard to the fact that in addition to basic or purposefully modified information about the area they usually contain the text documentation and guidelines for their use including description of methods of how to reach certain results, they generally conform with criteria for their ranking among expert systems. By approach to the given issue as well as by qualification standard of final user four principal models can be distinguished of geoinformation availability in risk localities of all kinds. The four models are as follows:

1. MULTILAYER BASIC INFORMATION FACILITY
   Information models of this type are represented by GIS with digital maps of those environmental factors that were considered relevant for the given problem by their designers. It is usually a systemic sequence of maps (including accompanying text) which are to introduce the given issue to the user, to make the user acquainted with the area, its features, to create spatial conception about parameters or objects in the area, which can be important (from the viewpoint of the designer) for decision-making in risk situations. The digital map file with expert instructions and guidelines is modified in such way that it is easy to be used for anybody with no computer knowledge but equipped with sufficient experience in the given (risk) issue. Decision making is left to the user who is responsible for sorting out the system of presented information and integrate the data into a document for several variants of solution to the accident or another risk situation. The systems like these were set up for various purposes starting with defence of the population in the case of both civil and war nuclear disasters (Roger, Stella 1990), danger to inhabitants caused by toxic failure such as at production, storage or transport of toxic substances on an example of urbanized areas (McMaster 1988, Harris et al. 1991), or danger to inhabitants caused by

industrial air and water pollution (EPA study for the area of Chattanooga, Tennessee, USA).

2. MULTILAYER ASSESSMENT INFORMATION FACILITY
Information models of this type include already not only basic documents prepared by experts and instructions on how to use them, but also their purpose-oriented interpreted versions. The purpose-oriented GI systems of this type contain basic information about the territory in special digital files, their individual purpose-oriented versions to assess hazard rate of individual areas, objects, sites, phenomena, factors in relation to the source of uncertainty (hazard) in the territory, possibly also proposals for various measures leading to abatement of the hazard prior or post the event. User of such a system is usually a non-expert both in computers and in the given issue but he is rather appointed with executive and implementation roles at corrective measures. The systems of this type present series of electronic (digital) maps with different rates of accident risks both of natural and anthropogenic origin such as lightning, landslides, leakages of troublesome or toxic substances (crude oil accidents both on the dry land and at the coast), etc. (Jensen et al. 1990, Hession, Shankholtz 1988, Lamont 1991, Pearson, Wadge, Wislocki 1991).

3. STATIC ASSESSMENT MODELS follow out of the knowledge of correlations between "conditions", "causes", and "consequences" of risk phenomena in the environment, usually of anthropogenic origin. Systems of this type contain already a sharply separated data base (set of information about the territory) and knowledge base (instructions for how to use the data, what results to expect and how to evaluate them). Data operations are usually based on inquiries presented by the system in order to be instructed for next step while the user can make his(her) choice from many options and make use of the variant that suits best the situation. Proper content of the operations usually consists in generating combinations of thematically differing data in order to either search for certain combinations (threshold values, above- or below-average combinations of factor co-action) or for all actually existing combinations that can further be statistically classified particularly from the viewpoint of learning coherence among the phenomena (e.g. under what conditions a given phenomenon will reach given intensity and territorial extent). This procedure will make it possible to get to territorial projection of accident consequences within certain region (Davis, Whigham, Grant 1988, Sauchyn 1989)

4. PREDICATION DYNAMIC MODELS are based on complicated statistic operations which make use of functional and probability relations between relevant variables, thus introducing the equal fourth dimension into the issue - time. Degree of development in these systems can be very different. The most perfect of them introduce artificial intelligence which can operate instead of the user in certain part of decision making concerning further work proceedings. Nevertheless, the user is still responsible for checking the system operation. The expert knowledge based software is usually formalized empirical experience articulated into elementary relationships, functions and instructions which have accepted a wide range of relevant variables. Time sequence of modelled (static) situations can be kinetized, which will facilitate visual simulation of dynamics of the phenomenon. In some extreme cases, user of the system can be a non-professional with comprehensive knowledge of computing technique. This procedure is used to predict development of relatively very dynamic phenomena such as fires (Estes, McGwire, Fletcher, Foresman 1987, Kessel, Beck 1991, Wertz 1991), migration of air pollutants (models of atmospheric dispersion), that of water pollutants (hydrological models), pollutants in geological environment (geochemical models) with both short- and long-term prospects (ITC, 1993), floods (e.g. near Landesregierung von Steiermark in Graz, Austria).

With no regard to complexity of geoinformation facilities based on GIS, preference is being given to resolution capacity corresponding to the map scale of 1:25 000. This applies both to provision of data and their classification, and to the modelling of risk environmental phenomena within dry-land and water environments.

While the accident plans made in Czech conditions have to more or less adapt their graphical part to "preliminary model assessment of the course and extent of the accident for various cases and meteorological situations", organization of post-accident works is being limited only to research and demarcation of the contaminated territory. Practical consequence of this situation is the fact that there are additional material and financial requirements to collect, treat and pre-process the data, and additional costs that could have otherwise been used to eliminate or reduce consequences of the accident. On the other hand, the measures are often inadequate without thorough knowledge of the area.

4. Survey of tasks to build up geoinformation facilities in risk localities

Principal tasks for the case of implementing a purpose-oriented geoinformation facility in critical localities are as follows:

A) in the area of data base generation:
- definition of extent and size of the area of interest,
- selection and collection of relevant data,
- definition of necessary resolution for the data,

- harmonization or integration of the data.

B) in the area of generating the knowledge base for data management:
- definition of system functions,
- interpretation and purpose-oriented evaluation of relevant data,
- formalization of rules for manipulation with the data,
- determination of forms for demonstration of both initial and processed data,
- choice of demonstration means.

5. Consequences of toxic accidents and the need of geoinformation ensurance at sanitation works

Experience in how to generate a purpose-oriented GIS can best be gained on the case of an actual toxic accident. In the last 20 years there were many toxic and the like accidents which resulted in immense damages to environment and health (Table 1).

The leakages were recorded both in manufacturing plants and in warehouses whose surroundings were affected with toxic substances or increased radioactivity (Budský, Doležal 1989).

Whilst operational measures during the accident concerning rescue of human lives and properties are mostly well mastered, the post-accident measures are not prepared properly. Post-accident documentation studies are usually brought to end long after the event since all data are collected and processed much later.

6. Experience from the toxic accident in Kyjov-Boršov as a starting point for the compilation of a local GIS

One of instructive accidents happened in south Moravia (Fig.1) on 3 - 4 January, 1988 with basic sanitation to 5 January, 1988) in a warehouse of agricultural chemicals belonging to Agricultural Supplies and Purchasing at the village of Boršov agglomerated with the town of Kyjov at the distance of some 3 km from the town centre (Křivák 1988). Regarding the fact that there was no awareness about location of the warehouse, the fire brigade arrived to a completely different place because report on the accident was not accurate enough, which resulted in delayed fire eliminating works. Fire-extinguishing means had to be delivered to the fire including water from a fire hydrant in the 3 km distant town. This means that technical facilities for the case of fire were not paid enough attention in the warehouse. The decisive fire-extinguishing means was water with excessive water amounts infiltrating into the soil, draining away or changing into vapours.

The fire damaged some 150 MT of various chemicals which included organophosphates and other toxic substances. Further noxes were generated as products of interacting burning substances (Rosický, DoleŽal 1988). The majority of chemicals were not properly stored in the warehouse. A smoke cloud or fog came into existence at inversion stratification of the atmosphere at about 2.00 o'clock, being ca. 2 km wide and 20 m high. This cloud of irritating gases spread along the valley bottom and proceeded southwards to the town of Kyjov at the rate of 1 to 1.5 m.s-1 being later as long as some 5 kilometers. Composition of the cloud probably included also sulphurylchloride and chlorsulphuric acid, which both are known by their strong smoke effects and are harmful to human health. At the place of fire itself organic compounds of phosphorus, hydrogen cyanide, chlorine, hydrogen sulphide and other current products of combustion were detected.

Front end of the thick cloud reached northern limits of Kyjov. It was necessary to evacuate children from kindergartens as well as those from immediately endangered primary schools. Later the fog began to dissipate passing through western parts of Kyjov and reaching southwards as far as Dubňany in diluted form.

In terms of setting up a geoinformation system, the gained experience can be classified in several groups:

A) course of the accident:

1-Toxic substances were released due to accident in a relatively common object.

2-The area was contaminated by toxic fall out and polluted waters.

3-Places with stored toxic chemicals in the area had not been subject to inventory, a detailed information on their layout in the warehouse was missing.

