MORAVIAN GEOGRAPHICAL REPORTS

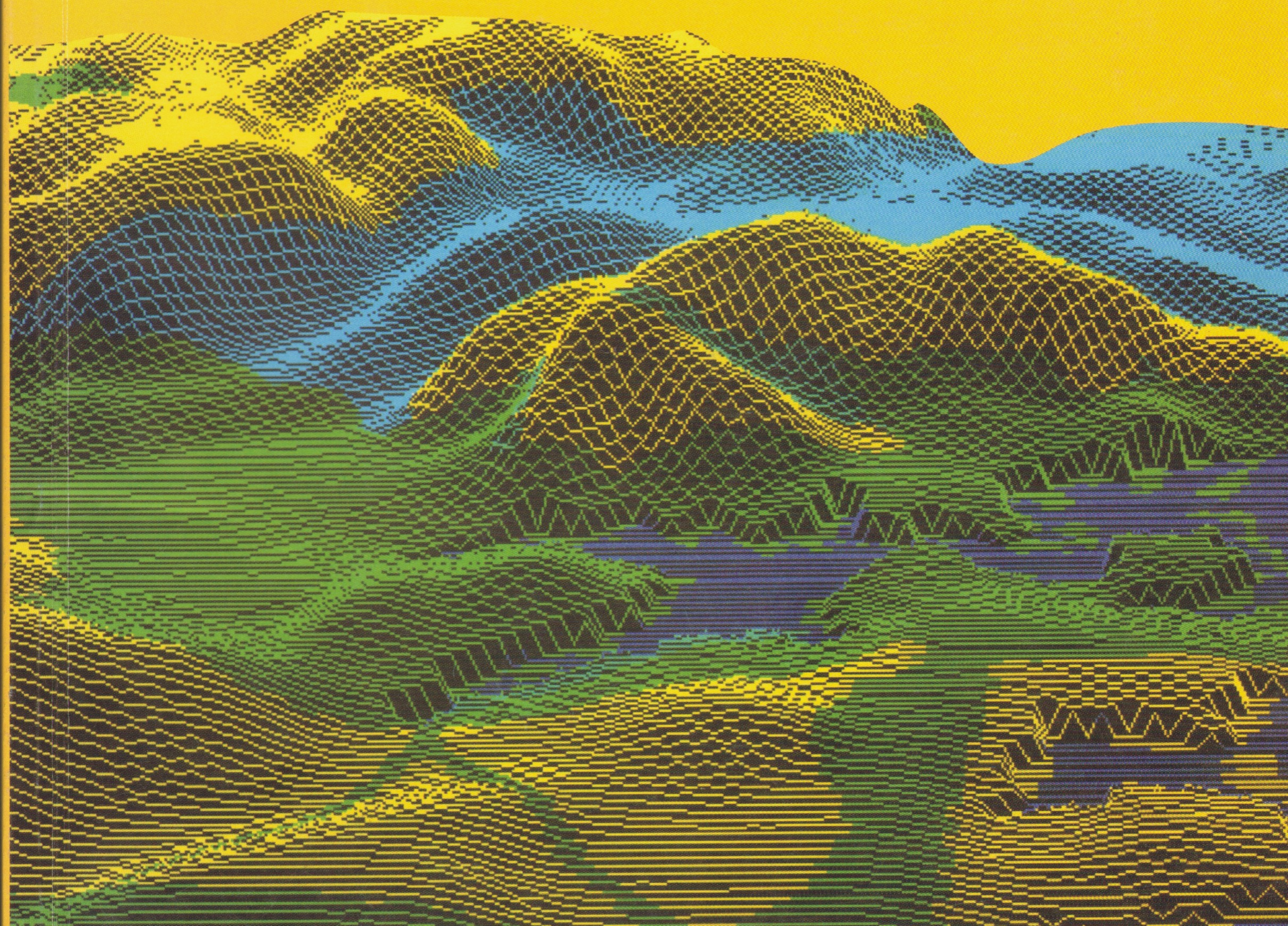
VOLUME 7

NUMBER

2

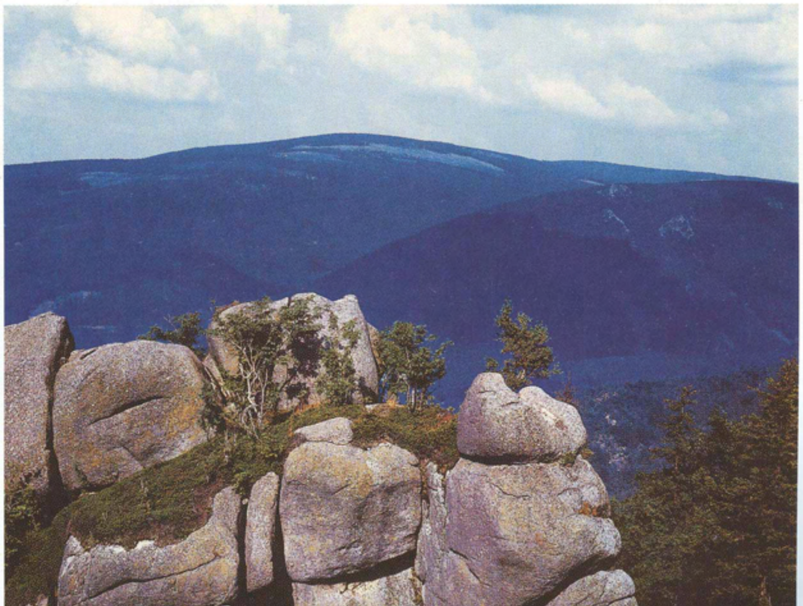
1999

ISSN 1210 - 8812



The nephelinite knob of Říp Mt. (460 m) in the Lower Ohře Plateau surrounded by lower Pleistocene terraces of Vltava and Elbe rivers.

Photo: B. Balatka



The Smrk Mt. (1124 m) of orthogneiss: the highest mountain in the Czech part of the Jizerské hory (Mts.). The vigorous tor of the Frýdlant crenel (900 m) in the front.

Photo: B. Balatka

Illustrations to A. Ivan's paper

MORAVIAN GEOGRAPHICAL REPORTS

PRICE

11 DEM
per copy plus the postage
22 DEM
per volume (two numbers per year)

MAILING ADDRESS

MGR, Institute of Geonics, ASCR
P. O. Box 23, CZ-613 00 Brno
Czech Republic
(fax) 420 5 578031
(E-mail) geonika@geonika.cz
(home page) http://www.geonika.cz

PRINT

PC - DIR Real, Ltd., Brno, Technická 2

ISSN 1210-8812

Articles

Reports

FLOODS IN THE MORAVA RIVER BASIN IN 1997 AND THEIR CONSEQUENCES FOR THE SOCIAL SYSTEM [1)]

Antonín VAISHAR, Jan LACINA, Stanislav ONDRÁČEK et al.

Abstract

The paper brings a basic characteristic of the Morava River basin which takes up a greater portion of the southern and central Moravia, a depiction of the settlement in the area and its economic utilization, conditions of environment which is impacted by anthropogenic activities, and it further deals with the extreme floods in the Summer of 1997 and their consequences. The Brno Branch of the Institute of Geonics, Academy of Sciences of the Czech Republic won a grant project from the Grant Agency of the Academy of Sciences of the Czech Republic named "Floods, Landscape and People in the Morava River Basin". Suggested are principal solutions for the project.

Shrnutí

Povodně v povodí řeky Moravy v roce 1997 a jejich důsledky pro sociální systém

Příspěvek přináší základní charakteristiku povodí řeky Moravy, které zabírá větší část jižní a střední Moravy. Zachycuje osídlení tohoto území, jeho ekonomické využití a stav životního prostředí, ovlivněného antropogenními aktivitami. Zabývá se extrémními povodněmi v létě roku 1997 a jejich následky. Brněnská pobočka Ústavu geoniky AV ČR získala na léta 1999-2002 grant Grantové agentury AV ČR s názvem Povodně, krajina a lidé v povodí řeky Moravy. Jsou naznačena základní východiska pro řešení uvedeného grantového projektu.

Key words: Morava River Basin, floods 1997, long-term consequences, Czech Republic

1. Characteristics of the basin

The Czech part of Morava River basin is a natural spatial unit situated at the crossing point of the Bohemian Highlands, the Carpathians and the Pannonia Province. The Morava River and the Dyje River, its dextral tributary, are the major watercourses of the Morava River basin.

The Morava River springs under Kralický Sněžník Mt. in an altitude of 1,380 m above sea level, and flows roughly in the north-south direction across the Mohelnice furrow through the Hornomoravský a Dolnomoravský Grabens, and at the joint Czech-Austrian border it takes the Dyje River, its most important tributary. The Bečva River which takes waters from the western part of the Beskydy Mountains is the most important sinistral tributary of the Morava River.

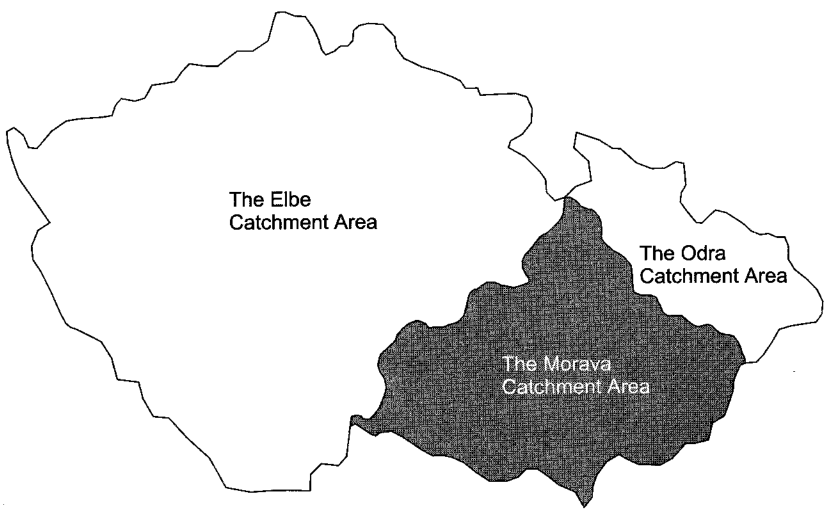


***Fig. 1:** Morava River Catchment Area within the territory of Czechia*

1) The paper was elaborated within the grant project of the CR AS Grant Agency Nr. A3086903/1999.

The Dyje River has two springs: the Moravská Dyje River springing in the Brtnická Highlands in an altitude of 635 m above sea level, and the Austrian Dyje (Thaya) springing in Lower Austria. The Dyje River flows in the west-east direction through the Dyjsko-Svratecký and Dolnomoravský Grabens. The Svratka and Jihlava Rivers draining the Bohemian-Moravian Highlands, the Brno Highlands and the northern part of the Dyjsko-Svratecký Graben are its important tributaries.

Some water-management figures characterizing both partial catchment areas of the Morava River basin

DATA	UNIT	MORAVA UPSTREAM DYJE	DYJE	TOTAL
area of the river basin	km^2	10691	13419	24110
of it on the territory of CR	km^2	9975	11144	21119
average annual discharge	m^3.s^{-1}	65.0	43.8	108.8
total annual run-off	mld m^3	2.05	1.38	3.43
minimum annual run-off	mld m^3	0.86	0.50	1.36
number of water reservoirs, total	N	14	20	34
total volume of water reservois	mil m^3	42.2	526.8	569.0
rate of storage	%	2.2	37.9	18.1
total abstraction of water from surface resources (1995)	mil m^3	86	124	210
total BOD_5 pollution discharged	t.yr^{-1}	2410	6510	8920
of it municipal waste water	t.yr^{-1}	2115	5557	7672
area of put-up irrigation systems	ha	2900	30000	32900

Atmospheric precipitation is the basic water resource for the whole area. Water reservoirs (man-made lakes and ponds) have been largely constructed in the part of the river basin formed by the Dyje River. In the partial catchment area formed by the Morava River, the rate of water storage is very low. Groundwater occurs in limited amounts, and is concentrated in the floodplains of the Morava, Dyje and Svratka Rivers and in other watercourses. The whole water demand for surface water abstraction is covered from water reservoirs on the one hand and directly from watercourses on the other hand. In consideration of the low rate of water storage and the high rate of abstraction of water, the water management balance in the Morava River basin is considerably unfavourable even if, in comparison to the year 1990, the abstraction of water dropped by 5.69 m^3.s^{-1}, id. by 46 %. The total amount of water abstracted in 1995 was 377 mil. m^3, of it 310 mil.m^3 were redischarged, with 279 mil. m^3 being polluted.

Water quality in the watercourses of the Morava River basin is not good. Watercourses are polluted by

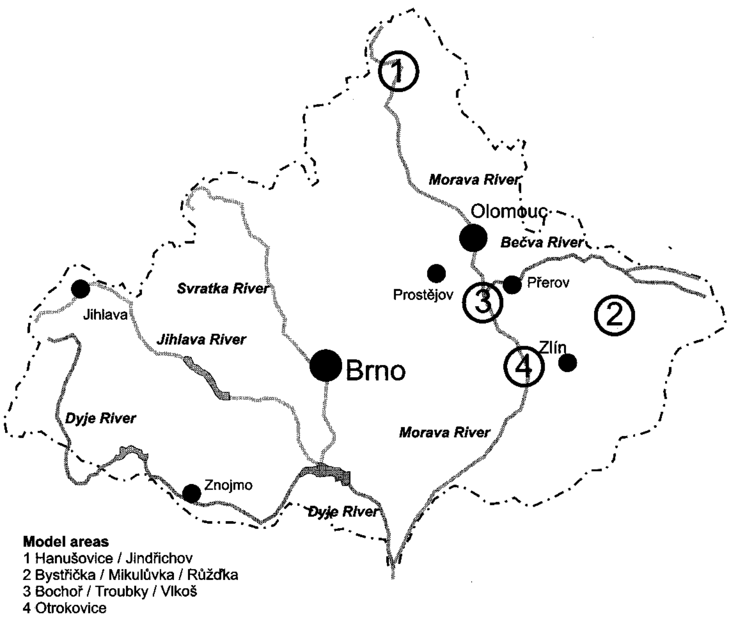


***Fig. 2:** The Czech part of the Morava River Catchment area with the greater settlements.*

discharged wastewater, and in terms of purity, they predominantly fall into Quality Ranges III and IV, with the purity decreasing to Quality Ranges IV and V downstream of big towns. Furthermore, also watercourses with low aqeousness, on which major sources of pollution with insufficient water treatment are located, are polluted to reach Quality Range V. These are: Trkmanka, Litava, Prušánka, Rokytka, Valová, Olšava and Haná. In contrast, Quality Range I only occurs in short sections in spring areas.

The average annual atmospheric precipitation is about 635 mm, with its maximum on Lysá Hora in the Beskydy Mountains (1,150 mm) and the minimum in Břeclav District (450 mm). Thus, the area involved may be ranked among those with average precipitation occurrence, with its southern part belonging to subarid areas. More than 34 % of the area is covered by forest plantations. In contrast, 53 % of the area is made up by agricultural land, with 45 % of it being arable land.

The length of watercourses important in terms of water management is 3,747 km, with the length of other watercourses being about 30,000 km. The most important rivers include:

RIVER	AREA OF THE BASIN (sq.km)	LENGHT OF COURCE (km)	FLOW Q_{100} $m^3.s^{-1}$	FLOW Q_{364d} $m^3.s^{-1}$
Morava	10690.9	284.0	715	5.60
Dyje	13418.7	209.3	867	8.12
Svratka	3998.8	174.0	440	2.17
Jihlava	2998.1	184.4	380	0.54
Bečva	1625.7	157.6	670	1.12
Svitava	1145.8	98.0	181	1.05

The largest man-made lakes in the Morava River basin include:

NAME	WATERCOURSE	IN OPERATION	VOLUME (mil.m^3)	HEIGHT OF DAM (m)
Nové Mlýny	Dyje	1978-89	133.90	9.8
Vranov	Dyje	1934	122.70	47.0
Dalešice	Jihlava	1978	122.20	88.0
Vír I	Svratka	1958	53.10	66.2
Brno	Svratka	1940	18.40	23.5
Mohelno	Jihlava	1977	17.00	38.7
Mostiště	Oslava	1960	11.00	32.7
Letovice	Křetínka	1976	10.58	28.5

In the Morava River basin, there are 2,900 ponds, with their total volume of water being 90 mil. m^3. The Nesyt pond embracing an area of 294.8 ha and having a volume of water of 4.33 mil. m^3 is the largest one.

Significant groundwater resources are to be found primarily in the quaternary fluvial sediments of the Morava, Svratka, Jihlava and Bečva Rivers and in some other areas. Their theoretically exploitable capacity is 8.48 $m^3.s^{-1}$. As a matter of fact, only 5.50 $m^3.s^{-1}$ is made use of.

The Morava River basin has a unique geographical position since all three main bio-geographical units of central Europe meet in it. The western Hercynian biogeographical sub-province meets here with the eastern Carpathian subprovince of the biogeographical province of central European broadleaved forests, with the Panonnian province reaching the southern part of the river basin. Characterized by a diversified relief and a diversified geological parent rock, this unique geographical position results in a diverse mosaic of ecosystems and a high biodiversity.

Within the range of altitudes of 148 m (the confluence of the Dyje River with the Morava River) up to 1,491 m (the Praděd Peak in Hrubý Jeseník Mts.), ecosystems of almost all central European altitudinal vegetation zones are represented: 1. oak, 2.beech/oak 3. oak/beech 4. beech 5. fir/beech 6. spruce/fir/beech and, in the highest altitudes, to some small extent, also 7. spruce and 8.subalpine.

The occurrence some species of submediterranean and pontic-panonnian geoelement on the absolute northern border of the area, such as Fraxinus angustifolia and Leucojum aestivum in floodplain forests, and Crambe tataria, Orlaja gradiflora, Inula oculus-christti etc. in warmer dry ecotypes, are among the significant specific features of biodiversity. Also some perialpine species, such as Cyclamen purpurascend, grow on the northern border of this enlargement. Of the significant animals living in this area, at least the residual populations of Otis tarda and Burhinus oedicnemus must be mentioned, both living in the southern part of the river basin. Here, also Merops apiaster has been spreading in recent years. Floodplain forests in the broad river floodplains are important nesting places of rare birds of prey (such as Milvus migrans and Falco cherrug). Also the sea eagle Haliaeetus albicilla hibernating here in large numbers tries to nest down in this area. The ponds and water reservoirs are important European winter habitats of birds, particularly of various species of geese and ducks. In the last years, the population of the "artificially" released beaver (Castor fiber) has been spontaneously spreading in the broad river floodplain of the Morava River. From the point of view of fauna, the mountainous, more continuously afforested parts of the river basin are also remarkable, among other things for the occurrence of big beasts of prey - lynx (Lynx lynx), wolf (Canis lupus) and brown bear (Ursus arctus), which are coming here from the Slovakian Carpathians. Of the game, the roebuck (capreolus capreolus) and the wild boar (Sus scrofa) occur here in large numbers. In the floodplain and mountain forests, also the European deer (Cervus elaphus) occurs.

In the Morava River basin, the most significant biotops with a high diversity of species and with the occurrence of rare and endangered species of flora and fauna include primarily floodplain forests and wetlands in the broad riverine floodplains. Furthermore, limestone rock cliffs and underground karstic phenomena, valley cuttings in the middle sections of rivers (primarily the rivers Dyje, Jihlava, Svratka and Rokytná) with a very diversified mosaic of ecosystems, nature-close meadows with scattered trees in the Bílé Karpaty Mts. characterized by an exceptionally high biodiversity (primarily of the Orchidaceae family) and forests with a natural composition of tree species ranging from oak groves, beechwoods and fir beechwoods to mountain climax clusters of spruce. Samples of these significant biotops and ecosystems are preserved in a dense network of specially protected areas. In terms of large protected areas, one national park (Podyjí) and 7 protected landscape areas (The Jeseníky Mountains - part of them, The Beskydy Mountains - part of them, The Bílé Karpaty Mts., The Žďár Highlands - part of them, Litovelské Pomoraví, The Moravian Karst and Pálava) may be found in the Morava River basin. In addition, the character of the harmonic cultural landscape is protected in natural parks so that large protected areas make up more than 14 % of the area of the river basin. Within these areas or outside them, 530 locations have been declared to be small protected areas (national nature preserves, national nature monuments, nature preserves and nature monuments), with their total area covering more than 17,000 ha. Two protected landscape areas - The Pálava and The Bílé Karpaty Mts. - have been included in the worldwide network of biospherical preserves of the UNESCO.

The valley floodplain and the valley of the Morava River and its tributaries are natural migration routes of plants and animals. Some of them have been included - as significant European bio-corridors with the appropriate bio-centres of European importance (there are 11 of them in the Morava River basin) - in the European Ecological Network of the UNESCO.

However, the prevailing part of the territory of the Morava River basin is, to a various degree, subject to anthropogenic influences and changes. The forests that would have covered - without man´s interventions - almost the whole area of the river basin take up only one third of it at present. The flat parts of the river basin are almost forest-free, on the contrary, the mountainous parts are almost continuously afforested, with spruce being the prevailing tree species in higher altitudes and pine prevailing in lower altitudes. Natural broadleaved forests have been preserved predominantly in the Carpathian section of the river basin.

Agricultural field landscape prevails in the lowland sections of the river basin, while meadows and pastures prevail in the mountainous parts of the river basin. Numerous orchards may be found especially in the southern half of the river basin, with extensive vineyards to be found in the southernmost part of the river basin.

The main influences and phenomena having negative impacts on the ecosystems in the Morava River basin include:

- continuous breaking of land connected with the liquidation of meadows, pastures and scattered vegetations of tree species and with an intensive application of chemical substances,
- large-scale drainage of wet agricultural land,
- large-scale transformation of originally broadleaved and mixed forests to coniferous monocultures,
- impacts of phytotoxic air pollutants in the mountainous sections of the river basin,
- technical regulations of watercourses,
- construction of water reservoirs in the ecologially most valuable sections of the river basin.

At present, landscape management programmes focus on reducing negative trends which still continue. These programmes include; in particular, the revitalization of water-courses, the establishment of spatial systems of ecological stability, rural landscape revitalization and a new approach to forest management based on preferring natural aspects of forest management.

The landscape in the Morava River basin has been exploited by man since prehistoric times. The lowlands, id. the Dyjskosvratecký, Hornomoravský and Dolnomoravský Grabens, represent, together with the Elbe River area, the most fertile part of the Czech Republic. Intensive agriculture exercised in these regions has

Fig.3: Ripped off rails in Rapotín, Šumperk district, 20 July 1997. Photo: V. Galgonek

significant impacts on water management because of high water consumption including irrigation, intensive large-scale landscape transformation which substantially affects the hydrological regime, and last but not least, because of waste generated by an excessive application of fertilizers and in large-scale livestock operations. During the period of socialism, intensive agriculture expanded into hilly and piedmont parts of the river basin where such form of farming was neither effective nor suitable from the point of view of landscape management.

The basic pattern of cities and towns in the Morava River basin was established in the early Middle Ages. Brno, the biggest city of Moravia, and its agglomeration lie on the Svratka River. The ancient cultural centre Olomouc is located directly on the Morava River, while Zlín, developed by T. Baťa, a renowned entrepreneur of the inter-war period, lies, together with its satellite Otrokovice, on the Dřevnice River and at its mouth into the Morava River. These three urban junctions represent points, which are among the most significant ones in terms of water consumption and municipal waste water production. In addition, there are another three towns with a population of over 50,000 and 12 towns with a population between 20,000 and 50,000 in the Morava River basin. However, a number of rural regions are also typical of the Morava River basin, with a dense network formed by small towns with a population of less than 5,000 being their dominating element. Water consumption and waste water production in these regions are lower, indeed, but the construction of public water supply and sewage disposal systems and waste water treatment plants is financially more demanding.

What is typical of the Morava River basin is the mechanical-engineering manufacturing complemented by the processing of local resources in food, leather and wood-working industries and in the manufacture of building materials. Some of the plants operating in the above-mentioned branches of economy make higher demands on water consumption or they produce more waste water. However, textile industry was the original historical industry of Brno. Heavy industries - metallurgy, chemistry, power engineering - represent, more or less, the result of the so called socialist industrialisation when industrial plants were also located in small towns. The only Czech nuclear power plant as yet in operation is located on the territory of the Morava River basin near the village of Dukovany. The power plant makes use of water for cooling.

From the point of view of transport, Moravia is more or less a through-region. After the split of Czechoslovakia, the western-eastern directions lost their importance, and the traditional north-south and northeast-southeast directions were revitalized. Motorways and railways pass through the territory of the Morava River basin in these directions, with Brno being the main motorway junction and Břeclav the main railway junction (from the international point of view). Shipping has not developed here because watercourses to be found here represent their upper reaches.

The territory of the Morava River basin has also numerous attractive places in terms of recreation and tourist travel. Architectural and historical places of interest, protected areas, cultural and sport events and "undemanding" hiking are also of importance. Intensive recreation has developed primarily at waterworks, with the Vranov and Brno water reservoirs and the Nové Mlýny waterwork being the most important of them. Recreation at waterworks also serves as complementing other recreation and tourist travel activities.

The area of the Morava River basin is among those facing the least serious environmental problems. At the end of the period of planned economy characterized by major environmental problems, the vast majority of Czech areas with strongly degraded environment could be found on the territories of the basins of the Elbe and Odra Rivers. In terms of the whole of the Czech Republic, the only region with strongly degraded environment included part of the Brno agglomeration, namely the so called Posvitavská zone where old industries and residential neighbourhoods built in the period of the industrial revolution were concentrated. Besides air pollution, a high production of waste water manifested itself negatively, with this production reaching values of 4,000 t of BOD_5 annually.

The Lower and Middle Morava River Courses comprising the area from Hodonín to Kroměříž and Olomouc has been also declared an area with disturbed environment. In this area, adverse environmental impacts combine with those produced by the pattern of settlement, industries and intensive farming, the pattern of settlement being characterized by a very high density of municipalities, with numerous medium-sized towns being its dominating element.

In contrast, many regions with relatively little disturbed nature environment occur in the Morava River basin. Many of these regions have large protected areas (national parks, biospheric preserves and protected landscape areas). The Morava River basin is also a region with a relative high level of social control, the lowest incidence of socially pathological phenomena and a high demographic stability.

After 1990, the importance of many industrial, agricultural and municipal sources of pollution substantially decreased since production was reduced and natural resources started to be managed more economically. Problems associated with the rapid development of (individual) car transport got bigger. Not the quantity but the structure and the hazardous nature of harmful substances are becoming an issue of common concern as a result of new technologies being applied not only in industries but also in municipal management (packaging, washing and cleaning technologies etc.).

The major environmental problems faced by the region of the Morava River basin include particularly:

- complex impacts of large urban agglomerations, in particular Brno, Olomouc, Zlín-Otrokovice and, to some extent, also others, resting in the concentration of humans, their activities, industrial production and transport,
- complex impacts of large-scale farming operations, with these impacts manifesting themselves more and more in the most productive areas; these impacts include, first of all, unfavourable large-scale landscape management, mass application of chemical substances and the liquidation of significant segments of greenery,
- rapid development of individual transport, and the shifting of traffic streams from ecologically more favourable modes of transport onto roads.

As of 1 January 1996, Czech Republic had a population of 10,321,344 and this number decreased to 10,309,137 as of 31 December 1996. The latest data for villages are available as of 1 January 1996. As of this date, the territory of the Morava River basin had a population of 2,778,168 [2)], which makes up 26.9 per cent of the total population of the Czech Republic. The average population density in the Morava River basin is 131 inhabitants per square kilometre, which corresponds with the national density average.

The following towns with a population of over 20,000 inhabitants in 1996 can be found on the territory of the Morava River basin:

Brno	390,000	Kroměříž	30,000
Olomouc	105,000	Hodonín	29,000
Zlín	83,000	Valašské Meziříčí	28,000
Jihlava (part)	52,000	Uherské Hradiště	28,000
Přerov	51,000	Břeclav	27,000
Prostějov	50,000	Vyškov	23,000
Třebíč	40,000	Blansko	21,000
Znojmo	37,000	Otrokovice	20,000
Vsetín	31,000	Hranice	20,000
Šumperk	31,000		

2) The actual calculation based on the data for villages; in consideration of the fact that the boundaries of villages are not always identical with those of the river basin we shall continue to use the round data of 2.78 mil.

Of the 2.78 mil. inhabitants of the Morava River basin, 1,679,905 mil. of them, that is 60.47 per cent, lived in urban municipalities [3] in 1996. From the point of view of water management, the difference between central and marginal regions is very important since the individual regions may differ not only in the standard of public utilities available in municipalities but also in the provision of households with articles of long-term consumption. However, the most significant differences may be observed in municipalities with a population of 500. Generally, it is stated that it is not effective to build public water supply systems, public sewage disposal systems and classical waste water treatment plants in municipalities with less than 500 inhabitants.

In 1991 [4], 391,756 citizens of the Morava River basin lived in municipalities with less than 500 inhabitants (14.3 % of the total population) and 113,858 citizens lived in municipalities with less than 200 inhabitants (4.2 % of the total population). Since then the number of inhabitants in the smallest villages has been decreasing, on the other hand, however, some settlements tend to fall into this category. Therefore, the available figures may be, more or less, accepted as relevant also for the present-day state.

2. Disastrous Floods in the Morava River Basin in the Summer of 1997

As stated in our journal (Munzar,J. et al., 1997), in the summer of 1997, the Morava River basin (together with the Odra River basin and, to some smaller extent, the Elbe River basin) in the Czech Republic was hit by extreme floods. During 6 days in early July of 1997, $3.10^9 m^3$ of precipitation fell on the territory of Moravia and eastern Bohemia. The Morava River basin (excluding the Dyje River basin but including the Svratka River, a tributary to the Morava River) was among the most severely hit. These intensive rains caused an extreme run-off. As a result of this run-off, the values of centenary water were substantially exceeded in numerous places. The flood came very quickly especially in small river basins while Břeclav came under threat by the flood wave only eight days after the rains had set in.

According to the latest official estimations, the damage totals CZK 62.6 bil. (about US 1.7 bil.), with 538 towns and villages having been affected and 49 people having lost their lives. 2,151 flats have been completely destroyed, 5,652 flats have become uninhabitable for a long period of time and 11,000 flats have been damaged. About 10,000 people have become homeless. Furthermore, 25 railway bridges, 13 railway stations, 946 km of railways, 51 road bridges and 592 km of roads have been destroyed or severely damaged. About 2,000 km of roads have become non-passable. About 100,000 telephone stations have been completely destroyed or put out of operation temporarily. About 100,000 ha of agricultural land have been flooded, with the crop having been completely destroyed. 291 pieces of beef, 2,928 pigs, 20 horses, 200,000 pieces of poultry, 31,232 small domestic animals etc. have perished. Drinking water resources have been damaged or destroyed and waste water treatment plants flooded. The floods have also resulted in numerous landslides destroying or damaging other buildings and roads. Many damaged industrial plants have lost their buildings, machinery, output and raw materials. Many of their employees have lost their jobs. As a result, the national revenue has been much lower since fewer taxes have been paid to the treasury. Losses of psychological nature can hardly be calculated.

Anthropogenic interventions carried out in the landscape in the last centuries, particularly in the last 40 years, have undoubtedly contributed to the course of the floods and their implications. These interventions primarily include the following ones: intensification of farming, some melioration measures, the damaging of forests resulting in the decline in their water retention capacity, alignments and regulations of watercourses, the disrespect for flood control in the constructing of buildings and roads and the like. There are disagreements in terms of the importance of hydraulic structures, in particular man-made lakes that objectively retained flood waves in many places.

It may be assumed that the 1997 floods are not likely to reoccur in the near future. Nevertheless, each further hydraulic structure in the Morava River basin will have to consider the issues of flood risks.

The summer floods in Moravia and Silesia in 1997 opened a question of the relation between extreme climatic and hydrological situations on one part, and the landscape on the other. What actually was the share of contemporary landscape management methods in the course and consequences of the floods? What was the significance of big technical works on water courses? What landscape management measures should be adopted in the future: should we rather rely on technical solutions, or should we return to natural processes, and to what extent this would be realistic at all? The direct consequences of floods were summarized. The counts of victims, financial losses, material losses, counts of killed animals, value of destroyed crops are known. However, what are the effects of floods, their consequences and following measures on present

[3] The statistical definition of the city (town) is not used in the Czech Republic since it has lost its sense. Municipalities that have acquired the legal status of a city (town) are considered to be cities (towns).

[4] In consideration of the fact that for parts of municipalities only data are available that have been collected for the census, some older data have been used for the purposes of this analysis.

Fig.4: A flooded village near Otrokovice, 12 July 1997. Photo: V. Galgonek

lives of people and functioning of afflicted seats? Is it truth that the psychological and moral losses after these disastrous events can have a much more serious long-term impact than the direct losses on health and property? There is practically no experience in this country with floods of the extent as in 1997. This is understandable since local people have not met with the phenomenon within historical times.

Intensive technical discussions have taken place, focusing mainly pragmatic solutions of the post-flood situation. There are severe disputes between water management experts who prefer measures of technical character and nature protectionists who prefer the effort aimed at a return to the natural functioning of water ecosystems and landscape. Yet, in the background of all these discussions, there is often the financial side of the problem: who will acquire the funds for the future flood control measures? Arguments are very often one-sided. Although the events of similar character and extent are not probably to be repeated in real time, all activities in the landscape within the reach of potential danger must be sized to the risk. The afflicted areas where losses are still far from being fully recovered might be very sensitive even to disasters of much smaller extent and different nature.

There is no doubt that the anthropogenic intervention made in the landscape during the recent centuries contributed to the course and consequences of floods. Let us just mention the consequences of agricultural production intensification, some reclamation measures, damage to forests and worsening of their retention capacity, straightening and regulation of water courses, non-respecting flood protection at building objects and communications, etc. The disputes also concern the significance of waterworks, particularly dam lakes which could hold the flood waves at many a place.