Table 1: List of toxic accidents (by various authors, complemented)

Place	Year	Released substance	Persons		Affected area km^2
			killed	injured	
Potchefstron	1973	amoniak	18	?	n.1
Flixborough	1974	cyclohexane	28	?	n.1
Seveso	1976	dioxin	-	n.100	n.10
Bhópál	1984	MIC 2	2 500	n.1000	n.100
Chernobyl	1986	U235	35	n.10 000	n.1000
Kyjov	1988	toxic smoke	-	n.100	n.10
Tomsk	1993	U235	?	?	n.10

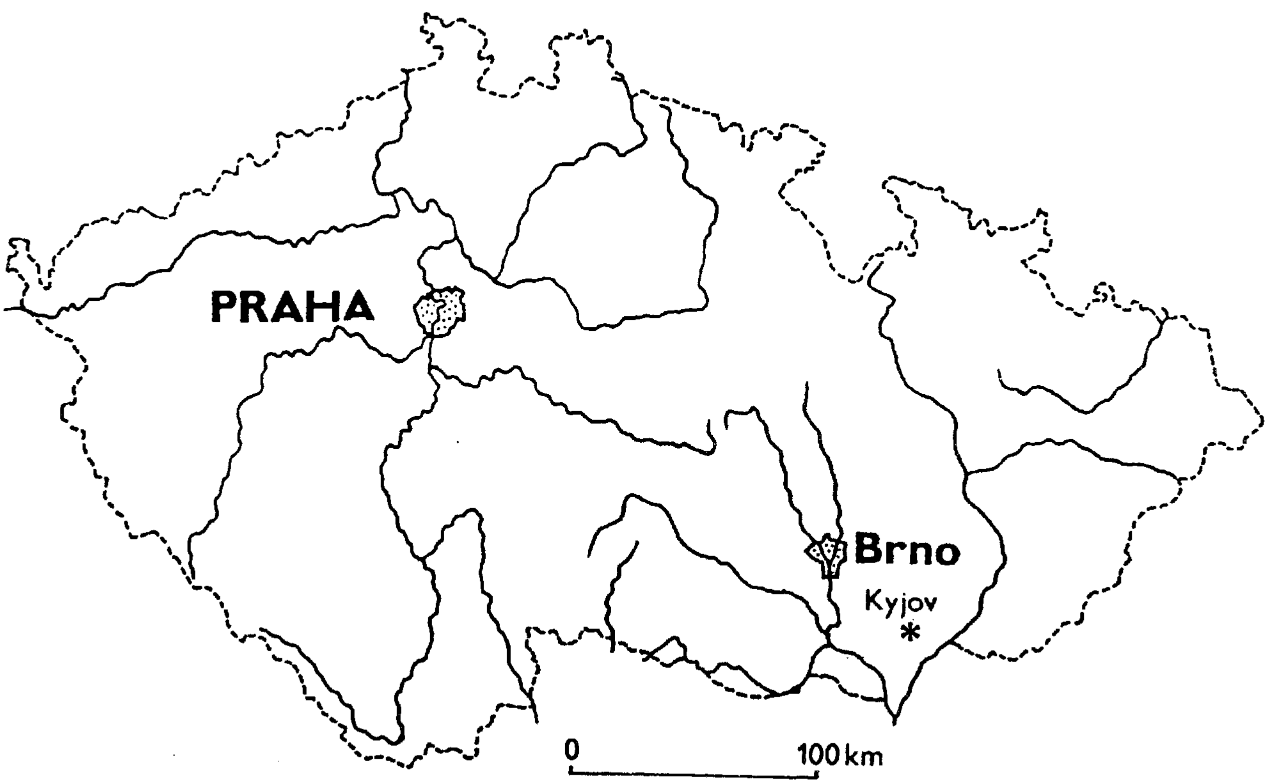


Fig.1: Position of the Kyjov toxic accident area in the Czech Republic

4-Actual storing of the chemicals was incompetent (is this usual?).

5-Fire safeguard measures were absolutely insufficient (fire-extinguishing means and water were missing).

6-Data on levels of some substances in environment prior the accident were missing for the purpose of comparison, status of the territory was not known.

B) adopted conclusions:

1. It is necessary to ensure long-term post-accident monitoring particularly that of underground waters and water courses (tap water).
2. Monitoring of adjacent lands to be made in neighbourhoods into which the fire-extinguishing water was drained.
3. Mathematic procedures to be worked out for modelling chemical leakages.
4. Deposition to be ensured of post-accident overburdens, residuals etc. including contaminated soil.
5. A board of experts to be established at governmental level, which would specialize in chemical accidents.
6. To ensure awareness and preparedness of population in the surroundings of risk localities.
7. To instruct manufacturers to add instructions for use and handling their products in the case of explosion or fire.
8. A statement that similar accidents could occur at any place in the country.
9. Detailed accident plans to be elaborated (yet, the proposal of binding content does not include any obligations to become familiar with natural condition of the territory).

Many similar pieces of knowledge, which were recognized to be relevant to the scope of GIS, have considerably influenced appearance of the system, its structure, construction and functions the example of the given area not being the only reason.

7. Case of the geoinformation ensurance for the locality of Kyjov-Boršov

7.1 Natural background of the locality

The area under study is of elongated shape at length and width of 12 and 7 km, respectively and it includes the Kyjovka river valley from southern edges of Chřiby Mts. up to the northern margins of local outlets of the Dolnomoravský úval its width reaching neighbouring valleys of Kyjovka river tributaries which were not affected by the toxic cloud (the main cloud was neither dispersed nor displaced into the neighbouring narrower valleys) but partially afflicted with vapours after the fire had been localized that related to the change of atmosphere (Fig.2). Eastern and western edges of the territory under study follow in fact the high watershed topography of these small valleys against more distant water catchments. The area of 84 square kilometers should be sufficient for the case of planning sanitation measures.

The geoinformation system under construction will assist to ensure the post-accident provisions, and is not meant to model the course of the accident or the spread of pollutants. This issue has usually been neglected.

7.2 Choice, assessment and purpose-oriented interpretation of basic information documents

Available data are subject to assessment from the viewpoint of their purpose within the GeoRisk system. Their interpretation consists in prediction of pollutant behaviour in individual landscape "spheres" of the given territory.

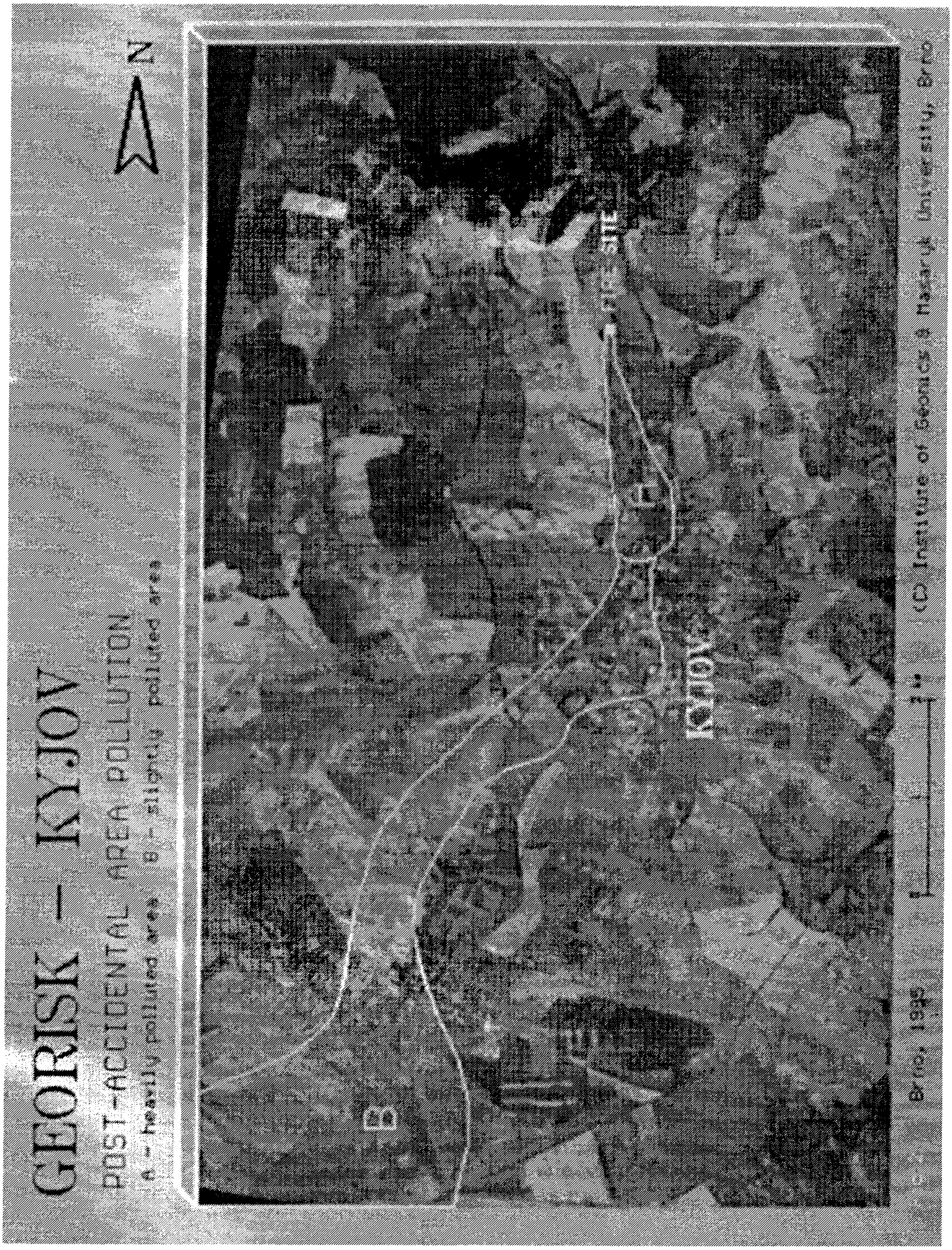
Following data were collected and considered irreplaceable in order to cover spheres of possible migration of pollutants in terms of available information:

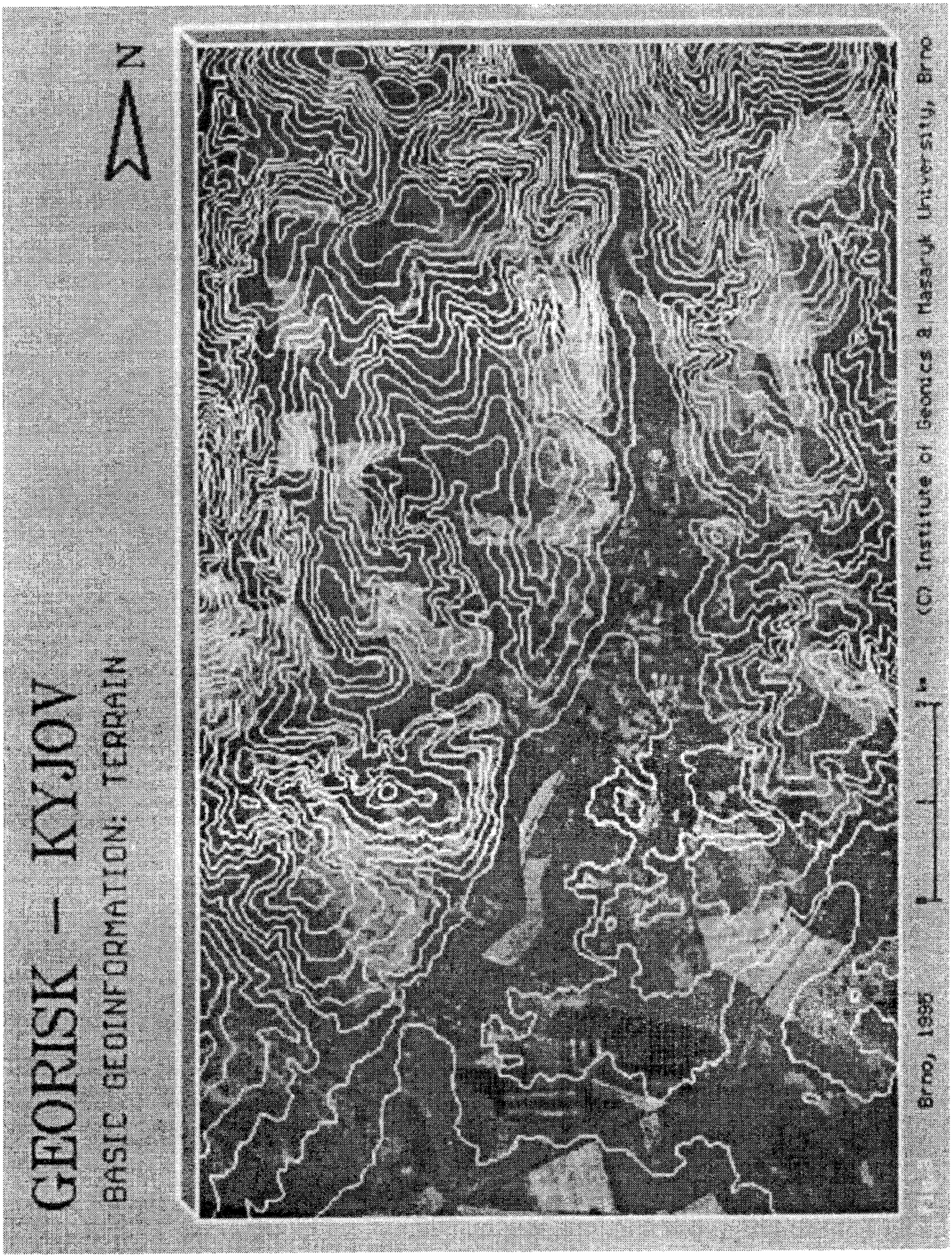
1. for the sphere above the Earth surface - the land use map. However, it showed that the land use map would always follow out of old and with the fire asynchronous information. Moreover, some of the data can exhibit very short life (agricultural crops, buildings). By experimenting with aerial and satellite images it has been found out that as to the content, most acceptable would be the satellite photographs of high resolution. The above-surface sphere is best represented in the system of high resolution satellite photography (Fig.2) that can well inform about the surface cover with biomass, which is important from the viewpoint of general estimates concerning retention function of the plant (and other) cover for pollutants. In addition to all this, satellite imagery facilitates a far better orientation in the terrain than a current map since it contains considerably more information. In the present version of GeoRisk system, major task of the image is to enable orientation within the terrain at learning, assessing and decision-making operations.
2. for the Earth surface - which is best represented by a digital elevation model. Its role in the system consists in generating three-dimension models of the area in order to acquire better ideas about the situation and definition of inclining line aspect at any point of the area under study. Information about topography can also be represented in the system by a mere map of contour lines (Fig.3) and slope areas. The slope areas in three categories of 0-3°, 3-15° and above 15° assist at estimating the rate of pollutant superficial motion.
3. for the soil environment - which is best represented in maps of soil species (mechanical composition and particle-size distribution of the soil) and in maps of soil types (processes in the soil). Particle-size distribution informs about permeability rate of the soil for water as the major transport medium of pollutants and about nature of this motion (filtration-seepage-flow). Typological information provides general relation of the soil to subsurface water (water table movement, periods of incidence near the surface) and water regime (leaching regime means greater danger to subsurface waters in geological environment than evaporization regime with pollutants being prone to generation of secondary cummulations on the soil surface or in its vicinity).
4. for the geological environment - This is described in the screened geological map with important for the motion of pollutants being namely mantle formations and structure of parent rock. An important characteristic of the mantle formations is their mechanical composition which can distinctly affect entrance of the pollutant into deeper layers as well as its further migration especially if its transporting medium is water or the pollutant itself is liquid. In solid substratum, however, the decisive importance is that of bedrock water (liquid) permeability potential which is given both by particle-size distribution of the rock, sealing rate and rate of tectonic disturbance.

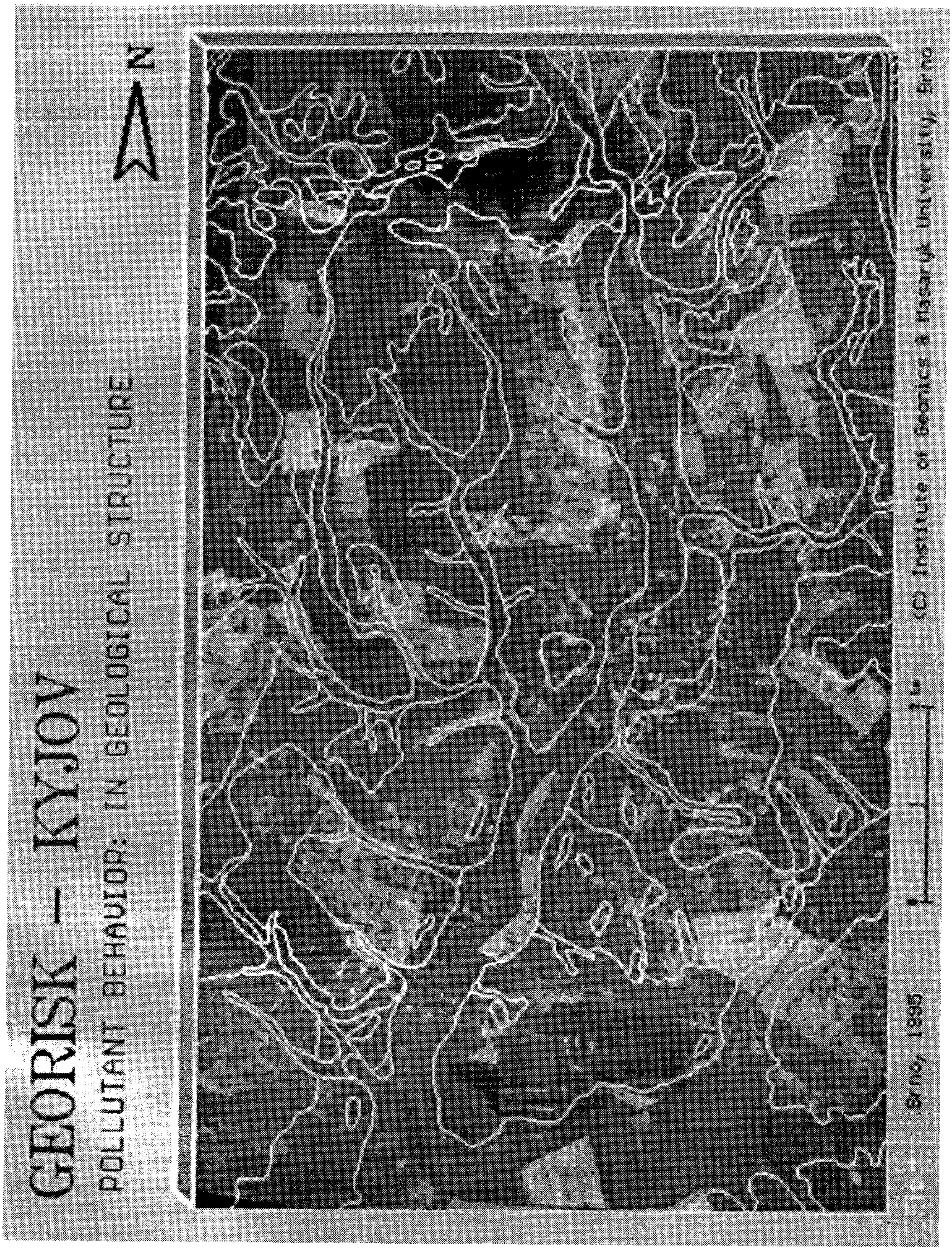
Additional information on the river network and roads serve to immediately control field works. Knowledge of the basic communication network is necessary for decision-making about access possibilities of machines, communications could later be also subject to decontamination. The GIS included contours of the toxic cloud formed during the accident as well as the area of impacted territory (Fig.1).

Methods and results of interpreting fundamental data are adapted into the text form accompanying each of the maps. This concerns description of the character of the elements being mapped by topics (soil, geological substratum, impact of topography) and by the reason for selection of sanitation measures.

The greatest problems are caused by classification of behaviour of various pollutants in environment, or within individual components of this environment. There is no sufficiently detailed knowledge at present, which would describe interactions of individual pollutants with individual kinds of environment (see Fig.4). Therefore, there cannot be any other possibility of resolving this task than to attempt at interpreting behaviour of the decisive transporting medium of the pollutant. This simplification is sufficient to organize sanitation works in the field, which should ensure safeguard over decisive masses of the pollutant in the environment. However, the information about the pollutant can affect - both in detail and conceptionally - the decision-making processes at controlling sanitation works if producer of the chemical substance or any expert at toxic substances would provide information on behaviour of these substances within the given environment. It seems useful therefore to collect informations about concrete pollutants and store them in a special block of questionnaires. The questionnaire block can serve to precise character of the pollutants.


GEORISK — KYJOV
POST-ACCIDENTAL AREA POLLUTION
A - heavily polluted area B - slightly polluted area
N
KYJOV
B
2 km
Brno, 1995 (C) Institute of Geonics & Masaryk University, Brno


GEORISK – KYJOV
BASIC GEOINFORMATION: TERRAIN
N
Brno, 1995
(C) Institute of Geonics & Masaryk University, Brno


GEORISK — KYJOV
POLLUTANT BEHAVIOR: IN GEOLOGICAL STRUCTURE
N
Brno, 1995
(C) Institute of Geonics & Masaryk University, Brno

7.3 Defining resolution level

Resolution level of the applied data issued from the use of a bottom map at the scale of 1:25 000 (Gauss-Krueger projection) with all used documents having been manually transferred into it after geometrical and optical corrections). Regarding that all these data should be presented on the screen of a common PC, a minimum area distinguished is 8 mm^2 (512 x 360 pixels).

7.4 Initial corrections and processing of basic documents

Proper preparation of the data for digitalization respected the need for harmonization. At transferring areals of valley bottoms, precise geometrical harmony was needed with preferring geological information which was considered to be most reliable. The same applied to border lines between soil types and soil species areas.

The methods and results of interpreting basic and integrated data have been accomodated into accompanying texts to each of the maps.

7.5 System structure and content

With regard to the fact that the data have to be permanently complemented and accommodated similarly as content of the proper geoinformation system, it was decided that presentation of the knowledge in traditional form of local atlas would not be made and all efforts were directed to generate a computer variant of the facility, hardware being the common personal computer 386. Instrumentation of this type is financially available to any organization which would feel a need for similar geoinformation facility and would not insist on any specific peripheries or accessories (colour screen and common printer are a condition). Software is designed for MS-DOS based computers and can be filed under current directories or stored together with data on floppy discs and installed when necessary on a disposable PC.

The post-accident information system GeoRisk in the version submitted has been designed as a local electronic atlas of the area of Kyjov under study. It means that it contains a whole range of fundamental and derived thematic maps related to the issue of environment impairment by a possible accident or to post-accident provisions. The maps represent a data base which has been complemented with a satellite photograph for orientation in the territory. The knowledge base is symbolized by the sequence of explanatory texts and purpose-oriented explanatory notes to the maps.

The present functional version of the GeoRisk system consists of the following three groups of stored data:

1. Entrance and explanatory text. The whole information system is being introduced with a text "GEORISK IS INTRODUCING ITSELF" which contains reasons for the system to be designed. The following text "TERRITORY IS INTRODUCING ITSELF" includes the basic description of the toxic accident and its scenery - location, size, basic elements of area character. In addition to these introductory texts, each of maps is being supplied with similar explanatory legends, be it basic maps or derived maps linking up with them. Up to now, the system contains three map series, each of three members, with accompanying texts which describe purpose-oriented geological environment, soil types and soil species, behaviour of pollutants in these environments, and explanation to selection of protection and remediation measures after the possible accident.
2. Basic and derived maps. These maps provide spatial information about the territorial differentiation and incidence of geological formations, soil types and soil species. The linking range of derived maps (purpose-oriented assessment maps) informs about behaviour of the pollutant at the soil surface (from the map of soil types), in the soil environment (from the map of soil species), and in geological bedrock (from the geological map - Fig.4). Another purpose-oriented series of maps provides a survey on distribution of protection and remediation measures in the area for the case that the territory has been contaminated.
   This group of information includes also elementary maps of traffic network, river network, relief (contour lines - Fig.3) and actual contamination of the area with toxic accident (Fig.2).
3. Legends to the stored maps. These are generally element legends in which all items contained in the given map are being accompanied by serial number and explanation to the contents of the sign.

7.6 System function and utilization

Major function of the GeoRisk system consists in providing to the user necessary information in the course of post-accident measures in the area.

The content of data files (text, map and legend) is presented in basic menu. In this basic menu the user can make his (her) own choice by using the code or the cursor. The selected file will then appear on the screen. Should this file be a map, the user can move the cursor across the screen and ask for an information about the given locality at a selected place. The information will appear in a special window in the corner of the screen. This procedure can be selected both at reading the map or for a combination "image-map" (a B/W map at the background of the image). Similarly, the user can magnify the selected place in order to learn the locality in details. The given file is easy to leave and the user can make another choice immediately.

The system does not enable the user to enter the data nor texts or legends. However, he is allowed to transfer selected data out of the system for his(her) own purpose-oriented processing. The user is welcomed to make combinations of a satellite imagery and contour maps of basic geoinformation, possibly also those of road maps or river network with any basic map or with satellite photograph.

Another method of use consists in looking for preliminarily determined combinations of parameters from individual basic maps.

8. Prospects of the GeoRisk system and other environmental GISs

The system of GeoRisk was built up in a version which can satisfy the common user with its user-friendly operation and suits anybody with no specific qualifications or skills. The user can get the data to his(her) requirements and does not need to use complex methods of computing technique. The given version is a basic model of the system, which can perform its function in the given area with no additional information with the exception of those describing the type and localization of the pollutant in the territory.

Establishing the computer assissted systems for geoinformational ensurance of hazardous sites should be obligatory for owners according to the law in the future. This kind of computer systems of geoinformation ensurance of hazardous localities will experience further modifications and improvements both in terms of its theoretical conception and as to its functions. This also applies to better utilization of remote sensing so that the imagery can be used to assess surface of the terrain from the viewpoint of categorization of active surface retention functions for the pollutant under motion, considerable reserves being seen also in possibilities of using digital model of the terrain. The three-dimensional simulations mean better instructive understanding of the accident area under study.

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GREGOR MENDEL AND URBAN ENVIRONMENT

Jan MUNZAR

Abstract

The article is a contribution to historical monitoring of environmental changes. It also brings some new information about deterioration of air in urban areas in the 60s of the 19th century on the example of Brno. The data have been excerpted from two meteorological publications by Gregor MENDEL, founder of genetics (1822-1884), of which the first deserves attention due to presented documentation on urban heat island including a discussion about its causes and introduction of a term "Rauchnebel" - German predecessor to the English term of smog. The second article presents interpretation of local differences in surface ozone concentrations detected by Schoenbein method both on the basis of differences in air pollution rate in the centre and in the outskirts of the town, and with regard to annual course of wind velocities (aeration).

Shrnutí

Gregor Mendel a životní prostředí měst

Článek je příspěvkem k historickému monitoringu environmentálních změn. Přináší některé nové informace o znehodnocování ovzduší měst v 60. letech 19. století na příkladu Brna. Jsou excerpovány ze dvou meteorologických publikací zakladatele genetiky Gregora Mendla (1822-1884). V první stojí za pozornost dokumentace městského ostrova tepla, diskuze o jeho příčinách a zavedení pojmu "Rauchnebel" - německého předchůdce anglického pojmu smog. Ve druhém článku jsou lokální rozdíly v koncentracích přízemního ozónu, zjištěné Schönbeinovou metodou, interpretovány jak na základě rozdílů ve znečištění ovzduší v centru a na okraji města, tak s přihlédnutím k ročnímu chodu rychlosti větru (provětrávání).

Key words: urban environment, air pollution, urban heat island, 19th century, Gregor MENDEL, Brno, Czech Republic

1. Introduction

Attempts at historical monitoring of environmental changes should include information about gradual deterioration of air in towns and industrial agglomerations from the period prior to instrumental measurements. The basic idea can be provided for example by individual, non-systematic records spread in various historical sources of written nature (Munzar 1994 a,b).

It is not generally known that the issue of urban environment was dealt with in a pioneer way by founder of genetics and natural scientist Gregor MENDEL who lived and worked in Brno and whose 110th death anniversary was commemorated in January 1994. Two of his meteorological works namely concern problems of climate in Brno, particularly its temperature peculiarities (in contemporary terminology of urban heat island) and air pollution in connection with measuring surface ozone values.