The flood manifestations in floodplains as well as the effects of slope movements in catchment areas were investigated in the second half of 1997 by hydrologists, water management experts, quaternary and engineering geologists. The relevant institutions obtained partial information about the changes in the landscape (e.g. Morava Catchment Area, T.G. Masaryk Research Institute of Water Management, Czech Hydrometeorological Institute, Czech Geological Institute). Departmental research reports were worked out which assessed the flood situation and included sets of corrective measures for the future. Nature protection institutions of the Czech Ministry of Environment such as the Agency for Nature and Landscape Protection, Headquarters of protected landscape areas and national parks assessed the manifestation of high precipitations and floods with regard to nature and landscape protection. District councils of afflicted areas made inventories of basic changes to be able to figure losses in the given district. A number of private companies such as Hydroeko Brno, Fontes Brno took part in the processing of hydrological consequences after floods in floodplains, partial floods in Moravia (e.g. the catchment area of Rožnovská Bečva). The assessment of flood consequences was also contributed to by a voluntary association Union for the Morava River Brno, which processed the flood results in the catchments of Morava and Odra from the viewpoint of claimed losses and introduced alternative environmental measures to be used in the case of future floods.

3. The Grant Project "Floods, Landscape and People in the Morava River Catchment Area"

We can state that there is a whole lot of partial knowledge about the manifestations of extreme rainfall and flood in 1997. Yet, the chain of events, their coherence and links among individual physical and geographical landscape components (relief, biota) have not been studied so far. Relations between the landscape physico-geographical (natural) components and socio-geographical components (population, settlements, industries and traffic) which were impacted and disturbed by the floods and slope movements have not been studied either.

Unlike the Elbe River catchment area, there are no documents available up to now, which would make it possible to compare with floods and their effects before 1900. And this is exactly from where flood measures adopted in for example Germany, Switzerland or Italy are derived: it is always the study of reconstructed catalogue of historical floods - dated a couple of centuries back. According to the preliminary orientation survey, the very first records about floods in the Morava catchment area originate in the 13th century; more detailed entries date back to the 16th century. This means that it should be feasible to attempt at a documentation of historical floods for a time period of 400 - 500 years, as it is common today in EU countries.

The Brno Branch of the Institute of Geonics, Czech Academy of Sciences solves in the years 1999 -2002 the grant project No. A3086903 Floods, Landscape and People in the Morava River Catchment Area in the period of 1999 -2002. The project does not aim at the study of flood-related technical and water management problems. It aims at a complex expression of the relation between the extreme floods and the landscape. The authors wish to contribute to the knowledge of functions of the present landscape including settlements and technical works at floods and at the liquidation of their consequences. Another objective should be our opinion to possibilities of future landscape management with regard to the risk of floods as well as to the human aspect of the issue. Yet another new aspect should be flood losses which cannot be expressed in money, economic or moral terms. The authors would also like to try to test a hypothesis originating from the research of other large-scale accidents and disasters (such as Nuclear Power Station Chernobyl) which claims the socio-psychological consequences to be in long-term view much more serious than the immediate losses.

The authors consider the historical-geographical aspect to be equally important. In terms of their extent, the floods of 1997 were apparently the most extensive floods in the historical times. However, they were not the only extraordinary floods occurring in this country. Unlike in the Elbe catchment area, this historical aspect has not yet been properly studied and assessed. What was the manifestation of these events at times when the landscape transformation has not yet reached the present stage? This question can only be answered by the historical geographical research.

From the viewpoint of natural systems, the floods can primarily be considered hydrological or climatic phenomena. And there are many exact data on these aspects. Yet, the authors would like to focus on the relation of floods to the landscape as a whole, a partial objective being the processing of physical and geographical characteristics such as relief and biota in valleys and floodplains afflicted by the floods as well as that of slope deformation effects in the physical a geographical sphere of the landscape. The studies are going to be made to reveal correlations in the valley bottom-valley slope system within reliefs and the aspects between dynamic effects of flood processes, relief and biota on new formations. Another goal will be to find out correlations with the socio-geographical sphere of the flood-affected landscape on the basis of physico-geographical characteristics.

Use will be made of the already existing information from departmental institutions as well as from the district and municipal councils on flood consequences in the area of interest. This will be followed up by the field research with methods of detailed geomorphological and biogeographical mapping of delineated model areas. The model areas will be defined as follows: Šumperk district (Hanušovice-Jindřichov) on the upper reach of Morava River, Vsetín district (Růžďka, Mikulůvka, Bystřička - destruction of settlement by slope deformations, Bečva floodplain, links between new formations of relief and biota), the middle and lower reach, catchment parts of Bochoř, Troubky, Vlkoš (Přerov district) and Otrokovice (Zlín district) - studying mutual relationships between some physico-geographical components and the socio-economic sphere.

An entirely unknown sphere are human aspects of floods and post-flood situation. The authors will not concentrate on the direct consequences that have been expressed numerically (although the figures are being cast doubts upon today). They would rather focus on the present situation in regions and seats most affected by floods. The time offset is very suitable. At the time immediatelly following after the floods, some surveys were made into a problem. However, the human aspects seem to be coming to the surface only now when the issue is not given prior attention any more. The human aspects in the affected areas and seats can be classified into several problem groups as follows:

- The course of bringing new life to the most affected villages; (does the jeopardy and impact lead to co-operation or rather to the protection of individual concerns; what is the role and behaviour of municipality, individual associations, people, what are stages of this process and the prospects for the nearest future);
- The renovation of housing resources; (what are the chances of people without shelter or with heavily damaged houses, what motivation do they have to build a new house in the same locality or elsewhere, what should be done with old people for whom the building of a new house is not realistic any more, was the destruction of some parts in the village a new impuls to find better solutions of housing problems);
- The renewal of infrastructure, manufacturing facilities and agricultural land resources (what are social impacts of damaged facilities - unemployment, availability, loss of earnings, what is the motivation for the renewal of these facilities, etc.);
- Socio-psychological aspects; (how the consequences of the specific people's behaviour under stress situations show with the time offset of several years, how the flood consequences reflect in the citizen's attitudes, what are socio-pathological phenomena, what is the weight of social losses in the whole structure of flood losses);
- The opinion level as related to the future life in localities under the flood danger; (where the inhabitants can see the causes of serious flood losses, do they take the government assistance for sufficient, how do they see their own financial and other participation at the liquidation of losses, what measures would they prefer in order to prevent extreme consequences of floods in the future, etc.).

The authors do not intend to express in figures the flood consequences or flood control measures. Neither they plan to map them in detail in all regions and seats. They will rather focus the understanding of mechanisms occurring in the flood-affected areas. Several model regions or seats are going to be chosen for the purpose, - usually those ranking with the most affected in the Morava River catchment area and in the partial catchment of Bečva. Research methods will correspond with the set objectives: field research and observation, methods of behavioural geography, controlled interview and public inquiry. Results of these methods will be complemented with the analysis of "hard" data available (investments, unemployment, health aspects and the like). The sense of research is a monitoring of flood consequences in the mentioned spheres and its evaluation. This is why the authors expect a multi-fold implementation of the circle: designation of the issue - field research - evaluation - generalization and designation of new problems. A considerable part of the work is going to be the concise assessment of natural and social aspects of floods and their manifestations in actual landscape.

References

BUČEK, A. - MIKULÍK, O. (1990): Geosystémová diagnóza a prognóza životního prostředí. Geografický ústav ČSAV Brno. 212 pp.

HLADNÝ et al., (eds.) (1998): Vyhodnocení povodňové situace v červenci 1997. Ministerstvo životního prostředí ČR Praha. 163 pp.

MUNZAR, J. - ONDRÁČEK, S. - TÁBORSKÁ, J. (1997): Disastrous floods in Moravia and Silesia in July 1997. MORAVIAN GEOGRAPHICAL REPORTS 5, 2, p. 44-59.

VAISHAR, A. (1998): Danube Pollution Reduction Programme. MORAVIAN GEOGRAPHICAL REPORTS, 6, 1, p. 61 - 62.

VAISHAR, A. (1999): Floods in Moravia 1997 and Regional Development. In: Regional Prosperity and Sustainability. REGIOGRAPH Brno, p. 192-200.

Authors´ addresses:

RNDr. Antonín Vaishar, CSc. et al.
Academy of Sciences of the Czech Republic
Institute of Geonics, Branch Brno
P. O. Box 23
613 00 Brno, Czech Republic
e-mail: vaishar@geonika.cz

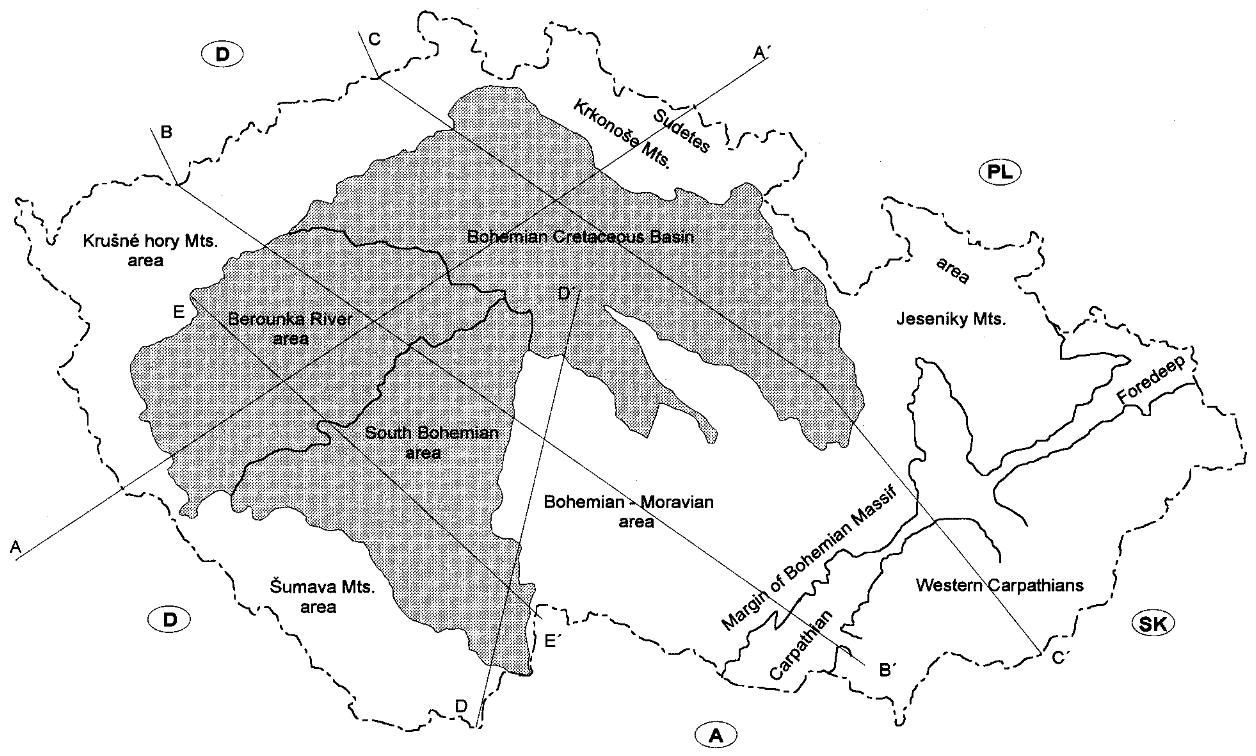
Reviewers:

Prof. RNDr. Jozef MLÁDEK, DrSc.
RNDr. Alois MATOUŠEK, CSc.

GEOMORPHOLOGICAL ASPECTS OF THE LATE SAXONIAN EPIPLATFORM OROGENY OF THE BOHEMIAN MASSIF (PART 2) *)

Antonín IVAN

Geomorfologické aspekty mladosaxonské epiplatformní orogeneze a zdvihu



The position of the Bohemian Basin (grey) and its three parts situated in the Czech Republic (Ivan, 1999)

7. The macroregion of marginal elevations: Main morphostructural features

7.1 Two types of marginal morphostructural elevations

The rhomboid of marginal elevations embracing the Bohemian Basin forms a wall which partly doubles (Hromádka, 1956). The outer side of the wall mainly opens into the subdued relief; it is only in the South-West and South-East that the wall is accompanied by the narrow Alpine and Carpathian Foredeeps. The arrangement of elevations is a consequence of the rejuvenation of faults running along the major tectonic directions, ie. NW-SE (up to WNW-ESE), which can be seen in the longer and higher elevations of the Šumava Mts. and Sudeten Mts., and NE-SW (up to ENE-WSW) which includes the lower and shorter Krušné hory Mts. and Bohemian-Moravian elevations. From the morphostructural point of view, however, a disctinction into the southern, Moldanubian, Šumava and Bohemian-Moravian elevations which altogether form the great South Bohemian System (Hromádka, 1956) - see Table 1 (Ivan, 1999 - Part I), and the northern, Saxothuringian, Krušné hory and Sudeten elevations would be more appropriate. The basement of the southern elevations is more consolidated and their topography in which the dome-like features prevail over the block-faulted features lacks the Upper Paleozoic and younger platform sediments at higher altitudes. The less consolidated northern elevations have a more complex dominating block-faulted topography

*) Part 1 see Moravian Geographical Reports No 1/1999.

with the Carboniferous, Permian and Mesozoic sediments occurring even in strongly uplifted parts. It is only the eastern part of the Bohemian-Moravian elevation that is beyond this framework.

The division of morphostructural elevations is in principle identical with the regional geomorphological regionalization of the Czech Republic (Czudek, ed., 1972). The Zábřežská vrchovina (Highland) and the Mohelnice Furrow (components of the Sudeten System in the quoted regionalization) call for a further discussion. In our opinion, the Zábřežská vrchovina (Highland) is closer to the Bohemian-Moravian elevation (the Brno subsystem) from the morphostructural point of view while the Mohelnice Furrow rather belongs to the Hornomoravský úval (Graben). The first mentioned unit with its geological structure (Devonian and Lower Carboniferous in the Drahany development) and the block-faulted topography with circular features is nearer to the Drahanská vrchovina (Highland). A morphostructural boundary with the Sudeten elevation is the important Bušín Fault connecting the Mohelnice and Králíky Furrows. The Mohelnice Furrow in the NNW continuation of the Hornomoravský úval (Graben) appears a mirror reflection of the Králíky Furrow in the southern end of the Kłodzko Basin. This concept suits better the comprehension of the Hornomoravský úval (Graben) as a double graben, which is further supported by new geological data indicating that the furrow is filled with Miocene and Pliocene sediments (Růžička, 1989) suggesting a connection with the Carpathian Foredeep.

The topography on the contacts of rhomboid sides is very complicated with depressions and elevations on the crossing of weakened zones. Particularly on both ends of the Šumava Mts. elevation, there are broad depressions significant as transport routes leading into the heart of the massif (the Lužnice and Ohře Rivers). Corresponding orographical elevations to alter the direction of important watershed lines are the Novohradské hory (Mts.) in the SE and the Smrčiny (Mts.) in the NW. The complicated contact of the Krušné hory (Mts.) and Sudeten Mts. elevations marks the crossing of the Ohře rift and Elbegraben with the Lusitanian faults along which subsided the Upper Paleozoic and Upper Cretaceous deposits (comp. Mattern, 1996), drawn into the uplift of the Krušné hory (Mts.). The fault crossing gave rise to the large Zittauer Basin and to the lesser pronounced orographical knot of the Lužická pahorkatina (Hilly Land).

7.2 Morphostructural features of southern marginal elevations

The angle of the longer axes of the Šumava and Bohemian-Moravian elevations is nearly 90° with a contact point being the orographical knot of the Novohradské hory (Mts.) (partially in the SSW-NNE direction). The elevations are in contact with the both young orogenes: the longer one of the Šumava Mts. with the East Alps, the shorter Bohemian-Moravian elevation with both the West Carpathians and the East Alps. With the exception of the eastern part of the Bohemian-Moravian elevation and the NW part of the Šumava elevation, the two elevations are built of the Moldanubicum, the oldest, most consolidated and almost cratonized part of the Bohemian Massif, for which the term of "weak shield", originally used by Klein (1974) for the Massif Armorican would be appropriate. The two elevations are characteristic of their absence of the Upper Paleozoic and platform sediments and the common largest Variscan granitoid intrusion of the Bohemian Massif, the Central Moldanubian Pluton with two horseshoe-shaped branches - the western branch of the Šumava Mts. elevation in the SE-NW direction, and the eastern Bohemian-Moravian one in the SSW-NNE direction in whose axial and at the same time summit parts the Main European Divide of Danube and Elbe is situated. The Pluton is mostly unroofed in the southern parts of the area, on the orographical knot of the Novohradské hory (Mts.) where the two branches join meet.

The south-western and south-eastern margins of the Bohemian Massif were exposed to orogenic stresses of the Alps and Carpathians from the Upper Cretaceous. The stresses gave rise to flexures and forebulges complicated by cross and strike faults. The young flexural uplift of the southern edge of the Šumava elevation is a probable cause to the isolation of the South Bohemian Basins from the Alpine Foredeep. In general, the southern systems are dominated by the anticlinal uplifts of large radius, complicated by faults. The north-eastern and north-western slopes of the Šumava and Bohemian-Moravian elevations facing the Bohemian Basin, respectively, are low and gentle, being determined by the young bend deformations of crystalline rocks.

7.2.1 The Šumava marginal morphostructural elevation

The core of the elevation is formed by the Šumava (Mts.) - in German Böhmerwald - and the Bavarian Forest (Bayerischer Wald), which are accompanied by the Novohradské hory (Mts.) - the Weinsberger Wald in Austria - in the SE, and by the Český les and Oberfälzer Wald in the NW. The Šumava elevation is the most compact, strongly uplifted and domed part of the Bohemian Massif. It is one of the less geomorphologically explored parts of the Bohemian Massif.