2. Heat island in the town of Brno

In January 1863, three years before publishing his famous work on experiments with crossing pea plants, Gregor MENDEL presented a work written in German language "Notes to graphical and tabelar survey of meteorological situation in Brno" (Mendel 1863) at a meeting of Society for Natural Sciences in Brno. It was his first publication in meteorology, and at the same time it was the first newly concepted assessment of climate in Brno based on average annual course of temperatures and air pressure values, cloudiness, atmospheric precipitations and wind direction or velocity. However, MENDEL also reported of an experimentally found fact that temperature values in the town centre are higher than in the outskirts: "*Air temperature was monitored in Pekařská Street /Grosse Baeckergasse/ by means of special instruments made by firm Kappeller to these purposes. Experiments which were recently made in the inner town and in one of neighbourhoods in the outskirts have brought a certain evidence that average annual air temperature values increase considerably towards the centre of the town. The observed temperature difference appears to be larger in summer and winter than in spring and autumn, showing very markedly particularly during days with clear sky and calm air. We will not tackle causes to these temperature differences in details here. However, we should remark that on hot and bright summer days, considerable increase of temperature is being caused by sun-heated paving, walls and roofs made of stone or covered with tiles. In winter time, the warm air is leaking through doors and windows and along with hot smoke rising from chimneys and smoky fog (orig. Rauchnebel) contributes to temperature reductions. The studies made in Pekařská Street are very close to values of average temperature found in Brno. It is to be presumed that the average air temperature of inner town is by several tenths of a degree (RÉAUMUR) higher, with genuine temperature of open surroundings being lower by the same value. Precise calculation of the difference will be made possible only on the basis of further observations.*" (Mendel 1863).

Even with the Brno scientist coming back to this topic no more in any of his other publications, it can be stated that apart from the experimentally found fact about higher average air temperature values in the town centre in contrast to those of non-influenced surroundings (outskirts) causes to this phenomenon were explained in a correct way. This was the first work which tackled the issue of urban heat island on the territory of the former Austrian Monarchy. Up to now, the first publication about anthropogenic impacts on air temperature in the town centre was considered to be a work by Austrian meteorologist Julius von Hann, which was published nearly a quarter of the century later (Hann 1885).

Mendel's mentioning the "smoky fog" in town, in other words smog, also deserves attention. Nevertheless, the word smog as it is used today (from English words *smoke* and *fog*) was first used by English physical practician Harold A. Des Veaux (Heidorn 1978) as late as in 1905, which is some forty years later.

3. Ozone and air pollution in Brno

The survey of meteorological observations made in Moravia and Silesia in 1863 (Mendel 1864) includes a passage which is devoted to air content of surface ozone, detected by Schoenbein method. Tables bring data on monthly averages in ozone concentrations at following four stations: Těšín (Teschen), Kroměříž (Kremsier), Brno (Brünn) and Jihlava (Iglau).

It follows out from Mendel's comments that the first attempts at measuring ozone values in Brno were made as early as in 1858. As at air temperature measurements, it was a synoptical (synchronous) measuring in two localities: Staré Brno (Altbrünn) and Dornych (the ehen suburb of Dornrössel), in order to evaluate the affect of different aspects. Ozone concentration differences between the two monitoring sites appeared to be surprisingly great - reaching even 6 or 7 degrees of the Schoenbein scale. They were explained both by the existing air pollution and by wind status. MENDEL claims: "*For these mutually nearly antithetical results in terms of maxima and minima, a rather simple solution can be found at hand when using data from the more precise research made by Schoenbein, Kletzinsky and others. It has namely been proved that air pollutants of different kinds, which occur in towns at all times, split and bind atmospheric ozone with their action being more pronounced with time length. This is the reason why the air flowing above the town is always lacking ozone in its lower layers when leaving the town and is not lacking it when entering the town area, the ozone losses being greater with slower flow of air. It is therefore understandable why northern and north-western winds* *in Dornych suburb where they leave the town can exhibit only a weak reaction on ozone paper slips while southeastern winds arriving from open surroundings can show full effect. The observation site at Staré Brno can speak of exactly opposite results due to its position. As it is shown in the table, distribution of monthly average values in Brno was rather strange in the course of the year. The lowest ozone content was observed in late autumn and in winter, ie. in the time when the town was covered with mist and industrial smoke (Dunstnebel) for more days under weak wind. On the other hand, the nearly double maximum values were recorded in summer months with considerably more rapid exchange of air*" (Mendel 1864).

For our present time, historical origin of the used method of measuring surface ozone is not important. What is considered important is the fact that the quoted passage links up with the older one on "smog" in Brno from 1863, thus being another contribution to historical monitoring of environmental changes. Let us add that the famous episodes with persistent smog in London began to appear approximately ten years later (Heidorn 1978).

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Institute of regional geography in Leipzig

Antonín VAISHAR

INSTITUTE OF REGIONAL GEOGRAPHY[1] from Leipzig, Germany became another important foreign partner to the Brno Branch of the Institute of Geonics, Czech Academy of Sciences. The INSTITUTE was founded 1 January 1992 within transformation of the former GDR Academy of Sciences and today it is funded half by German federal government and half by the Saxon Ministry for Science. Founding director was Prof. Hanns J. BUCHHOLZ from Hannover, who was replaced with Prof. Alois MAYR from Münster in the end of 1994.

Research studies made in the INSTITUTE are regularly concentrated on Germany and Europe, namely on the macro-region of central and eastern Europe, which is under the process of transformation. This issue is one of points of mutual concern to both partners. As to specialization, the INSTITUTE employs mainly human geographers and its research activities are focused on the following problems:

- analysis of spatial structures, spatial potentials and development processes in their regional differentiation,
- analysis of spatial and structural interactions between social, economic and political systems in spatial consequences of European integration,
- theory of regionalization,
- regio-geographical inventory.

The INSTITUTE links up both with traditions of the German geographical institute and its predecessors (1896-1968) and with regio-geographical works of the Institute for Geography and Geoecology (1969-1991). All these institutions resided in Leipzig, too.

Scientific part of the INSTITUTE divides into two scientific divisions: German national history and geography (Head-L. SCHARMANN), and Regional geography of Europe (Head-F. GRIMM). Other workplaces of the INSTITUTE are as follows: department of cartography (K. GROSSER) whose major task consists in working out graphical parts of publications issued, geoinformatics (O. MARKGRAF) which works with ARC/INFO system, and one of the most popular geographical libraries in Germany (I. HOENSCH) with 177 thousand bibliographical units and 800 exchange partners. There are altogether some 35 workers working in the INSTITUTE, of whom 15 are scientists.

Within not even two years of its existence the INSTITUTE can boast with considerable amount of work done. This can be documented by publications issued: it is a quarterly journal EUROPA REGIONAL in German with English, French, Spanish and Russian summaries. There have been four issues up to now, devoted to various regions in Germany, eastern and western Europe. Very impressive in terms of graphics is a small geography of Germany "Das vereinte Deutschland" of 88 pages which is to be shortly followed by a monograph "Deutschland in Europa". Another publication series is "Daten - Fakten - Literatur zur Geographie Europas" whose first issue "Natur, Wirtschaft und Oekologie der Stadt Kaliningrad" was devoted to the less known Baltic region of Russia. The INSTITUTE has taken over the series of the former Institute for Geography and Geoecology "BEITRAEGE ZUR REGIONALEN GEOGRAPHIE" having equipped it with new A4-size graphics. Up to date the series includes two monographs: "Landwirtschaft in Deutschland" and "Zentrensysteme als Traeger der Raumentwicklung in Mittel- und Osteuropa". The second publication deserves more attention since it includes the territory of our country.

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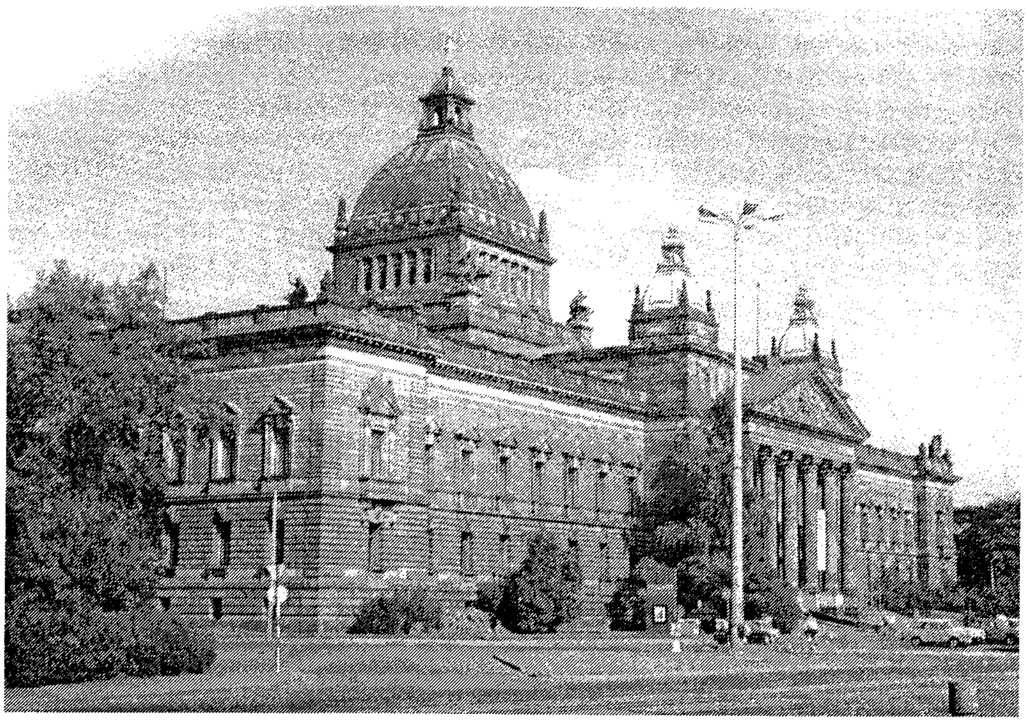
1 original name "Institute für Länderkunde", Leipzig, Beethovenstraße no. 4



Leipzig. Historical building of the Imperial Court (well-known from the Dimitrov-action), where the Institute of Regional Geography is settled till this time. It is to be removed to a new modern building in the suburb Paunsdorf.

Cooperation between the Brno Branch, Institute of Geonics, Czech Academy of Sciences and the INSTITUTE for Regional Geography, Leipzig is expected to bring a contribution to exchange of scientific information, support of contacts in partner countries, possibly also joint research of border land regions. Personal contacts between specialists of the both institutions are a matter of course. Apart from common regional interest in central and eastern Europe, junction points seem to be also some material problems related to transformation of the society.

Systems of settlement centres as bearers of spatial development in eastern and central Europe

The publication was made in close collaboration of more than fifty geographers from 14 countries of the region under study. The analysis includes former socialist countries of central and eastern Europe the area being demarcated by right-bank Ukraine, Baltic countries and Pskov and Leningrad districts of Russia including St. Peterburg in the East, Slovenia, Hungary and Romania in the South. The monograph consists of two parts of which the first brings evaluation of international structures and trends, the second one tackles systems of centres in individual countries and regions. Objective of the study was to provide a certain analysis to the expected development in transforming countries of eastern Europe, and to evaluate opportunities and risks of this development from the viewpoint of European Union and Germany. Taking into account the fact that ten of the thirteen countries under study came into existence only after 1990, the situation was brand new. Authors followed out of a justified presumption that prospects of centres are decisive for future development in regions. The analysis was made of political and administration functions, other important functions in management, science and education, culture, communications and leisure activities, transport functions and potential of the population.

One of results of this work was division of the centres into five categories. Category A includes 1-million capitals such as Prague or St. Petersburg. Category B includes Baltic capitals and centres of Slovenia, Slovakia and Moldavia along with several other centres incl. Brno whose relatively high classification is given namely by specific functions (trade fairs, six universities, seat of some government bodies), to lesser extent then by transport function. On the other hand, Brno belongs to the smallest centres of its category in terms of population numbers and would not bear comparison with capitals such as Odessa, Riga or Lódż. According to German classification system, its level would be rather that of Bremen or Nürnberg: however, these German towns exhibit fully developed functions while the towns of eastern Europe only combine actual status with their potential. Deeper and more complex research of centres significant from German point of view has been suggested that should concern capitals, Baltic harbour towns, Poznań, Brno and Lvov.

The second largest Moravian town of Ostrava has been included into category D together with Pilsen, Olomouc and Zlín then in category E. Limiting factors in the case of Ostrava were those of environmental character. Disputable can be considered allocation of Olomouc to the same category as Zlín with its extreme traffic situation and one-side development. Moravian centres of the 3rd order include Jihlava, Znojmo, Opava and Šumperk.

Territorial historical structure of the Czech Republic seems to be rather a difficult problem for the authors, which is quite understandable. Yet, the sentence "*Lands of the Czech Crown contain -in addition to Bohemia in narrower sense (Prague) also the lands of Moravia (Brno) and Silesia (remains from the 18th century with the capital of Olomouc)*" is incorrect[2]. This minor rebuke should not degrade significance of the work. It is rather meant for us to pay more attention to our own terminology if we do not wish somebody else from abroad to do it with having no detail knowledge of our historical development[3].

The work brings attention to the fact that traffic system in the Czech Republic has to be reorganized in connection with the split of Czechoslovakia and Soviet Union and with getting closer to western economic systems. It also comments upon the necessity of finding a solution to serious environmental problems of entire northern half of the territory. It is apparent that these aspects and their long-term affects will show later at forming the network of residential centres. A relatively high standard is appreciated at area and urban planning experience exhibited by Czech institutions: here the publication mentions Research Institute of Building and Architecture, TERPLAN, Geographical Institute of Czech Academy of Sciences, and the centre for Theory of Architecture and Development of Residential Centres at the Institute for History of Arts, Czech Academy of Sciences. Unfortunately, some of these organizations do not exist any longer.

A territory of special interest for our German partner seems logically to be the Bohemian-Bavarian and Bohemian-Saxon border lands.

Leipzig - Americanization of the City?

It is quite understandable that Leipzig stands in the centre of attention for experts from the Institute of Regional Geography. The town of Leipzig - one of the most important and

2 Czech Republic is historically divided into Bohemia, Moravia and the part of Silesia. Capital of Bohemia has always been Prague whilst two Moravian towns of Brno and Olomouc used to compete for capital function in Moravia. The Czech part of Silesia which is not continuous territorially, has never acted as a separate land. The system of lands does not exist at present, and therefore, it is not possible to speak of capitals. Significance of the individual lands is seen in cultural and ethnic values.

3 The terminology seems to be clear in German and Roman languages. In English language the Czech Republic or Czechia consists of two parts: Bohemia and Moravia. Analogically, Tschechische Republik in German language (sometimes Tschechien or Tschechei) consists of Böhmen and Mähren, in French the Republique Tchéque (Tchéquie) of Bohéme and Morave. The basic problem seems to remain in the Czech language which does distinguish Bohemia and Moravia, not having a special name for the entire state formation. The names of Czech Republic or Czechland do not satisfy the need since the solution is not properly legible to foreign countries and the problems seems to be contained in the adjective.

largest cities in the pre-war Germany, financial and business centre, residence of imperial court, centre of polygraphy and culture - used to be the second largest town of the former GDR until unification of Germany. However, its financial and commercial role has long ago been overtaken by towns in western parts of the country such as Frankfurt. Leipzig has become a centre of heavy industry and connects to open-cast mining of brown coal and chemical industries, which have gradually led to devastation of natural environment. The town has retained its tradition of trade fairs: nevertheless, its importance has been restricted - similarly as in the case of Brno - by liquidation of market mechanisms.

The unification of Germany came at the time when Leipzig was considered to be one of the largest industrial centres. Its urbanized core was too small as a result of underestimation of the necessity of developing services in conditions of centrally planned economy. The town core was surrounded with a band of blocks of flats from Gruender epoch, which combined with industrial plants at some places. In some peripheral central zones the housing facilities were falling into disrepair. In contrast, panel neighbourhoods were erected for tens of thousand people in outskirts of the town with all possible disadvantages known in this type of housing. Transport was ensured mainly by the dense and large-capacity tram network with additional bus lines and the town elevated railroad line. Internal town roads were not modernized since their condition seemed to be sufficient for the then traffic systems.

The unification of Germany has brought to Leipzig the transition from one type of socio-economic system to another in practically an overnight time. Nearly all mines (with only one single exception) were closed, the brown coal based chemical industry extincted. On one hand, this fact showed to have positive consequences from environmental point of view, and the danger of mining expanding to the very city limits was suddenly averted. However, consequences in terms of employment rate were not so favourable. The majority of other manufacturing companies (perhaps with the exception of building industry) could not stand competition of West German firms and employment rate in the industry marked a rapid fall. Number of inhabitants, which had been decreasing for some time, crossed the half million limit in downwards direction in 1992. Some experts expect further considerable reductions in population due to the lower employment rate in industry as town-forming function.

The town traffic system failed. People living in the eastern parts of Germany where they used to wait for cars many years started frantical purchasing of second hand western cars which immediately overloaded narrow streets of the inner city. Trams made in Czechoslovakia can make their way through step-by-step moving motorcades only with difficulties. Atmosphere in the town, improved due to restrictions and prepared ban in using brown coal, was again impacted by smog generated by irregular movement of automobiles. Although the bicycle becomes a means of traffic which seems to be better than the car from the viewpoint of operation and parking in the inner city, Leipzig inhabitants feel that the operation of their new passenger cars has become a part of their new identity.

Extensive building can be seen in some urban parts close to the centre. Old blocks of flats are being taken down and new administration buildings rapidly grow in their places. Developers believe that they will all be used for banking houses, offices and other institutions. Leipzig suddenly recalls its pre-war function as that of a banking centre in Germany. Prices of real estates rapidly increase. The centre "North" is being finalized, the centre "East" is under construction, the centre "South" is being planned. (Valuable urban park on the confluence of Elster and Pleisse rivers is situated westwards of the centre.) However, other neighbourhoods with old blocks of flats at less attractive places namely eastwards of the centre hopelessly fall into ruins.