In the Šumava Mts. are strongly elevated remnants of planation surfaces (1200-1400 m) whose very old origin (pre-Upper Cretaceous) cannot be excluded. In the SW, the Šumava Mts. decline towards the Bayerischer Wald with an up to 300 m high fault scarp along the rejuvenated Bavarian Quartz Lode (Pfahl), which again falls as a high piedmont with its tectonic scarp on the Danube Fault (overthrust?) into the Alpine Foredeep. It was this position why the Bayerischer Wald was originally called the "balcony of the Hercynian

Europe" in the relation to the Alps (Désiré-Marchand and Klein, 1987).

A young NE tilting of the Šumava Mts. is assumed along the rejuvenated faults trending NW-SE (the Bavarian and Bohemian Quartz Lodes) that could have been analogical to movements occurring in the final stages of the Variscan orogeny. The tilt, suggested by the diminishing of the Blanice Furrow in the SSW direction, contributes to the gradual transition of the Šumava Mts. into the Bohemian Basin. In the Šumava elevation we can therefore judge on a repeated tilting to the NE and a deeper denudation on its SW side.

The faults in the NW-SE and NE-SW directions predetermined a rectangular drainage pattern in the Bayerischer Wald, with erosion basins and hydrographical knots, which disabled any direct consequent drainage into the Danube River. In the NE, the Šumava Mts. slowly and with sporadic fault scarps melt into the piedmont. With the exception of the upper Vltava River flowing through the predetermined Vltavice Furrow (reverse fault?), the Blanice River and the Křemelná River whose direction is parallel with the longer axis of the Šumava Mts., the eastern part of the elevation has a dendritic drainage pattern, suggesting an uplift of rather the dome-type.

Interesting are the ring structures on granitoids (Sedmihoří) and granulites (Blanský les Mts. in the SE part of the Šumava Mts.). The latter are considered to come into existence on the basement of a double (40 km thick) crust, and are interpreted as tectonic intrusions (Vrána and Štědrá, eds., 1997). The ring structures are influenced by block tectonics and by margins of the České Budějovice Basin, Kaplice Furrow and Lhenice Graben. Šrámek and Mrlina (in Vrána and Štědrá, eds., 1997) mention the geophysically proven vertical movements of the Prachatice Granulite Massif to the depth of 8 km.

The NW continuation of the Šumava Mts. is the Český les (1042 m) and the Oberpfälzer Wald, both partially formed by the Saxothuringicum which is geologically close to the Teplá-Barrandian area with the Late Variscan granitoid massifs. Denudation of the Late Variscan Falkenberg granite (age approx. 310 Ma) whose original thickness was 9 km amounts to about 3 km. The SW edge of the Oberpfälzer Wald is on the contact with the Mesozoic sediments of the South German Block dominated by thrust faults of the Franconian Lineament and by the Amberg and Luhe cross faults. A superdeep KTB borehole (9101 m) in the Saxothuringicum revealed heavy intraplate deformations with block dislocations and with repeating metamorphites on the large post-Variscan, probably Mesozoic overthrusts which at the same time suggest a strong post-Cretaceous uplift (ca. 3 km, younger than 100 Ma, Zulauf and Duyster, 1997).

The Upper Cretaceous at the western edge of the Cham-Furth Senke depression suggests a theoretical possibility of the transversal connection of the Franconian Cretaceous with the Bohemian Cretaceous Basin. In the East, the Český les Mts. gradually inclines down to the Cheb-Domažlice Graben, delineated by the Bohemian Quartz Lode and the West Bohemian Ductile Zone along which the Moldanubicum was rapidly uplifted during the Upper Carboniferous (Zulauf, 1994). The Oberpfälzer Wald and Smrčiny represent a classical area for the development of piedmont benchlands in the conception of W. Penck. Neither the KTB borehole results nor the fission track dating (Bischoff et al., 1993) did not corroborated the theory and rejected any attempts at its rehabilitation (Désiré-Marchand and Klein, 1987). A decisive role in the development of the topography was played by block tectonics.

7.2.2 The Bohemian-Moravian marginal elevation

It has a lesser absolute height than the Šumava marginal elevation, a more complicated geological structure, a more subdued topography which contrasts also with other marginal elevations. The lesser height results in the opening of the whole ring of marginal elevations to the East. The structural complexity follows out of the influence of two orogenies, ie. the Variscan orogeny and the Alpine orogeny with the opposite vergencies (Stráník et al., 1993). The Variscan nappe structure with tectonic windows is confirmed also by the latest research (Jaroš, 1991). The elevation has the following two subregions: the south-western subregion formed by the Moldanubicum and Moravicum, and the north-eastern subregion of the Brunovistulicum. A boundary between the two subregions is the Boskovice Furrow with the Diendorf Fault stretching in the NNE-SSW direction, which is cut through by the Dulkesteiner Wald on the southern bank of the Danube River.

7.2.2.1 The subregion of the Bohemian-Moravian Highland and Waldviertel

The relief combines the influence of the Late Variscan faults in the NNE-SSW direction on which the asymmetrical furrows (Boskovice, Blanice and short Jihlava Furrow) came into existence with the dislocations in the NW-SE to WNW-ESE directions that delineate the course of the Danube River in the South and the southern edge of the Bohemian Cretaceous Basin between Kolín and Letovice in the North. Due to the threshold block near Amstetten the subregion is in a close contact with the East Alps in the South, while having a much looser relation to the West Carpathians in the South-East owing to the broad Carpathian Foredeep.

Fundamental parts of the subregion are the Bohemian-Moravian Highland and the Waldviertel. The diminishing Carboniferous and Permian fill of the furrows towards the SSW (as a consequence of a larger uplift

Fig.6: *Prepared trachyle laccoliths of the Bezděz Mt. (604 m) and the Malý Bezděz Mt. (587 m) on the contact of the Ralská pahorkatina (Hilly Land) and the Jizerská tabule (Plateau). Photo: B.Balatka*

in the end of the Variscan orogeny) and the general inclination towards the East result in the highest relief in the South and West.

The Bohemian-Moravian Highland has no larger individualized central parts and it very gradually slopes down from the altitudes of about 700 - 800 m to those of 250 - 400 m at the massif margin, distant some 70 km. However, the slope continues towards the South-East for about 60 km under the deposits of the Carpathian Foredeep and the Flysh Carpathians with the generalized eastward slope gradient being less than 1°.

The topography of the western part of the Bohemian-Moravian Highland involves granites of the Central Moldanubian Pluton whose N-S axis is rather tightly followed by the Main European Divide, and the Rastenberg granite in the Třebíč Pluton. The rocks of the metamorphic mantle exhibit sporadic inselberg type elevations (Svatá hora Mt., 679 m). In the northern part of the Pluton, there are isolated blocks of Čeřínek (761 m) and Melechov (709 m) on fine grained to moderate grained Eisgarn granite, so far interpreted as horsts. According to the latest research (Breiter et al., 1998), however, they are - in the comparison with the surrounding granites - younger and more homogeneous circular-shaped structures forming deep seated stocks. A ring structure of probably Upper Paleozoic age from the vicinity of Pelhřimov was described by Vrána (1990). The Variscan nappe structure dominating in the structure of the eastern part of the highland is not apparent in the topography. In this part of the Bohemian-Moravian Highland, there are extensive remnants of etchplain (locally of escarpment character) at the formation of which marine processes participated, too. It is a very complex polygenetic landscape whose several parts (such as on the wedge-shaped block of the Železné hory Mts.) are remnants of the exhumed pre-Upper Cretaceous planation surface. The remainders of kaolinic weathering products are at some places thicker than 100 m (Kužvart, 1965). Sporadic Miocene duricrusts form a hill near Lažánky above the depression with kaolins, thus suggesting a young relief inversion. The eastern edge of the massif has planation surfaces incised into up to 250 m deep canyon-shaped valleys of the Dyje and Svratka Rivers (Ivan and Kirchner, 1995).

7.2.2.2 The north-eastern subregion of Brněnská vrchovina Highland

The heterogeneous topography of the Brněnská vrchovina (Highland) is characterized by an ever tighter contact with the West Carpathians in the NE direction. The subregion consists of four parts as follows:

1) The Boskovice Furrow is a narrow halfgraben (NNE-SSW) filled with Carboniferous and Permian and partially also with Miocene marine deposits. The

central part of the furrow forms a cross threshold (Žernovník horst) where the planation surface passes from the crystalline rocks onto the Carboniferous and Permian deposits (Ivan, 1996). Northwards of the threshold the furrow is crossed by the asymmetrical Blansko Graben (NNW-SSE) filled with the subsided Upper Cretaceous sediments. These sediments were partially denuded before the Lower Badenian, which gave rise to a wide depression (Svitava River Paleovalley?) filled with Miocene calcareous clays laying over the Carboniferous and Permian sediments (Jurková, 1975). The remnants of Cretaceous deposits form the bottom of the Blansko Graben or conspicuous buttes (relief inversion). The complicated tectonic development shows in the thrust of the Brno massif over the Cretaceous sediments (Melichar and Hanžl, 1999). The southern part of the Blansko Graben used by the Svitava River has a blind end southwards of Blansko; however, the river continues through a 30 km long gap in granite up to the very margin of the Bohemian Massif in Brno. The narrower southern part of the furrow is characterized by the transversal drainage pattern with the valley gaps of Svratka and Jihlava R. (Hrádek, 1995, 1998).

2) The block relief of the Bobravská vrchovina Highland(478 m) on heavily faulted to mylonitized rocks of the Brno Massif is characteristic of a double graben of the Brno Basin with the central horst (Ivan, 1992b) which is a NW continuation of the Nesvačilka graben. The basement surface was deeply denuded as early as in the Devonian and repeatedly buried and exhumed since that time. Any other essential basement surface degradation did not occur. The Brno Basin is a morphostructural knot partially used by the rivers of Svitava and Svratka, with numerous partial grabens and tectonically predisposed valleys with the Miocene sediments thick over 200 m. Some horsts in the Brno Basin were remodelled into karst inselbergs (Panoš, 1964). In the Brno Basin , there are also subsided blocks of Jurassic limestones.

3) The NE part is the Drahanská vrchovina Highland (735 m) consisted of folded Devonian and Lower Carboniferous sediments, which are cut by the pre-Upper Cretaceous planation surface. It is a young dome morphostructure (Hrádek and Ivan, 1974), accompanied on sides with smaller fault blocks. In the belt of the Moravian Karst Devonian limestones, there are numerous fossile karst forms including deep sinkholes filled with Mesozoic reworked tropical weathering products. The narrow subsided blocks of Jurassic sediments on the western margin of the highland suggest pre-Upper Cretaceous extensional tectonics. In the eastern part of the highland in the valley of the Rakovec brook, there is a small and much discussed graben structure with the filling by Miocene sediments.

4) The Zábřežská vrchovina Highland (714 m) is in geological terms a component of the Sudeten System. However, as far as its morphostructure is

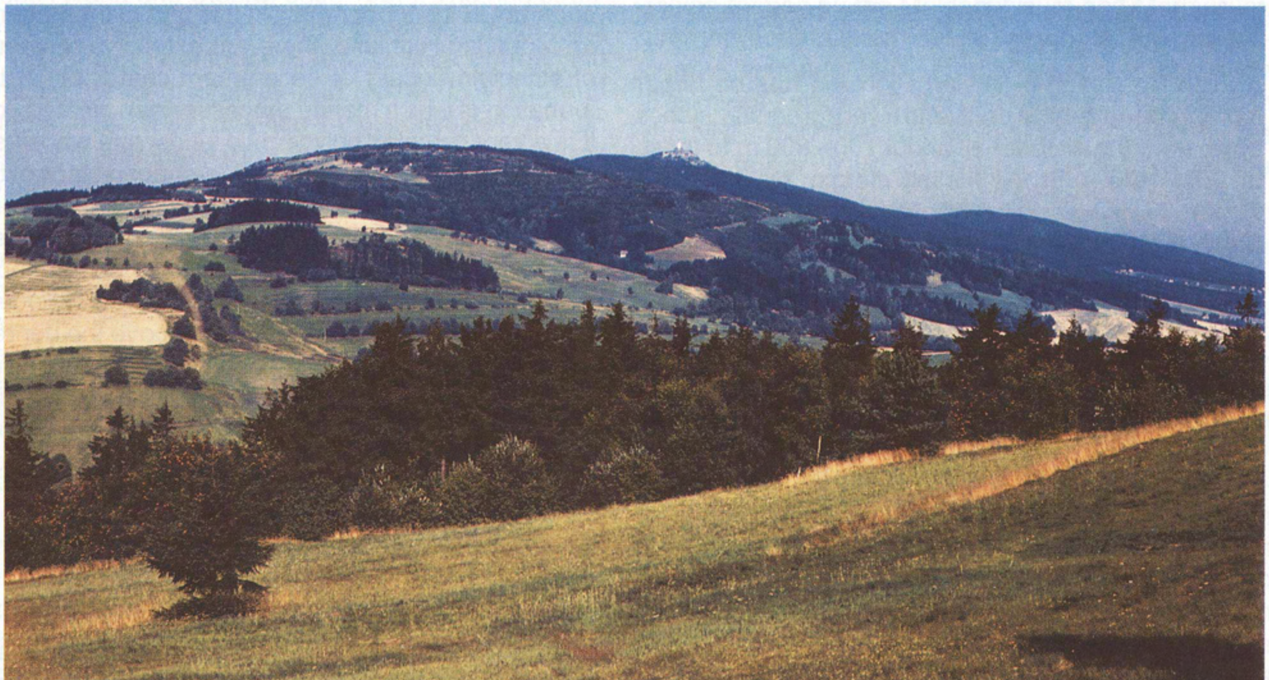


Fig.7: The anticlinalridge Ještědský hřbet: an uplifted narrow zone of Paleozoic rocks and their Permian and Cretaceous cover at the Lusatia Fault. Photo: B.Balatka

concerned it rather belongs to the Brno Highland (see Chapter 7.1). It is formed by folded, weakly metamorphed Lower Carboniferous sediments (slates, greywackes). It is an anticline horst with pronounced dome features, which separates the Bohemian Cretaceous Basin from the Hornomoravský úval (Graben) that -as a part of the Carpathian Foredeep- reaches far into the Bohemian Massif in the NW. The N-S axis of the Zábřežská vrchovina (Highland) is in the continuation of the Drahanská vrchovina (Highland) axis. With the regard to this axis, the direction of fold structures in the Bohemian Cretaceous Basin (NNW-SSE) appears oblique. In the northern summit part (Maletín), there is a denudation remnant of the Cretaceous sediments, suggesting a possible connection of the Bohemian Cretaceous Basin with the eastern foreland of the Bohemian Massif. Features of the highland interesting from the point of its morphostructure are the transversal valley gaps in the W-E direction and the ring structures also suggested by the valley pattern.

7.3 Main morphostructural features of northern marginal elevations

The Krušné hory (Mts.) and the Sudeten (Mts.) elevations whose axes contain the angle larger than 90° do not have (with the exception of the eastern termination of the Sudeten Mts.) any direct contact with the Alpine-Carpathian orogene. As compared with the southern elevations, their basement is younger and their topography more complex and heterogeneous. The metamorphic Proterozoic and Paleozoic sediments and granitoid rocks are accompanied with the folded Variscan molasses, platform Mesozoic deposits and neovolcanites. The Variscan nappe structure is today resolved from the viewpoint of plate tectonics. A joint orographical knot of the northern elevations is the Lužická pahorkatina (Hilly Land). Its low altitude probably relates to the crossing of the Elbe Lineament and the Ohře Rift.

7.3.1 The Krušné hory (Mts.) morphostructural elevation

The elevation is one of geomorphologically well explored parts of the Bohemian Massif (Král, 1968). Its main SW-NE tectonic direction was determined by the pre-Variscan tectonics characterized by a complicated dome uplift with the axis of the same direction, accompanied by a heavy denudation (according to Škvor, 1983, some 13 km). The prevailing part of the denudation must have occurred prior to the intrusion of the Variscan Plutons. The elevation can be characterized by gradual passes toward the neighbouring units - the Bohemian Basin in the ESE, a large block known as the Lower Saxony intraplate tectogene (Illies and Grainer, 1976) in the NW, separating the Bohemian Massif from the Rhenish Massif. The originally large block with asymmetrical doming disintegrated into the following three parts due to the Tertiary block-faulting:

a) The NW highest part, formed in the Krušné hory Mts. and the Smrčiny Mts. mainly by crystalline rocks and by Upper Cretaceous sandstones in the Děčínská vrchovina (Highland).

b) The central subsided block with the Ohře Rift and with several separate tectonic and/or erosional basins, partially filled with the Tertiary deposits combined with brown coal and neovolcanic rocks.

c) The SE block, formed by both the crystalline rocks of the Slavkovský les (Mts.) and the Tepelská vrchovina (Highland), and by the neovolcanites of Doupovské hory (Mts.) and České středohoří (Mts.).

7.3.1.1 The north-western block

The Krušné hory (Mts.) - an asymmetrical horst with the gentle slope up to 40 km long stretching in the NW direction and with the planation surfaces so far interpreted as Piedmonttreppen (see Büdel, 1977) and newly rejected in the Smrčiny Mts. (Désiré-Marchand and Klein, 1987). Important are Carboniferous and Permian deposits and Upper Cretaceous sediments both in the summit parts and in the Elbegraben (Mattern, 1996). The most marked form is a young fault scarp of the Krušné hory (Mts.) facing the Ohře Rift, studied in the connexion with the intensive open mining of brown coal at its foot (e.g. Rybář, 1998). In the Upper Paleozoic the large Krušné hory Pluton with partial plutons of Karlovy Vary and Smrčiny intruded (see Vrána and Štědrá, eds., 1997). According to Klomínský and Dudek (1978), the Krušné hory Plutons represent an example of shallow bodies intruding in the zone of fracture tectonics. Some examples indicate that the pluton was covered only by its own ejecta. The youngest part of the pluton is formed by the Teplice porphyry connected with the Altenberg caldera. All these features suggest a small depth of the post-Variscan denudation. A problem of the younger development is the extent of the Upper Cretaceous marine transgression and its interconnection across the summit area of the Krušné hory (Mts.) with the sea in Saxony.

7.3.1.2 The Ohře Rift

The Ohře Rift is the most pronounced young linear morphostructure of the Bohemian Massif on whose rift origin do not exist unequivocal opinions (see e.g. Mísař et al., 1983). The rift origin was documented mainly by V. Kopecký (1978). The relatively narrow rift developed on the system of three parallel faults and is discontinued by the stratovolcano of the Doupovské hory (Mts.) and by the České středohoří (Mts.). The Rift is not a uniform graben but a series of more or less independent basins (Cheb, Sokolov and Most Basins) interconnected by the Ohře R. valley. An inseparable part of the Ohře rift issue is the SE fault scarp of the Krušné hory (Mts.). The undulating course of its foot

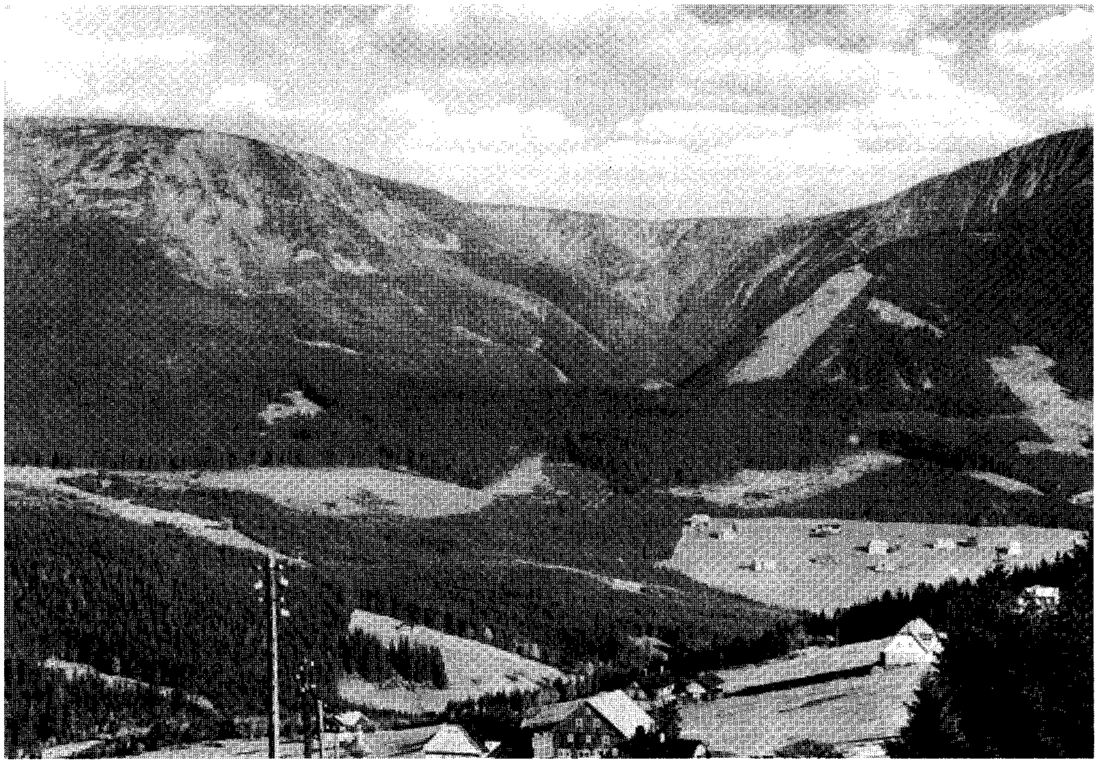


Fig.8: *The Krkonoše Mts., Pec pod Sněžkou. A view from the South into the glacial cirque Obří důl with the Studničná hora Mt. to the left and the Sněžka Mt.to the right. Postcard from the archives of B.Balatka*

and the very variable cross profile provide evidence of the origin; however, no listric faults have been yet found which are characteristic of the rifts (see Summerfield, 1991). The NE volcanic part of the rift has no fault scarp on the eastern side.

The development of rift structures in the Variscan Europe in response to the collision of Euroasia and Africa plates in the foreland of the Alpine orogeny showed a sporadic volcanic activity as early as in the Uppermost Cretaceous (e.g. Illies and Greiner, 1978; Jowett, 1991). Also, the considerable age of the pre-rift volcanism in the Bohemian Massif suggests its relatively early origin with the radiometric age of some neovolcanic rocks being 77 or 65 Ma (Vokurka and Bendl in Vrána and Štědrá, eds., 1997). Of several volcanic stages in the Bohemian Massif the most important one was that of the Oligomiocene (37-17 mil. years). The rift origin is further supported by the crust thinning (although lesser than in other West-European rifts) and by the evidence of an extensive elevation of the sublithospheric asthenosphere reaching here from the area of the Rhenish Massif. According to Zeman (1978), the elevation development could have been accompanied by a regional downsinking of the crust, documented by the Upper-Cretaceous sediments. The issue of active or passive rifting is still opened; it seems however that the sedimentation in the basins of the Ohře Rift was simultaneous with the volcanic activity in the majority of cases. We assume that the Ohře Rift most probably came into existence rather through the passive rifting at which volcanism in the connexion with the mantle doming and the thermal uplift played an important role while the en bloc uplift of the whole elevation most probably occurred later. The development of rift basins was to the various extent influenced by cross and strike faults and by the type of sedimentation. These were the reasons for a rather differentiated development of the topography in the respective basins. The underlying rock of the largest Most Basin contains partially the Carboniferous and Permian deposits and partially the Upper Cretaceous sediments whose continuity with the Bohemian Cretaceous Basin was discontinued by the development of the České středohoří (Mts.). The sedimentation development of the Most Basin is characterized by fluvio-limnic cones with the beginning of the limnic sedimentation in the basins being dated in the Eocene (42 Ma). A critical survey of issues of the chronostratigraphical division of the Tertiary basins in the western Bohemia was made by Malkovský (1995). The issue of the development of the Ohře River valley in the Most Basin was last discussed by Tyráček (1995) who mentions a total of 25 accumulation terraces (after Balatka and Sládek, 1976). According to their opinion, the represent the most comprehensive terrestrial record concerning the end of the Tertiary and older Quaternary in Central

Europe. However, regarding the fact that the tectonic zone is young, immediately called into question is the general validity of the terrace height scheme in this area and its significance from the viewpoint of the general uplift of the Bohemian Massif. The development of the Cheb Basin with the most conspicuous block features, youngest sedimentary filling, volcanism and seismic activity relates first of all to the reactivation of the Mariánské Lázně Fault (NNW-SSE) on the eastern side of the basin. The movements resulted in the partition of the Ohře River and in the formation of a river lake. The doming of the southern edge of the Ohře Rift is well seen from the asymmetrical position of the divide between the Ohře and Mže Rivers, closely to the SE edge of the basin (Kynžvart saddle, 604 m).

7.3.1.3 The Slavkovský les (Mts.) and neovolcanic mountains

The SW part of a very heterogeneous lower wing of the Krušné hory (Mts.) elevation asymmetric anticline which borders the Ohře Rift in the South-West is formed by the crystalline rocks of the Slavkovský les (Mts.) and Tepelská vrchovina (Highland), whilst the NE portion is formed by the neovolcanites of the Doupovské hory (Mts.) and České středohoří (Mts.).

The Slavkovský les (Mts.) is a mosaic of smaller blocks uplifted into different levels. The most intensive faulting occurs in the vicinity of the crossing between the Ohře Rift and the Cheb-Domažlice Graben. At some places the rocks of the Karlovy Vary Pluton show a typical granite relief with structurally conditioned inselbergs at different stages of development (Špičák, 827 m; Chrudim, 838 m) and there are also sporadically occurring inselbergs on serpentine (U tří křížů, 817 m) and neovolcanites. The line of Podhorní vrch (847 m), Hůrka (817 m) and Uhelný vrch (772 m) probably delineates the Litoměřice Deep Fault. The granite tectonics also shows in the drainage pattern and in the development of river valleys.

Above the step-like scarp of the Mariánské Lázně Fault high up to 300 m, there are the highest blocks of the Slavkovský les (Mts.). In the SW, the fault scarp delineates the markedly asymmetrical Cheb-Domažlice Graben with a negligible filling of young sediments (in contrast to the Ohře Rift). In geomorphological terms the graben belongs in the Podčeskoleská pahorkatina (Hilly Land) which is a part of the Šumava system. The floor of the Cheb-Domažlice Graben exhibits a prevailingly subdued, erosion-denudation relief, partly on younger granites of the Karlovy Vary Pluton (similarly as the scarp on the Mariánské Lázně Fault). In the valley of the Lipoltovský brook, there are forms of granite weathering near the Kynžvart Castle, suggesting the development towards inselbergs.

The Slavkovský les (Mts.) inclines very gently (flexure?) towards the Teplická vrchovina (Highland) which geologically ranks with the Teplá-Barrandian area. In the transition area there is a zone of the higher relief in the approximately SW-NE direction on the rocks of the Mariánské Lázně metabasite complex. The Mariánské Lázně Fault passes into mica schists in the Tepelská vrchovina (Highland), in which the fault scarp is lower and spreads into several parallel branches used by the asymmetrical tributary valleys of the Kosový Brook that further on to the SE cross the fault scarp along an antecedent valley.

In the close NE vicinity of the Slavkovský les (Mts.), there is a relatively dissected stratovolcano of the Doupovské hory (Mts.) (diameter ca. 30 km) that reaches into the left bank of the very narrow Ohře River valley in the NW. Separate lava sheets cover the eastern slopes of the Krušné hory (Mts.). The Doupovské hory (Mts.) have a radial drainage pattern dividing the structural surfaces on the lava flows and nappes due to erosion. The Doupovské hory (Mts.) stratovolcano produced 122 km^3 of volcanic rocks as compared to 52 km^3 of these products from the České středohoří (Mts.) (Vokurka and Bendl in Vrána and Štědrá eds., 1997). A new piece of knowledge is the occurrence of neovolcanite table-shaped bodies on the contact of crust and mantle, which came into existence through the process of underplatting.

A detailed analysis of Tertiary volcanic activity was made by Hradecký (in Vrána and Štědrá, eds., 1997) who found out lahars and pyroclastic flows in radial arrangement as an important component of the stratovolcano and presumed the repeated explosive Plinian type eruptions. The denudation remnants of lahars in radial valleys are the manifestation of relief inversion. In addition to the main eruption centre with the crater near Doupov-Nivy, there were other smaller centres with eruptions of Strombolian and Hawaiian types.

In the NE continuation of the Doupovské hory (Mts.), there is the considerably larger České středohoří (Mts.), formed by a great number of separate neovolcanic residual hills of varying petrographical composition and different stages of denudation, which in terms of morphostructure form a tectono-volcanic horst. The horst is separated from the Doupovské hory (Mts.) with a low and flat Žatec Basin (the southern part of the Most Basin) whose relief is partly on the Upper Cretaceous sediments. The intensive denudation of volcanic rocks in the České středohoří (Mts.) was facilitated also by the little resistant Upper Cretaceous and Miocene deposits. The geophysical research revealed that the Doupovské hory (Mts.) developed on the faults of WSW-ENE direction while the České středohoří (Mts.) on the dislocations of NW-SE direction (Malkovský et al., 1985) whose significance for their morphology is rather secondary, however. The feature most probably relates to the fault crossing of the Ohře Rift and the Elbe lineament. The SW-NE movements which gave the České středohoří (Mts.) their horst character were also the cause to the rise of the antecedent Elbegraben valley (Kalvoda and Balatka, 1995). The valley deepening in the Upper Pliocene and Quaternary is over 170 m.

7.3.2 The Sudeten marginal morphostructural elevation

The geologically and geomorphologically most complex elevation of the Bohemian Massif consists of three vaguely separated parts. The higher West Sudeten with the dominant Krkonoše Mts. (and their highest point of the Bohemian Massif - Sněžka Mt., 1602 m) and the East Sudeten (Hrubý Jeseník Mts. - Praděd, 1490 m and Králický Sněžník, 1423 m) are interposed with the disputable lower Central Sudeten (the Orlické hory Mts. with Deštná, 1115 m in the SW and with the Góry Sowie Mts. and Wielka Sowa, 1014 m in the NE), originally representing a transversal Upper Paleozoic and Cretaceous depression. A common characteristic of the West and Central Sudeten is their sialic basement, appurtenance to the Lugicum (metamorphed Lower Paleozoic sediments, Cadomian and Variscan granitoids), and the morphologically conspicuous subsided Fore-Sudetic block. The basement of the East Sudeten is simatic, belonging to the Brunovistulicum (metamorphed Upper Paleozoic). The Sudeten structure is interpreted as a nappe structure. Recent interpretations follow out of the plate tectonics, oblique collision, and distinguish several terranes (see e.g. Cymerman and Piasecki, 1994). An extensional collapse occurred towards the end of the Variscan orogeny (e.g. Mazur, 1998). The West and Central Sudeten decline to the South into the Bohemian Basin while the transition to the Central European Lowlands in the North is facilitated by a subsided Fore-Sudetic block. The northern slopes of the East Sudeten fall directly to the Central European Lowland (partly on the Opole Cretaceous) the southern foreland being formed by the block of the exposed basement of the Brněnská vrchovina (Highland). The West and Central Sudeten are crossed by the Elbe-Odra divide and the East Sudeten by the Danube-Odra divide. A typical feature of the Sudeten Mts. are numerous intramontane basins. The later development is characterized by young volcanism. The northern parts of the Sudeten were in the Pleistocene modelled by continental glaciation which reached far into the South in the Kłodzko Basin.

7.3.2.1 The West and Central Sudeten

The morphologically important dislocations are of the NW-SE to WNW-ESE direction with the Lusatian, Inner-Sudetic and Marginal Sudetic Fault. A very marked southern edge of the West Sudeten forms a fault scarp on the Lusatian overthrust, delineating the anticlinal Ještědsko-Kozákovský hřbet (Ridge) on the contact with the Bohemian Basin. The block uplift on the northern side of the Krkonoše Mts. and Jizerské hory (Mts.) bears upon the main Inner-Sudetic Fault. At the northern foot of the Krkonoše Mts., there is the Jelenia Góra Basin with a typical granite relief, deep weathering products and inselbergs (Migon, 1997). The northern foreland also includes the narrow North-Sudetic Depression in the NW-SE direction where the thickness of the Upper Cretaceous deposits amounts to 1300 m (Milewicz, 1997). A young overthrust was found in the Orlické hory Mts. (comp. Cymerman, 1990). During the Upper Cretaceous the area of the Central Sudeten was flooded by a sea separating the West-Sudetic and East-Sudetic islands. A great part of the Central Sudeten is formed by the Carboniferous and Permian deposits and Mesozoic sediments of the Inner-Sudetic depression of the NW-SE direction, ending in a brachysynclinal closure in the NW and by smaller brachystructures in the SE. The synclinal attitude led to the development of cuestas and relief inversion. The core of the uplift structure is formed by the crystalline rocks, the syncline wings are of Mesozoic, Triassic and mainly Cretaceous sediments. In the post-Cretaceous period a tectonic uplift of both Carboniferous and Permian, and Cretaceous rocks occurred, whose height was nearly 1000 m. The Wielki Szczeliniec (Mt.) built y Cretaceous deposits in the Polish part in the Góry Stolowe (Mts.) reaches the height of 919 m and the Hejšovina (Mt.) in the Czech part has the height of 828 m. The Permian porphyry of the Královecký Špičák (Mt.) in the Broumovská vrchovina (Highland) was uplifted into the height of 881 m. The northern edge of the Central Sudeten is formed by the block of Sowie Góry (Mts.) with very old rocks close to the Moldanubicum. The fault scarp situated on the Marginal Sudetic Fault is the highest in the Sowie Góry (Mts.) with very young features (Migoń, 1993).