Most surprising is hasty development of suburbanization that has appeared almost from one year to another. The principle qualitative change was stimulated by construction of large manufacturing and wholesale facilities (Gewerbepark) and huge shopping centres outside the town on lands adjacent to the motorway. Schkeuditzer Kreuz has become a natural crystallization core: it is a highway crossing Berlin - Munich and Halle - Dresden (which should be extended at both sides). It is located between Leipzig and

Halle, near the international airport of Schkeuditz. From the national German point of view the area is unusually attractive with central position as related to the old-new federal land. Other areas such as Sachsenpark and Saalepark northwards and westwards of Leipzig, respectively, have been made use of for similar purposes. The latest facility of this kind is being built at Paunsdorf suburb which should also become a new seat of the Institute für Länderkunde next year. The Leipzig Exhibition Centre is being moved closer to the motorway including the infrastructure, too, with costs for this displacement reaching some 1.3 billion DM. After Fürth the second central of mail-order warehouse QUELLE is being built at 1 billion DM costs. Four giant shopping stores with furniture have been erected within a distance of 20 km.

All these functions call for necessary infrastructure. Parking places for thousands of cars were at the first place. It is dangerous to leave the car without memorizing well the row number as finding the parked automobile can be difficult among so many other cars. A new airport is under construction at Schkeuditz, which should take over a certain portion of mail service functions performed by the Frankfurt Airport for the East at present. The tens of thousand shopping people have to be fed, entertained, their children have to be looked after. The Saalepark shopping centre has fifty shops of store character, but it is already equipped with a central street with rest zones, a cinema and other activities. Thus, a new town has been erected on the green meadow with thousands of new jobs but with no dwelling function so far. Dwelling houses creep to the vicinity of the centre rather in bewilderment only recently.

The above method of creating working and servicing concentrations inevitably relates to ownership and use of the passenger car. Although the parks are within the reach of bus lines, some 90% of visitors arrive by cars. Boom of the parks was contributed to also by the hunger of inhabitants in Leipzig to own their own cars. However, the automobile way of living does not crave for enclosed spaces of the inner town and prefers fast motion along the multilane highways. Nevertheless, it is worth adding here that the highways around Leipzig, which usually miss the out-side lane, are extremely overloaded and traffic is often not continual at all.

In the case of Leipzig, we can see a sharp conflict of competition between the town core and suburban zones. Seen from the strictly functional point of view, there is a question what really is a central place in terms of services and working functions - whether it is the town of Leipzig or Schkeuditzer Kreuz. In addition to these considerations, housing facilities seem to be looking for areas other than the city itself. Migration balance of Leipzig with many villages in its surroundings has become passive lately. Even though the absolute volumes seem to be rather small up to now. the qualitative change has already shown with the pre-war blocks of flats and panel neighbourhoods which fall into desrepair having lost theiı attractiveness long ago.

Another problem consists in a seeming disproportion between the expected drop of demographical potential due to falling industrial production and rapid development of terciary and quarternary spheres. At observing registration signs of cars parking around shopping centres, we shall find out that function of the cars is spatially limited by a circle of several tens of kilometers. Another question is the fact that should the inhabitants of Leipzig, Halle and surroundings make their shopping in these shopping centres, they are also supposed to draw in financial funds from somewhere outside. It seems that restoration of the industry (naturally with different branch and size structure of companies, with less employees and with different technologies) is practically the only possibility of how to permanently get some supplies of finance into the region from outside. Condition is not seen in an necessity of all industrial plants being localized directly in Leipzig, but it is now for certain that without the industry the project would not be realistic. Objectives speak of 250 000 new jobs in 2005-2010, of which 55-60% are supposed to be the office jobs. As to industry, certain hopes are being connected with the project of a technological and innovation centre that is supposed to become an impuls for growth of new competitive companies by means of connecting the scientific and technical potential of Leipzig with enterprising activities.Of traditional industries, polygraphy and telecommunications seem to be having the brightest prospects. The most advanced telecommunication centre in Germany is being built exactly here in Leipzig.

Life of the town of Leipzig as well as that of its inhabitants has been changed more than a bit within the last five years. To certain extent we can speak about the danger of americanization of the city life, displacement of attractive places and facilities toward highways and into open areas, and partial disintegration of the inner city. Experts from the Institute fuer Länderkunde, Martin Luther University, Halle as well as those from area planning institutions in Leipzig itself believe that it will not happen. Tools are seen in area planning projects, similarly as in old federal lands, particularly in Northern Rhein-Westfalen. Very important should be considered reconstruction of parts in Leipzig, which are close to the town centre. Nevertheless, area planning in conditions of market economy can only generate a certain area offer or to put brakes on undesirable activities. Actual development of these functions means to find strong developers with sufficient finance, who would be prepared to invest their money into town reconstruction and revitalization of its old central and centre-adjacent structures.

It does not seem that Brno could be put to jeopardy like this. Leipzig is an exception even in German conditions. Towns of West Germany already experienced the above development and gradually have been made to build up protection mechanisms. Implementation of needs claimed by inhabitants of East Berlin have been naturally taken over by capacities existing in West Berlin. Other towns in East Germany including the Saxon metropolis of Dresden are smaller than the agglomeration of Leipzig and Halle, their localization being less favourable. However, some manifestation of the above trends can be predicted even in our country, and the example of Leipzig shows that the process can be very rapid.

Interesting for us should be a theoretical problem of what in fact is to be considered residential centres with the above described development - whether the towns or the highway crossings. Consequently, we can ask what function will be left to the classical towns after the considerable portion of working and service activities and later also dwelling facilities have been displaced to open areas and to the vicinity of highways. Up to now, it seems that the towns and their centres will be left mainly the "genius loci" of town cores, ie. cultural and historical potential which is capable of generating intellectual values.

Four years after

This was the name of a workshop held in the district town of Sonneberg (Thuringia) in October 1994, which was prepared by the Institute fuer Länderkunde jointly with some other institutions. Scope of the repeated seminar (the first one was held at the same place in 1990) was to monitor residential and geographical situation in the former borderland between GDR and GFR, ie. at places where natural development of settlements and centres used to be disrupted by the inpermeable state border in the recent past time.

Sonnenberg was known by its extreme position: on three sides it was cut off from the other world by state border between the German Democratic Republic and West Germany as well as from the rest of Thuringia and ridges of the Thuringian Forest. The town was in close touch with Coburg district that fell to Bavaria. With Neustadt bei Coburg (ca. 11 thousand inhabitants) Sonneberg (25 thousand inhabitants) practically made a twin town. Sonneberg was an important producer of toys (including the PICO company well known in our lands) as well as a centre of ceramic manufacture for electrotechnical industry. Suitable natural conditions of the town surroundings of the Thuringian Forest supported recreational function of the region. Industry in Neustadt has always been associated primarily with SIEMENS company.

In the period of GDR, the toy-making industry (formerly spread into numerous family businesses and working on the basis of home manufacture) was concentrated into a sole combine and specialized to supply COMECON countries similarly as the ceramic production. Utilization of the area for recreational purposes was made imposssible in the

60s after regime on the state border had been sharpened and a part of the region became an enclosed zone. The natural relationships and division of functions with the towns of Neustadt, Coburg, Kronach and other centres in Upper Frankonia were interrupted. In terms of traffic, Sonneberg was nearly cut off from the other world and lived on practically only industrial production.

Changes that arrived at the turn between the 80s and 90s have brought disintegration of COMECON as well as reduced purchasing power of former partners. Internal market was sufficiently supplied with products from the western part of Germany and from abroad. This naturally led to actual disintegration of original industrial combines. Immediately after Germany was unified again, people logically started hectic shopping and travelling. It did not take too long, though, and the lower purchasing capacity of Sonneberg inhabitants came to surface. Efforts of Thuringian authorities to stimulate prosperity from the central Thuringian area of Eisenach - Gotha - Erfurt - Weimar - Jena - Gera remain on the paper since there are no funds to make them true.Unemployment rate is closely below the 10% limit with experts speaking of a serious situation that would mean approximately a double. The town population is generally expecting some assistance from Bavaria, but the area of Coburg was considered peripherial also by West Germany and the unemployment rate here amounts to similar level as on the Thuringian side of the former border line. Yet, opening of the border reflected positively in improved offer of jobs as well as in services. The region of Coburg has accepted some ten thousand workers from the Thuringian side, of whom 7.5 thousands were from Sonneberg itself. Some villages around Sonneberg attempt at returning to recreational functions.

The seminar was devoted to changes in the structure of centres in the region. It was stated that restoration of the normal status is not simple as the two parts of the region were developing under entirely different socio-economic conditions for 40 years. During this period, Sonneberg lost its former equal position with Coburg. Certain barriers are still seen even in efforts at collaboration with Neustadt since the formerly less important Neustadt has become a much stronger partner financially. For Sonneberg it is psychologically very difficult to come to terms with the fact that the traditionally smaller and less important partner occupies an equal if not even more significant position at present.

Leipzig. The city core. It is demarcated by a grand street in the form of a ring. The University building in the middle is the dominant of the core. To the right, there are cultural attractions of the town: Philharmony (in front) and Opera (at the back). Rear border of the core is formed by the typical railway station surrounded with industrial plants. At the right side of the view, rebuilding of subcentral part can be seen.

Condition of dwelling houses on both sides of the former border indicates better and more advanced standard in Bavaria and higher degree of preserving traditional values of building style in Thuringia. Sonneberg, too, belongs to towns afflicted by hasty building of a shopping centre on a green meadow at the times of shopping fever: the centre represents a severe competitor to the town core at present. Some industrial facilities fall into ruins, some have been taken down. However, there some new smaller industrial plants with advanced technologies rising up as affiliations and daughter companies of western firms. Completion of traffic infrastructure is being planned.