An important dislocation is the Hronov-Poříčí Thrust Fault. The southern margin of the Central Sudeten is formed by the Orlické hory (Mts.) on the southern slopes of which the Cretaceous sediments reach the height of up to 600 m, whose removal led to the exhumation of the pre-Upper Cretaceous planation surface. Another important structure of this part of the Sudeten Mts. is the Orlice-Kłodzko Dome, divided by the Kłodzko Basin filled with the Upper Cretaceous sediments. The eastern part of the Dome belongs in the East Sudeten. The denudation of the Cretaceous sediments in the axial part of the uplift resulted in relief inversion. The Cretaceous sediments crop out in the southern narrow part of Kłodzko Basin, Králíky Graben. Malkovský (1979, Fig. 16) pointed out the resemblance of the basin with the rift structures (aulacogen?). The basin is delineated by overthrust faults. The character of the filling suggests synsedimentary uplift movements (comp. Jerzykiewicz, 1971). Maximum thicknesses of the Cretaceous sediments are to be found in the constricted and blind-end southern portion of the basin (Králíky Graben). The southern part of the graben is drained towards the South into the Morava River, the central part towards the West into the Elbe River, and the northern part towards the North into the Odra

River. The Sowie Góry (Mts.) are partitioned from the unique inselberg of Sleza (718 m) by a depression filled with sediments whose thickness amounts to 600 m (Grocholski, 1977). The Paczkow graben (Dyjor, 1983) in the foreland of the Rychlebské hory (Mts.) is of a similar structure. In the Žulovská pahorkatina (Hilly Land), there is a inselbergs topography on Late Variscan granites (Ivan, 1983), surprisingly with no traces of the rock relief having been modelled by the continental glaciation. Morphologically important are neovolcanites both in the Czech Republic and in Poland (e.g. Cwojdziński and Jodłowski, 1982) and kaolinic weathering products (Kužvart, 1965). The Fore-Sudetic block in the SE ends with the Žulovská pahorkatina (Hilly Land), and further to the East, there is a flat relief of the Middle Polish Lowland on the deeper subsided Paleozoic rocks that is partly covered with the Opole Cretaceous in the northern foreland of the Zlatohorská vrchovina (Highland) and the Nízký Jeseník Mts. The Cretaceous sediments are cut by deep paleovalleys filled with Miocene sediments and stretch in the SE direction into the Carpathian Foredeep (Kotański and Radwański, 1977).

In Sudeten, Jahn (1980) and Walczak (1968) drew up a concept of the mountain uplift proceeding in stages with three levels of planation surfaces of different ages.

7.3.2.2 The East Sudeten

The geological and geomorphological boundary between the Central and East Sudeten Mts. is not unambiguous and is usually located into the Kłodzko Basin or into the Ramzová saddle. The boundary in the Kłodzko Basin ranks with the East Sudeten the eastern half of the Orlice-Kłodzko Dome, i.e. inclusive the Králický Sněžník (Mt.) and the Rychlebské hory (Mts.). However, the Kłodzko Basin bends into the NW-SE direction and does not disturb the continuity of the southern margin of the Sudeten. This means that the scarp on the Marginal Sudetic Fault continues undisturbed to the Rychlebské hory (Mts.). The scarp topography changes only on the crossing with the Ramzová thrust (Ivan, 1997), and across the Hrubý Jeseník (Mts.) and Nízký Jeseník (Mts.) the dislocation exhibits features of a fault valley or those of a fault-line valley. The transition character of the area between the Kłlodzko Basin and the Ramzová Saddle calls for a further morphostructural research and discussion. The East Sudeten have a very tight contact with the West Carpathians on their SE side. The block of Maleník (479 m), partly covered with a flysh nappes in the Miocene and partitioned from the Nízký Jeseník Mts. by a young graben of the Moravská brána (Czudek and Dvořák, 1989), is the only part of the Bohemian Massif integrated into the structure of the West Carpathians.

The East Sudeten have a western and south-western higher crystalline part and a lower southern and south-eastern part that mainly consists of the Lower Carboniferous sediments and its character is rather that of a piedmont. The East Sudeten begin in the West with the orographical knot of the Králický Sněžník Mts. (1423 m) on whose SW spur (Klepý Mt., 1119 m) the watershed divides of Danube-Elbe, Danube-Odra and

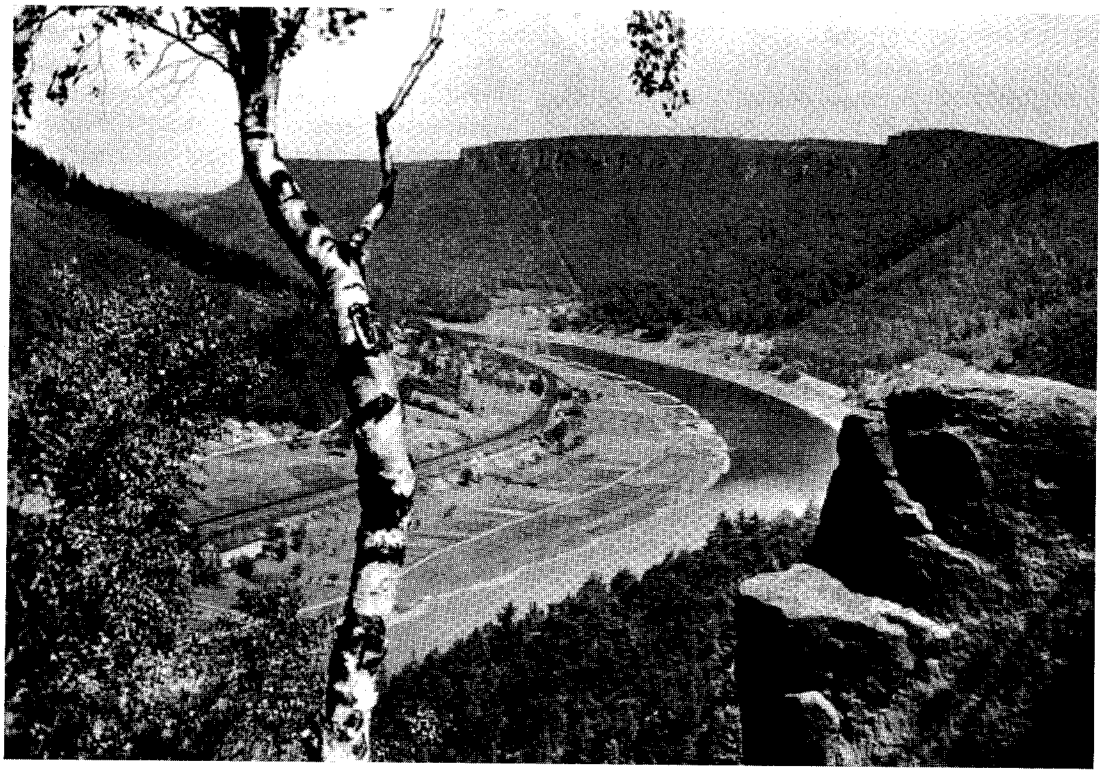


Fig.9: The Elbe River canyon in the Upper Cretaceous sandstones of the Děčínská vrchovina Highland. Postcard from the archives of B.Balatka

Elbe-Odra have their contact point. The block structure of Hrubý Jeseník Mts. is well characterized by the rectangular drainage pattern of the main water courses with marginal tectonic slopes and dome-like features. The young tectonic structure is interpreted as a result of faulting the uniform planation surface (Demek, 1971). Height differences of planation surface remnants are considerably greater on high blocks than on lower ones (e.g. in the Nízký Jeseník Mts.). The size of intramontane basins is lesser than in the West and Central Sudeten. The denudation reached the lesser depth and granitoid bodies are only weak unroofed (Šumperk Pluton) with exception of the Žulová Pluton.

The topography is characterized by intensive faulting along the young faults of NW-SE direction (transversal to the main SSW-NNE direction of the Variscan structure) and the older dislocations of the SW-NE direction. With the exception of the Králický Sněžník (1423 m), the high blocks form the Rychlebské hory Mts. (1125 m), the Hrubý Jeseník Mts. (1491 m), and the Zlatohorská vrchovina Highland (974 m, in Polish Góry Opawskie). The highest parts are formed by old crystalline domes, the eastern wing of the Orlice-Kłodzko Dome in the Králický Sněžník Mts., and the Keprník and Desná Domes in the Hrubý Jeseník Mts. The postulated nappe structure is not unambiguous. An important feature of the Variscan and younger block movements was the tectonic inversion which manifests in great differences of block denudation (Pouba and Mísař, 1961). The movements of opposite tendencies occurred also in younger periods and on the Marginal Sudeten Fault in the Rychlebské hory Mts.(Oberc, 1967). Towards the East and South the crystalline ocks pass into slightly metamorphic Lower Carboniferous sediments which form the Hanušovická vrchovina Highland (1003 m) and the Nízký Jeseník Mts. (800 m) with the topography in general gently sloping to the South and East.

The southwestern piedmont of the Králický Sněžník Mts. and Hrubý Jeseník Mts. is broader than the northern piedmont, and gently slopes to the South. Regarding the absence of the Fore-Sudetic block, the Nízký Jeseník Mts. can partly be considered an eastern and southern piedmont of the Hrubý Jeseník Mts., developed on the crossing of the Sudeten and Brno elevations. It partially concentrates the drainage into the Hornomoravský úval (Graben) and into the Carpathian Foredeep. The cross faults exhibit unimportant occurrences of Pleistocene neovolcanites. The relief is typical of intensive faulting, especially in the Hanušovická vrchovina (Highland) with the tendency of developing blocks into inselbergs.

8. Discussion on the issue of the Bohemian Massif post-Upper Cretaceous uplift

a) The development of the very heterogeneous Bohemian Basin in the central part of the Bohemian Massif, which forms a so called "mountain basin" structure, has been unjustly and neglected issue. Another problem - the post-Cretaceous uplift of the marginal elevations has to be resolved both as related to the orogeny in the East Alps and West Carpathians (in the Moldanubian elevations), and in the relation to the development of rift structures and young volcanism (in the Saxothuringian elevations). These are multidisciplinal complex issues whose final solution will call for a cooperation with other experts, particularly in geophysics.

b) Some aspects of the genesis of the extraordinary complex Bohemian Basin were mentioned in Chapter 6. It is to be presumed that the development of this large and unusually situated depression has a relation to the late Variscan extensional collapse. The related rock deformations were described from various parts of the Bohemian Massif (Lobkowitz et al., 1994; Schulmann et al., 1994; Mazur, 1997; Zulauf et al., 1997). Most probably due to the collapse, the denudation depth of the Bohemian Basin was lesser at these places than in the marginal parts of the massif, which could be evidenced by numerous Carboniferous and Permian basins and by the preservation of Paleozoic sediments as a roof pendant of the Central Bohemian Pluton. A stable core of the Bohemian Basin is the Teplá-Barrandian area in which the Paleozoic sediments represent a record of numerous transgressions and regressions, showing a tendency to the repeated burial and exhumation of the relief (manifestation of conservative isostasy?; Vrána and Štědrá, eds., 1997). The young uplift of the Bohemian Basin within the uplift of the whole Bohemian Massif suggests a fact that the basin floor on the contact with the marginal elevations is apparently higher than the foot of these elevations on the reverse side. The latest relief development is characterized by the exhumation of the pre-Cretaceous planation surface that most probably induced a mild isostatic uplift indicated by a occurrence of river terraces (e.g. Balatka and Sládek, 1962; Balatka, 1992). The vertical span of the Quaternary terraces in the Bohemian Basin is 100-120 m. The issue of terraces in river gaps is discussed in Kalvoda and Balatka (1995). Nevertheless, the use of the terraces to assess the uplift must be very careful (Semmel, 1991). According to Machatschek (1927), the hydrographical changes in the eastern part of the Bohemian Basin suggest a relative sinking of the basin floor. The changes in the direction of the Vltava River in southern Bohemia (Balatka and Sládek, 1962) most probably relate to the orogeny in the East Alps.

c) The two types of marginal elevations have different basements, a different relation to the area of the Alpine-Carpathian orogeny, and the character of their uplift is apparently also different. A greater coherence between the uplift of the Bohemian Massif and the Alpine-Carpathian orogeny is assumed

Fig.10: The granite isolated hill of Kapucín in the north of the Plzeňská pahorkatina (Hilly Land) with the weathering forms and rock degradation. The marginal scarp of the Čistá-Jesenice granite massif in the background. Photo: B.Balatka

in the southern Moldanubian elevations on the basis of a direct contact with the quasiparallel parts of the East Alps and West Carpathians, despite the fact that their basement is older and more consolidated. The differences between the Šumava and Bohemian-Moravian elevations are interpreted as a partial response to the different character of the uplift in the East Alps and West Carpathians, and it can be expected that they played a certain role in the uplift. Particularly the Moldanubian basements of the Šumava elevation and the western part of the Bohemian-Moravian elevation, reinforced with numerous Variscan granitoid massifs, exhibited a trend to the long-term (secular) uplift. The eastern part of the Bohemian-Moravian elevation with the basement belonging to the Brunovistulicum is situated on a simatic block with the weaker tendency to uplift. These elevations miss any larger areas of platform sediments, young volcanites or diminishing volcanic activities such as CO_2 springs. Other features are low thermal flow and very low seismicity. Presumably, the entire post-Variscan and post-Cretaceous crustal uplift in the southern elevations was greater than that in the northern elevations.

d) On the other side, the basement of northern Saxothuringian elevations is younger with a considerable extent of metamorphic and non-metamorphic Paleozoic sediments including the Carboniferous deposits. Particularly important are the Mesozoic sediments, especially the Upper Cretaceous. Some intramontane depressions have also the Miocene sediments. The granitoid massifs (Cadomian - Lusitanian and numerous Variscan Plutons) are of a lesser extent and nearly missing in the East Sudeten. The young volcanites and greater thermal flow are bound to the Bohemian-Silesian neovolcanic arc. Higher seismicity relates to young block-faulting. With the exception of the termination of the Sudeten elevation, the Saxothuringian elevations do not have a direct contact with the Alps and Carpathians but reach higher absolute heights. It seems that the post-Cretaceous uplift of the northern elevations relates to young volcanism (underplatting?). The uplift perhaps started later but was more rapid with the topographic uplift being greater than in the southern elevations.

e) The great differences in the height and topography of the Šumava and Bohemian-Moravian elevations are preliminary put into connexion with the differences in the structure and strength of the Moldanubian and Brunovistulian basement. The differences induced different reactions in the development of the West Carpathians and East Alps. These structural differences between the tectonics of young mountains were first stated by Andrusov (1968) and later by Trümpy (1973). The West

Carpathians exhibit a conspicuous orogenic polarity (Jiříček, 1979). The more consolidated Moldanubicum blocked the movement of the Alps towards the North while the heavily disturbed Cadomian Brunovistulicum most probably enabled the escape of the West Carpathians towards the North in connexion with the rotation of Carpathian-Pannonian blocks in the Neogene thus facilitating the thrusting of flysh nappes of the Carpathians onto the platform foreland. According to Krzywiec and Jochym (1997), the two orogens went through the different types of subduction (in the sense of Royden). The West Carpathians show rather signs of retreating subduction which is characterized e.g. by a shallower distubance of the basement, lower relief (and hence weak erosion), and the rise of extensional ackarc basins (in our case the Pannonian basin) on the thrusting plate, while the East Alps rather exhibit signs of advancing subduction with a more pronounced compression, deeper disturbance of the basement, higher relief, and more intensive erosion. It is to be presumed that the so called effective lithosphere elasticity thickness in the Moldanubicum is greater than in the Brunovistulicum when the above quoted authors mention its thickness in the westernmost parts of the Polish Carpathians (with the Brunovistulicum basement) of 8 to 16 km. The orogeny in the East Alps was much stronger than the orogeny in the West Carpathians with the nappe structure showing a strong compression, a much stronger uplift and deeper denudation (the tectonic window of Hohern Tauern).

f) The subsided eastern part of the Bohemian Massif forms basement of the whole West Carpathians up to the Peripienian lineament, considered as subduction zone. According to Roth (1980), the Outer West Carpathians are not an independent lithospherical block but an elongated rootless allochtone. The same author claims (Roth, 1978, p.350) that the marginal part of the Bohemian Massif on the contact with the Carpathians "had experienced since the Late Cretaceous more conspicuous and more differentiated vertical movements than other parts of the platform". The young tectonic movements in the foredeep are complicated and include a horizontal component, too (Vyskočil and Zeman, 1980). The margin of the Bohemian Massif in the SW Moravia originated in the Eocene (Seifert, 1992). The Brunovistulicum exhibits severe tectonic disturbances by longitudinal and cross faults (whose conspicuous manifestation are double grabens such as the Hornomoravský úval /Graben/ and the Brno Basin) and is gradually covered with sediments of the Carpathian Foredeep and with nappes of the Outer West Carpathians towards the East. The topography of the margin of the Bohemian Massif forms a complicated subdued flexure (Hrádek, 1998) which is partitioned into large blocks with the buried subaerial relief by the cross faults. The foredeep is 5 to 40 km wide. In central Moravia, oil and gas are mined from the deep crystalline weathering products. In the Ostrava Basin, the Miocene sediments trans-

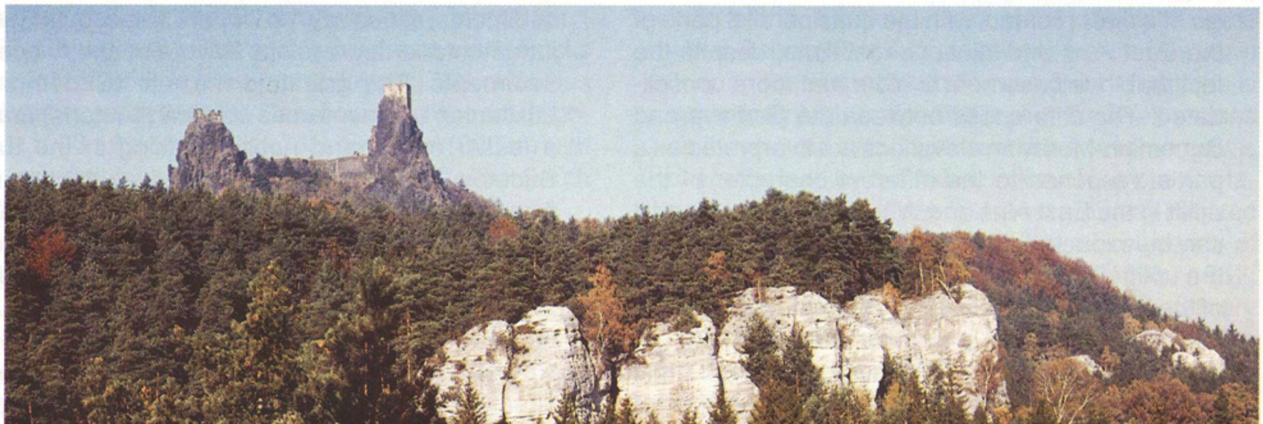


Fig.11: A prepared basalt vein of the Trosky Mt. (514 m) in the Turnovská pahorkatina (Hilly Land). The Apoleniny skály (Rocks) of Coniac sandstones in the middle. Photo: B.Balatka

gressed on a denudated front of the flysh nappes. The remnants of the buried etchplain on the Variscan consolidated basement are dissected by up to 1500 m deep paleovalleys filled with the Miocene sediments. The existence of the buried etchplain is suggested by red beds interpreted as the remnants of deep weathering products. Their thickness amounts up to 230 m and they sporadically reach down to 600 m below the paleorelief surface (Dopita et al., 1997). Of the Šumava marginal elevation a direct contact with the Alpine foredeep can be seen in the Bayerischer Wald with conspicuous scarps on the system of Danube faults. The foredeep gets narrower towards the East. The greatest sediment thicknesses are found closely before the front of the Alps (Lemcke, 1984; Zwiegel, 1998). Between the northern front of the Alps and the SW edge of the Bohemian Massif, there is a buried horst elevation of Landshut-Neuöttinger in the Alpine foredeep (Lemcke, 1984), approximately parallel with the edge of the Bohemian Massif, from which some 1000 m of Mesozoic rocks were denuded. The Alpine foredeep is narrowest on the elevation of Amstetten on the right bank of the Danube R.

g) The causes to the Bohemian Massif uplift can be only speculated on so far; it is advisable to search for them in the upper mantle. Suk (1995) disclosed that the centres of volcanic activity in the western part of the Bohemian Massif were moving in the SW direction in the Upper Proterozoic until the Tertiary. The mantle origin of young volcanites was suggested also by Kopecký (e.g. 1978). According to Wilson (1997), the main areas of neovolcanic activity relate to the basement dome uplifts of wave length ranging from 200 to 500 km. Seismic tomography indicates that finger diapirs in the upper mantle of the French Massif Central are located in a depth larger than 300 km. In the Bohemian Massif, it was mainly the problem of the young uplift of the Krušné hory (Mts.) that was particularly discussed. Škvor (1983) explains it by a stage transformation of rocks and by their reduced density in the upper mantle. Zeman (1988) presumes under the Krušné hory (Mts.) an elevation of sublithospheric astenosphere and phase transformations of migmatites and metagranites.

h) The block activation of the Bohemian Massif margins started in the Upper Jurassic. There are evidence in the central parts of the massif of a cross strait running in the NW-SE direction (see Eliáš in Suk et al., 1984). North of Brno, there is a pre-Cretaceous subsidence of narrow blocks of Jurassic sediments which are put into connexion with the Deister phase by Malkovský (1979). After the regression of the Jurassic sea the subaerial development continued and the nearly perfectly planated pre-Upper Cretaceous surface can be considered a reference feature of later vertical movements. During the Jurassic the relief differentiation showed in the rise of a shallow marine basin which became a core of the Bohemian Basin and interconnected the boreal area in the NW with the Tethys area in the SE. The interconnection is suggested by the sediments of Klement Formation in the Pavlovské vrchy (Hills) in southern Moravia, and Teplice and Březno Formations in western Bohemia (Stráník et al., 1996). The Cretaceous basin was surrounded with isles which supplied clastic sediments forming several acial areas, and it is not clear to what extent they can reflect differences in the composition of source areas or important paleogeographical changes. A source of morphologically significant Cenomanian and Turonian block sandstones were granitoids of the Sudetic isles. The inner differential movements within the basin are indicated by the fact that the subsidence basement movements in the central part of the basin in the Upper Turonian superimposed the effects of global regression (Valečka nad Skoček, 1990). The final regression in the Santonian meant a return to the subaerial regime and was probably the very beginning of the slow epiplatform uplift. Although its life was relatively short, the Upper Cretaceous transgression (Alb/Cenomanian-Santonian) left at some places sediments over 1000 in thickness. After the regression, the Cretaceous cover was permanently exposed to subaerial denudation which was complicated by the Saxonian tectonics (a.o. development of the Ohře Rift), volcanic activity and later marine transgression on the massif margins.

The dating of tectonic movements does not have any reliable basis with the exception of a few works (e.g. Coubal and Klein, 1992) and is often speculative (Kopecký, 1972). The research and dating of young structures are easier in the Saxothuringian than in the Moldanubian elevations. A point of support is the Lower Badenian transgression in the eastern part of the Bohemian Massif, whose sediments filled the river valleys and buried the ramified valley pattern. In the western part of the massif in the area of the Ohře Rift (Most Basin) and South-Bohemian Basins, there are the Tertiary limnic sediments resting on the Cretaceous deposits. The transgression proceeded from the SE through the river valley and tectonically rejuvenated depressions and reached as far as in the eastern Bohemia. The transgression arrived in the already dissected topography with the Upper Cretaceous sediments evidently removed from the Boskovice Furrow (Jurková, 1975). The sedimentation of marine calcareous clays such as on the Main European Divide northwards of Svitavy (550 m) on the Upper Cretaceous sediments calls into question the absolute height of the sea level in the Badenian and the vertical extent of the post-Badenian uplift. The Badenian transgression occurred simultaneously with important tectonic events in the West Carpathians, particularly with the overthrusting of flysh nappes.

i) A classical method to determine the extent and character of tectonic uplift is the analysis of planation surfaces. In the case of the Bohemian Massif, the long-term research led to the formulation of two concepts of which the first one accepts the existence of an originally uniform planation surface (of peneplain type), faulted and uplifted to different altitudes (e.g. Demek et al., 1965), and the other one adopts the existence of the planation surfaces of stepped topography as a consequence of the uplift occurring in stages (Jahn, 1980 and works based on ideas of W. Penck). An extreme example of the first concept are works by A. Kopecký (1972, 1986, 1989) that issue from the existence of a uniform Meso-cenozoic planation surface of the peneplain type, developed near the main erosion base which was close to the present one in terms of its height. The uplift is understood as a (ductile) folding of the basement subaerial surface where the valleys of even the lowest orders are synclines and the ridges are anticlines. The faults are attributed only a minimum significance by this author (critique see Ivan, 1990).

A basis for the contemporary interpretation of the Bohemian Massif planation surfaces is the etchplanation in which surfaces identified as etchplains represent a strongly denudated basal surface of weathering (Czudek and Demek, 1971; Ivan, 1983; Král, 1985). This approach was generally criticized by Thomas (1994) and it seems that his newer classification contains better suited terms for this type of surfaces such as etchsurface or dominantly stripped etchplains. In some cases, exhumed etchplain escarpments would also be a fitting term.

A better contribution to the research of age of the Bohemian Massif planation surfaces can be the fission track method that brought surprising results in the SE part of the massif (Oberpfälzer Wald), in the connexion with the superdeep KTB borehole on the contact between the Moldanubicum and Saxothuringicum in the classical area for the exploration of foothill benchlands. The results with a sufficiently dense sampling network revealed a post-Cretaceous block structure and a heavy post-Variscan and post-Cretaceous denudation (Bischoff et al., 1993; Hejl et al., 1997). In front of the fault scarp there was a thick (up to 2000 m) cover of the Cretaceous sediments, which caused that its base was heated up by some 60°C. The values of the Neogene uplift seem too high to Bischoff et al. (1993). The application of this method could apparently provide more accurate data on the uplift of other parts of the massif basement (desirable would be the information from the northern elevations and from the Bohemian Basin).

Acknowledgement

I would like to thank Dr. Břetislav Balatka, CSc., Department of Physical Geography and Geoecology, the Charles University Prague for critical reading of the manuscript and suggestions that led to the improvement of the text. Last but not least, I am indebted to him for the photos. Dr. Karel Kirchner, CSc. and Mgr. Michal Bíl, Institute of Geonics, Branch Brno, Academy of Sciences of the Czech Republic are also thanked. Interpretations and shortcomings found in the paper should be attributed to myself. The research was partly supported by the grant No. 31 459 of the Grant Agency of Academy of Science of the Czech Republic , and by the grant No. 773/93 of the CR Ministry of Environment.

References

ANDRUSOV, D. (1968): Grundriss der Tektonik der Nördlichen Karpaten. Vyd. SAV, Bratislava, 188 pp.

BALATKA, B. (1992): Terrace systems of rivers of the Bohemian Upland and the Czechoslovak Carpathians and their comparison. In: Analysis and synthesys of geographical systems - Memorial Volume, Institute of Geography CSAS, p. 113 - 137, Brno.

BALATKA, B. - SLÁDEK,J. (1976): Geomorphological development of the lowerOhře basin. Rozpr. Čs. Akad.věd, mat. přír.,85,5, Praha, 70 pp.

BALATKA, B. - SLÁDEK, J. (1962): Říční terasy v českých zemích ,(River terraces in Czech lands). Praha, 580 pp. (in Czech)

BALATKA, B. - ROTH, Z. - SLÁDEK, J. - ZEMAN, A. (1983): Český masív: diskuse o jeho vymezování a tektonickém členění, (The Bohemian Massif: A discussion on its delimitation and tectonic division), Věstník ÚÚG, 58, 6, p. 369 - 376, Praha.(in Czech)

BATTIAU-QUENEY, Y. (1989) : Liens entre ĺ évolution géomorphologique des iles britanniques et les propriétés de la croute sousjacente. Révue de Géomorphologie dynamique, 38, 1, p. 1 - 15, Paris.

BERÁNEK, B. - SUK, M. - WEISS, J. (1980): Geological sections through Variscan orogene in the Bohemian Massif. Sbor. geol. věd, G, 34, p. 7 - 29, Praha.

BISCHOFF, R. - SEMMEL, A. - WAGNER, G. A. (1993): Fission-track analysis and geomorphology in the surroundings of the drill site of the German continental deep drilling project (KTB) Northeast Bavaria. Z. Geomorph. N. F., Suppl.- Bd. 92, p. 127 - 143, Berlin - Stuttgart.

BLÍŽKOVSKÝ, M. et al. (1988): Linear structures in the Czechoslovak part of the Bohemian Massif derived from geophysical data. Věstník ÚÚG, 63, 5, p. 275 - 240, Praha. (in Czech, English summary)

BLÍŽKOVSKÝ, M. - BUCHA, V. - IBRMAJER, J. - SUK, M. (1992): Geophysical pattern of the Bohemiam Massif. In J. Kukal (ed.) Proceedings of the 1st Intern. Conf. on Bohemian Massif, p. 21 - 28, Praha.

BOUŠKA, V. (1990): Mohou být Čechy starým obrovským meteoritovým kráterem? (Can Bohemia be an old huge meteorite crater?) Vesmír, 69, 9, p. 487 - 492, Praha. (in Czech)

BREITER, K. - GNOJEK, I. - CHLUPÁČOVÁ, M. (1998): Radioactivity patterns - constraints for magmatic evolution of the two-mica granites in the Central Moldanubian Pluton. Věstník ČGÚ, 73, 4, p. 301 - 311, Praha.

BREMER, H. (1985): Randschwellen: a link between plate tectonics and climatic geomorphology. Z. Geomorph. N. F., Suppl. - Bd. 54, p. 11 - 21, Berlin - Stuttgart.

BUDAY, T. et al. (1960): Tectonic evolution of Czechoslovakia. ÚÚG, Praha, 226 pp.

BÜDEL, J. (1977): Klimageomorphologie. Gebr. Borntraeger, Berlin - Stuttgart, 304 pp.

BUCHA, V. - BLÍŽKOVSKÝ, M., eds. (1994): Crustal structure of the Bohemian Massif and the Western Carpathians. Academia, Praha, 355 pp.

COUBAL, M. - KLEIN, V. (1992): Development of the Saxonian tectonics in the Česká Lípa region. Věst. ČGÚ, 67, 1, p. 25 - 45, Praha.

CWOJDZIŃSKI, S. - JODŁOWSKI, S. (1982): „Stained" basaltic concentrations of the Bohemian Massif and the Lower Silesia. Biul. Inst. Geol. 341, XXV, p. 201 - 229, Warszawa. (in Polish, English summary)

CYMERMAN, Z. (1990): Młodoalpejskije nasuniecie Żielenca w Górach Orlickich (Sudety). Przegl. geol., 38, p. 422 - 428, Warszawa. (in Polish)

CYMERMAN, Z. (1998): Młodoalpejskije fałdy w depresji połnocnosudeckiej: przykłady z wapenia muszlowego z Raciborowic. Przegl. geol., 46 (4), p. 348 - 354, Warszawa. (in Polish)

CYMERMAN, Z. - PIASECKI, M. A. J. (1994) : The terrane concept in the Sudetes, Bohemian Massif. Kwart. Geol., 38, p. 199 - 210, Warszawa.

CZUDEK, T. ed. (1972): Geomorphological division of the Czech Socialist Republic. Studia geographica 23, GGÚ ČSAV, Brno, 140 pp. (in Czech, English summary)

CZUDEK, T. - DEMEK, J. (1970): Some problems of surface forms interpretation in the Česká vysočina Highlands (Czechoslovakia). Zprávy GGÚ ČSAV, 7, p. 9 - 28, Brno.

CZUDEK, T. - DVOŘÁK, J. (1989): The origin of the morphostructure of the Moravian Gate. Sborník ČSGS, 94, 4, p. 241 - 248, Praha. (in Czech, English summary)

ČERMÁK, V. - ŠAFANDA, J. - ŠTULC, P. (1998): Thermal state of the Bohemian Massif. Geolines, 6, p. 14, Praha.

DALLMEYER, R. D.- FRANKE, W. - WEBER,K., eds. (1995): Pre-Permian Geology of Central and Eastern Europe. Springer-Verlag, 604 pp., Berlin, Heidelberg.

DEMEK, J. (1971): O vzniku povrchových tvarů Hrubého Jeseníku. (On the development of the Hrubý Jeseník surface forms) Campanula, 2, p. 7 - 18, Ostrava. (in Czech)

DEMEK, J. (1995) : Parallels between karst relief and granite relief: a case study of the Bohemian Highlands, Czech Republic. Acta montana IRSM AS ČR, A, 8 (97), p. 7 - 15, Praha.

DEMEK, J. et al. (1965): Geomorfologie českých zemí.(Geomorphology of Czech lands) NČSAV, Praha, 335 pp. (in Czech)

DEMEK, J. ed.(1987) Geografický lexikon České socialistické republiky. II. Hory a nížiny (Geographical encyclopaedia of the Czech Socialist Republic.II. Mountains and Lowlands), Academia, Praha, 584 pp. (in Czech)

DÉSIRÉ-MARCHAND, J. - KLEIN, C. (1987): Fichtelgebirge, Böhmerwald, Bayerischer Wald. Contribution a l´ étude du probleme des Piedmonttreppen. Z. Geomorph. N. F., Suppl.- Bd. 65, p. 101 - 138, Berlin- Stuttgart.

DOPITA, M. et al. (1997): Geology of the Czech part of the Upper Silesian Basin. Min. živ. prostř. ČR, Praha, 278 pp. (in Czech, English summary)

DUDEK, A. (1980): The crystalline basement block of the Outer Carpathians in Moravia: Bruno-Vistulicum. Rozpr. Čs. Akad. Věd, mat.- přír., 90, 8, Praha, 85 pp.

DYJOR, S. (1983): Evolution of Tertiary grabens situated before Central and Eastern Sudetes. III. Sympozjum Współczesne i neotektoniczne ruchy skorupy ziemskiej w Polsce, p.155 - 181, Wroclaw - Warszawa. (in Polish, English summary)

ELZNIC, A. - CHÁB, J. - PEŠEK, J. (1974): A graben structure striking north-northeast- south- southwest in the Plzeň and Žihle Basins. Folia Západočeského muzea v Plzni, Geologica 4, Plzeň, 18 pp.

EMBLETON, C. (1984): Geomorphology of Europe. Macmillan, London, 464 pp.

FAJST, M.,(1969): Problems of facies and tectonics of the Cretaceous at the southern boundary of the Výsoké Mýto and Svitavy syncline. Čas. min. a geol., 14, p.11- 22, Praha. (in Czech, English summary)

FINGER, F. - FRASL, G. - DUDEK, A. - JELÍNEK, E. - THÖNI, M. (1995): Igneous activity (Cadomian plutonism in the Moravo-Silesian basement). In Dallmeyer, R. D. et al. (eds.) Pre-Permian Geology of Central and Eastern Europe. Springer-Verlag, p. 495 - 507, Berlin, Heidelberg.

FUCHS, G. (1992): The southern Bohemian Massif- its structure and evolution. In Kukal, J.ed. Proceedings of the 1st Intern. Conf. on Bohemian Massif, p. 81 - 93, Praha.