Sonneberg will certainly remain a model example to study development of the residential system on the former border between the both German states. The situation in the region seems to resemble that of the Bohemian-Bavarian border. The border between Bohemia and Saxony seems to be of a different character: here, the German partner's position is strongly peripheral, support and assistance being expected from West Germany rather than from cooperation with towns in North Bohemia. This applies particularly to the Euroregion of the Neisse and possible forms of collaboration in this area. Considerably different is the situation of the Moravian border land where there are very strongly peripheral regions of Weinviertel and Waldviertel on the Austrian side of the border, the Polish border is characterized by lively trade rather than by collaboration of the residential systems, and the Slovak border presents brand new problems at all. In spite of the different character of problems, however, the seminar in Sonneberg pointed out importance of border-land geography even for us. The effect of state border, its opening on the one hand and closing as a barrier on the other hand, is a unique topic for geography examples for further studying being presented by issues of border effects on the formation of residential systems, travelling, solution of environmental problems, trade, traffic system, labour force market and perception of the border itself.

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The above suggested problems indicate that possibilities of the Brno Branch Office of the Institute of Geonics, Czech Academy of Sciences for collaboration with the Institute of Regional Geography in Leipzig are relatively wide and promising. However, their utilization will depend on financial funding available for individual projects.

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Jozef Jakál: Karst geomorphology of Slovakia

Typology. Map at the scale of 1:500 000. Geographia Slovaca, 4, 38 pp., Institute of Geography of the Slovak Academy of Sciences, Bratislava,1993.

Antonín IVAN

In Slovakia, carbonate rocks, limestones, dolomites, travertines are widespread mainly in core mountains . Very various karst phenomena occur, some of them quite unique. In the series Geographia Slovaca Jozef Jakál presents a new and original typology of karst in Slovakia with a coloured map at the scale of 1: 500 000, with additional data about caves and explanation text in English and Slovak languages.

In core mountains original upper Mesozoic fold and nappe structure was changed in relief of block mountains (horsts) and basins. Many complexes of Mesozoic autochtone and allochtone limestones and dolomites are liable to karstification. Lithology and age (Trias - Pliocene and Quaternary) of the carbonates are expressed in grey hachure (7 types).

As concerns the karstification process,the author distinguishes three types: a)karst process (chemical dissolution), 2) fluviokarst process in which fluvial erosion takes part, and 3) pseudokarst process (e.g.gravitational) in insoluble rocks. Intensity (degree) of karstification is expressed by six categories from complete development of exo- and endokarst, prevailingly autogenic development to fluvial relief with corrosion traces.

From the morphoclimatic point of view, only two types were determined, corresponding to altitudinal zonality. There are high mountain karsts with one subtype in combined fold-fault or inclined structures. In the second type of the Central - European karst of temperate zone there are subtypes of mountain and basin karst. Geomorphological or morphostructural criteria are decisive in more detailed classification . Among the mountain karst four subtypes are 1) plateau karst, 2) dissected karst of massive ridges, horsts and combined fold-faulted structures, 3) dissected karst of monoclinal crests and ridges, and 4) karst of klippen structure. Three subtypes of the basin karst are as follows: 1) karst of isolated blocks and monadnocks, 2)karst of foot plains and terraces,and 3) karst of combined fold-fault and inclined structures. Subtype of the karst of travertine domes and cascades occurs both in mountains and basins. The last geomorphological type is "cryptokarst ... in lenses of crystalline limestones and magnesites lying in impermeable Paleozoic rocks that does not manifest itself on the surface as the morphostructural karst type".

The typology is also important for Moravia, although in the Moravian part of Outer West Carpathians built by flysch and Neogene sediments only three important karst localities occur. Karst phenomena in Jurassic limestones of Pavlovské vrchy (Hills) in south Moravia and in the hill Kotouč near the town of Štramberk in north Moravia belong to the type of klippen structure in the mountain karst. As special case is the fossile tropical karst in Devonian limestone near the town of Hranice buried under Miocene marine sediments. The karst phenomena here developed in tectonic blocks of basement Bohemian Massif incorporated in the Carpathian system only in Miocene. Thus, with only one exception Moravian localities fit very well in Jakál's typology.

There is also a list of 329 important caves on the map, classified according the morphological type (caves, chasms), lenght, depth and secondary filling. Thus, the map affords exhaustive information and also its cartographic standard is high. In our opinion, the map presents substantial progress in carsologic mapping.

The Morava floodplain near Strážnice (SE Moravia) belongs among such valuable territories, the river forms here large meanders in the meander belt.

Photo: K.Kirchner, V. Nováček

The locality "Osypané písky" (Loose sands) is unique area with relatively natural development of the Morava river bed on the broad floodplain with collection of the vegetation association.

Photo: K.Kirchner, V.Nováček

In the west of Strážnice territory (built of wind-blown sands) is situated large sand-pit. The nothern part is already computely explited and the lateral face of the sand-pit is succesively suitable recultivated.

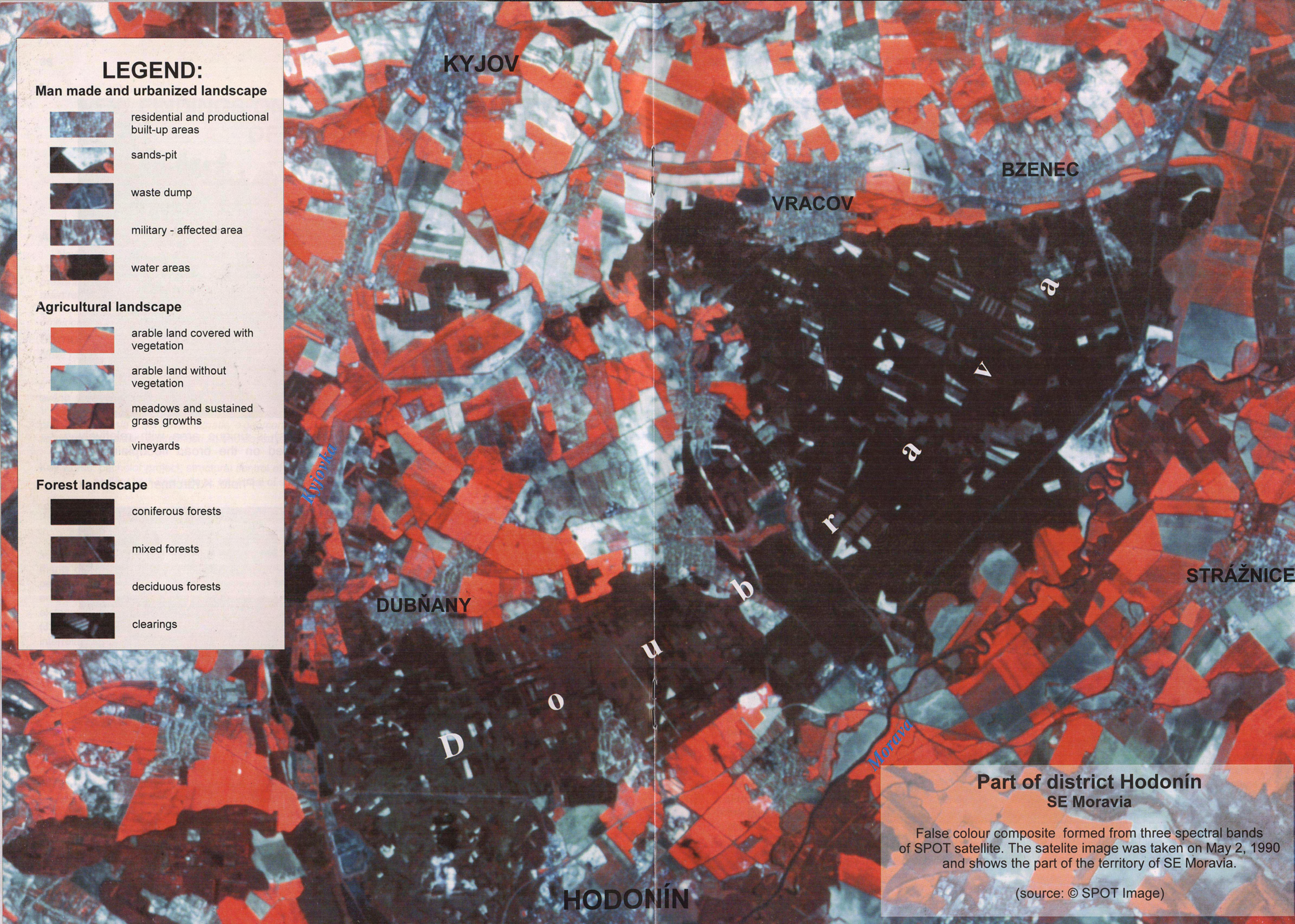
Photo: K.Kirchner, V.Nováček

Village Petrov: Folk wine cellar-architectural monument from 18th and 19th century.

Photo: K.Kirchner, V.Nováček

Aerial view of the district town of Hodonín (southern border).

Photo: V.Nováček



Part of district Hodonín
SE Moravia

False colour composite formed from three spectral bands of SPOT satellite. The satelite image was taken on May 2, 1990 and shows the part of the territory of SE Moravia.

(source: © SPOT Image)