FUCHS, K. - von GEHLEN, K. - MÄLZER, H. - MURAWSKI, H. - SAMMEL, A. (1983): Plateau Uplift. The Rheinische shield - a case history, Springer, Berlin, 411 pp.

GIESE, P. (1995): Main features of geophysical structures in Central Europe.In Dallmeyer et al. eds. Pre-Permian Geology of Central and Eastern Europe. Springer-Verlag, p. 8 - 25, Berlin, Heidelberg.

GROCHOLSKI, A. (1977): The marginal Sudetic fault against the Tertiary volcano-tectonics. Acta Universitatis Wratislaviensis. Prace Geol.- Min. VI, No. 378, p. 89 - 103, Wroclaw. (in Polish, English summary)

HASSINGER, H. (1925):Die Tschechoslowakei. Ricola Verlag, Wien, Leipzig, München, 618 pp.

HEJL, E. - COYLE, D. - LAL, N. - VAN den HAUTE, P. - WAGNER, G. A. (1997) : Fission-track dating of the western border of the Bohemian Massif: termochronology and tectonic implications. Geol. Rundsch., 86, p. 210 - 219, Stuttgart.

HIRSCHMANN, G. (1992): Connections between Moldanubicum, Bohemicum and Saxothuringicum from lithostratic viewpoint. In Kukal, J. ed. Proceedings of the 1st Intern. Conf. on Bohemian Massif, p. 112 - 120, Praha.

HOLUB, V. M. - SKOČEK, V. - TÁSLER, R. (1977): Paleogeographical analysis of the Permo-Carboniferous in the Bohemian Massif. In: Holub, V. M., Wagner, R. H. (eds.) Symposium on Carboniferous stratigraphy, p. 341 - 358, ÚÚG, Praha.

HOLUBEC, J. (1990): Structure of the Bohemian Massif. ÚÚG, Praha, 216 pp.

HRÁDEK, M. (1995): Valleys of the eastern margin of the Bohemian Massif: brief outline of their origin, age and natural hazards. Acta montana IRSM AS ČR , A, 8 (97), p. 29 - 41, Praha.

HRÁDEK, M. (1998): Main features of morphotectonic development of a platform in the period between tectogeneses examplified by the southeastern margin of the Bohemian Massif, Geolines, 6, p. 27 - 28, Praha.

HRÁDEK, M. - IVAN, A. (1974): Neotectonic fold-faulted morphostructures in the surroundings of the town of Brno. Sborník ČSSZ, 79, p. 249 - 257, Praha. (in Czech, English summary)

HROMÁDKA, J. (1956): The orographical division of the Czechoslovak Republic. Sborník ČSSZ, 61, 3, p. 161 - 180: 4, p. 265 - 299, Praha. (in Czech, English summary).

CHLUPÁČ, I. (1992) : The metamorphic Palaeozoic of the "islet zone" as a possible connecting link between the Barrandian and Moldanubicum. In Kukal, J. ed. Proceedings of the 1[st] Intern. Conf. on Bohemian Massif, p. 49 - 52, Praha.

CHRT, J. - BOLDUAN, H. et al.(1968): Räumliche und zeitliche Beziehungen der endogenen Mineralisation der Böhmischen Masse zur Magmatismus und Bruchtektonik. Z. angew. Geol., 7, p. 362 - 376, Berlin.

ILLIES, H. - GREINER, G. (1976): Regionales stress-Feld und Neotektonik in Mitteleuropa. Oberrhein. geol. Abh., 25, p. 1 - 40, Karlsruhe.

ILLIES, H. - GREINER, G. (1978): Rhinegraben and the Alpine system. Geol. Soc. of America Bulletin, 89, 5, p. 770 - 782, Boulder.

IVAN, A. (1983):Geomorphology of the Žulovská pahorkatina (Hilly Land), Zprávy GGÚ ČSAV, 20, 4 , p. 49-69, Brno .(in Czech, English. summary)

IVAN, A. (1990): Nature of neotectonic movements and relief development in area of the Hrubý Jeseník Mts. and eastern part of the Orlické hory Mts. Čas. Slez Muz. (A), 39, p. 277 - 281, Opava. (in Czech, English summary)

IVAN, A. (1992a): Morphotectonics on the contact of the Českomoravská vrchovina (Highland) and the Východočeská tabule (Tableland) in the surroundings of the town of Polička. In: Analysis and synthesis of geographical systems - Memorial. Volume, Institute of Geography CSAS, p. 157 - 168, Brno.

IVAN, A. (1992 b) The Brno Basin: double graben with central horst zone : problems of geomorphological division and genesis. Zprávy GGÚ, 29, p. 7-46, Brno. (in Czech, English summary).

IVAN, A. (1996): Morphotectonics of SE-margin of the Bohemian Cretaceous Basin, two half-grabens and their surroundings north of Brno (Moravia). Moravian Geographical Reports, 4, 1, p. 2 - 8, Brno.

IVAN, A. (1997): Topography of the marginal Sudetic Fault in the Rychlebské hory (Mts.) and geomorphological aspects of epiplatform orogenesis in the NE part of the Bohemian Massif. Moravian Geographical Reports, 5, 1, p.3 - 17, Brno.

IVAN,A. (1999): Geomorphological aspects of the late Saxonian epiplatform orogeny of the Bohemian Massif (Part 1). Moravian Geographical Reports, 7, 1, p.18 - 33, Brno.

IVAN, A. - KIRCHNER, K. (1995): Granite landforms in the Podyjí National Park, South Moravia. Acta montana IRSM AS ČR, A, 8 (97), p.17 - 27, Praha.

JAHN, A. (1980): The main features of the Tertiary relief of the Sudetes Mountains. Geographica Polonica, 43, p. 5 - 23, Warszawa.

JAROŠ J. (1992): The nappe structure in the Svratka Dome. In Kukal, J.ed. Proceedings of the 1 st Intern. Conf. on Bohemian Massif, p. 137 -140, Praha.

JERZYKIEWICZ, T. (1971): A flysch/littoral succession in the Sudetic Upper Cretaceous. Acta geol. pol., 21, p. 165- 199, Warszawa.

JIŘÍČEK, R. (1979): Tectonic development of the Carpathians in the Oligocene and Neogene In : M.Mahel' ed. Tectonic profiles through the West Carpathians. GÚDŠ, p. 203 - 214, Bratislava. (in Czech, English summary)

JOWETT, E. C. (1991): Post-collisional formation of the Alpine forelands rifts. Ann.Soc. Geol. Poloniae, 61, p. 37 - 59, Warszawa

JURKOVÁ, A. (1975): Geologické poměry Boskovické brázdy mezi Skalicí nad Svitavou and Bořitovem. (Geological situation of the Boskovice Furrow between Skalice nad Svitavou and Bořitov) Sborník GPO, 10, p. 41 - 53, Ostrava. (in Czech)

KALVODA, J. - BALATKA, B.(1995): Chronodynamics of the Labe River antecedence in the Děčínská vrchovina Highland, Czech Republic. Acta montana IRSM AS ČR, A, 8 (97), p. 43 - 60, Praha.

KLEIN, C. (1974): Tectogenese et morphogenese armoricaines et péri-armoricaines. Revue de Géographie physique et Géologie dynamique, 16, 1, p.87 - 100, Paris.

KLOMÍNSKÝ, J. - DUDEK, A. (1978) : The plutonic geology of the Bohemian Massif and its problems. Sbor. geol. věd, G, 31, p. 47 - 69, Praha.

KONDRACKI, J. (1977) : Regiony fizyczno-geograficzne Polski. Wyd. Uniw. Warszawskiego, Warszawa, 178 pp. (in Polish)

KOPECKÝ, A. (1972) : Main features of the neotectonics in Czechoslovakia. Anthropozoikum, 6, p.77 - 155, Praha. (in Czech, English summary)

KOPECKÝ, A. (1986): Neotektonik des Gebirges Hrubý Jeseník und östl. Teil der Orlické hory. Čas. Slez. Muz. (A), 35, p. 117 - 141, Opava. (German summary)

KOPECKÝ, A. (1989): Mapa mladších tektonických struktur Českého masívu 1: 500 000. (Map of younger tectonic structures of the Bohemian Massif) Praha, 18 pp., (in Czech)

KOPECKÝ, L. (1978): Neoidic taphrogenic evolution and young alkaline volcanism of the Bohemian Massif. Sbor. geol. věd, G, 31, p. 91 - 107, Praha.

KOTAŃSKI, Z. - RADWAŃSKI, S. (1977): Surface geology of the Opole region. Biul.Inst. Geol., Warszawa, 303, p. 91 - 172. (in Polish. English summary)

KRÁL, V. (1968): Geomorphologie des Hohen Erzgebirges und das Problem der Rumpffläche. Rozpravy ČSAV, mat.-přír., 78,9, 64 pp., Praha. (in Czech, German summary)

KRÁL, V. (1985): Verebnungsfläche der Böhmische Massivs. Studie ČSAV, 10, Academia, Praha, 76 pp. (in Czech, German summmary)

KRZYWIEC, P. - JOCHYM, P. (1997): Characteristics of the Miocene subduction zone of the Polish Carpathians: results of flexural modelling. Przegl. Geol., Warszawa, 45, 8, p. 785 - 792. (in Polish, English summary)

KUKAL, J. ed. (1992): Proceedings of the 1 st International Conference on the Bohemian Massif. Czech Geological Survey, Praha, 357 pp.

KUNSKÝ, J. (1968): Fyzický zeměpis Československa (Physical geography of Czechoslovakia),SPN, Praha, 537 pp. (in Czech)

KUŽVART, M. (1965): Geologic conditions of the Moravo-Silesian kaolins. Sbor. geol. věd, LG, 6, p.87 - 140. (in Czech,English summary)

KUŽVART, M. (1984): Ložiska nerudních surovin.(Deposits of non-ore raw-materials) Academia, Praha, 439 pp. (in Czech)

LEMCKE, K. (1984): Geologische Vorgänge in den Alpen ab Obereozän im Spiegel vor allem der deutschen Molasse. Geol. Rundaschau, 73, 1, p. 371 - 397, Stuttgart.

LOBKOWITZ, M. - ŠTĚDRÁ, V. - SCHULMANN, K. (1994): Late-Variscan extensional collapse of the thickened Moldanubian crust in the southern Bohemia. Journal of the Czech Geol. Soc., 41, 3 - 4, p.123 - 138, Praha.

LÜTZNER, H. (1988): Sedimentology and Basin Development of Intramontane Rotliegend Basin in Central Europe, Z. geol. Wiss., 16, 9, p. 845 - 863, (Berlin).

MAHEĽ, M. ed. (1974): Tectonics of the Carpathian-Balkan regions. GÚDŠ, Bratislava, 454 pp.

MACHATSCHEK, F. (1927): Landeskunde der Sudeten- und Westkarpatenländer. Verlag von J. Engelhorn Nachf., 440 pp., Stuttgart.

MALKOVSKÝ, M. (1974):Bohemian Cretaceous Basin and its basement. Ústř. úst. geol., 264 pp., Praha. (in Czech, English summary)

MALKOVSKÝ, M.(1977): Důležité zlomy platformního pokryvu severní části Českého masívu.(Important faults of the platform cover in the northern part of theBohemian Massif) Výzkumné práce ÚÚG 14, Praha, 30 pp. (in Czech)

MALKOVSKÝ, M. (1979): Tektogeneze platformního pokryvu Českého masívu (Tectogenesis of the platform cover of the Bohemian Massif) Knihovna ÚÚG, 53, Academia, 176 pp., Praha. (in Czech)

MALKOVSKÝ, M. (1980) : Saxon tectogenesis of the Bohemian Massif. Sbor. geol. věd. Geologie, 34, p.67 - 101, Praha.

MALKOVSKÝ, M. et al. (1985): Geology of the North-Bohemian coal basin and surrounding area. ÚÚG, Praha, 424 pp. (in Czech, English sum.)

MALKOVSKÝ, M. (1995) : Some problems of chronostratigraphical division of the Bohemian Massif Tertiary sediments. Knihovnička ZPN, 16, p. 25 - 36, Hodonín.(in Czech, abstract in English)

MAREŠ, S. (1968) : Density and porosity of rocks in the Carboniferous Kladno - Rakovník basin and the relationship to compaction. Čas. Mineral. Geol., 13, 4, p.391 - 404, Praha. (Czech, English summary)

MATTERN, F. (1996): The Elbe zone at Dresden - a Late Paleozoic pull -apart intruded shear zone. Z. dt. geol. Ges., 147 / 1, p. 57 - 80, Stuttgart.

MAZUR, S. (1998) :Variscan thrusting and extensional collapse in the Karkonosze - Izera Massif, West Sudetes: tectonics, sedimentary and magmatic record. Geolines, 6, p. 43-44, Praha.

MELICHAR, R. - HANŽL,P. (1999) : Impact of the tectonic evolution of the Western Carpathians on the Brno Massif (Abstr.) Mineralia Slovaca, 31, p. 70., Bratislava.

MIGOŃ,P. (1993): Geomorphological characteristics of mature fault-generated range fronts, Sudetes Mts., southwestern Poland. Z.Geomorph., N.F., Suppl.-Bd. 94, p. 223 - 241,Berlin-Stuttgart.

MIGOŃ, P. (1997): Crystalline rock inselbergs in Southwestern Poland. Origin and paleoenviromental significance. Studia geograficzne. LXVI, Wyd. Uniw. Wrocławskiego, Wrocław, 102 pp.

MILEWICZ, J. (1997) : Upper Cretaceous of the North-Sudetic depression (litho- and biostratigraphy, paleogegraphy,tectonics and remarks on raw materials). Prace mineralogiczcne i geologiczne, LXI. Wyd.Uniw. Wrocławkiego, Wrocław, 58 pp. (in Polish, English summary)

MÍSAŘ, Z. (1979): The position of ultrabasic rocks in geotectonic cycles and geological units of the Bohemian Massif. Geodynamic Investigations in Czechoslovakia,pp. 167 - 177, Bratislava.

MÍSAŘ, Z. - DUDEK, A. (1993): Some critical events in the geological history of eastern margin of the Bohemian Massif. Journal of Czech Geol. Soc., 38, 1 - 2, p.9-20, Praha.

MÍSAŘ, Z. - DUDEK, A. - HAVLENA, V. - WEISS, J. (1983): Regionální geologie ČSSR I, Český masív.(Regional geology of Czechoslovakia I,Bohemian Massif), SPN, Praha, 380 pp. (in Czech)

NOVÁK, V. J. (1947): Zeměpis Československa. (Geography of Czechoslovakia) Svět vědy a práce, 7, Praha, 301 pp. (in Czech)

OBERC, J. (1967): Randflexur der Sudeten und tektonische Lage des Grundgebirges von Rychlebské hory. Čas. min. geol, 12, 1, p.1 - 12, Praha. (in Polish, German summary)

OLLIER, C. (1985): Morphotectonic of Passive Continental Margins: Introduction. Z.Geomorph., N. F., Suppl.- Bd., 54, p. 1 - 9, Berlin - Stuttgart.

PANOŠ, V. (1964): Der Urkarst im Ostflügel der Böhmische Masse. Z. Geomorph., NF, 8, p. 105 - 162, Berlin - Stuttgart.

POUBA Z. - MÍSAŘ, Z. (1961): Einfluss der Querbrüche auf der geologischen Aufbau den Hohen Gesenkes. Čas. pro min. a geol., 6 (3), p. 316 - 324, Praha. (in Czech, German summary)

PRACHAŘ, L. - AMBROŽ, F.(1971): Tectonic Cretaceous block sunk 200m in Moldanubicum. Věst. ÚÚG, 46, p. 157 - 169, Praha. (in Czech, English summary)

PROCHÁZKOVÁ, D. - ROTH, Z. (1994) Chronology of movements in Central Europe in Neotectonic era. Čas. min. geol., 39, 1, p.85 - 87, Praha.

PROCHÁZKOVÁ, D. - ZEMAN, J. (1982): Relation between the deeper structure of the earth´s crust and propagation of seismic effects in Central Europe. Čas. pro min. a geol., 27, 4, p. 359 - 370, Praha. (in Czech, English summary)

RAJLICH, P. (1993): Variská duktilní tektonika Českého masívu.(Variscan ductile tectonics of the Bohemian Massif), Knihovna ČGÚ 65, 171 pp., Praha. (in Czech)

ROTH, Z. (1978): Geology of the Moravian platform and its relation to the Carpathians. Čas. pro min. a geol., 23, p. 349 - 356, Praha.

ROTH, Z. (1980): Západní Karpaty - terciérní struktura střední Evropy. (The West Carpathians- A Tertiary structure in central Europe) Knih. ÚÚG, 55, Praha, 128 pp. (in Czech)

RŮŽIČKA , M. (1989): Pliozän der Obermarchsenke und der Mohelnice - Furche. Sbor. geol. věd, Anthropozoikum, 19, p. 129 - 151, Praha. (in Czech, German summary)

RYBÁŘ, J. (1998): Ingenieurgeologischen Aufgaben bei der Beherrschung der Umweltbeeinträchtigung durch Rohstoffabbau. Z.dt. geol.Ges., 144, p. 270 - 278, Hannover.

SEIFERT, P. (1992): Palinspastic reconstruction of the easternmost Alps between Upper Eocene and Miocene. Geologica Carpathica, 43, 6, p. 327 - 331, Bratislava.

SEMMEL, A. (1991): Neotectonics and geomorphology in the Rhenisch Massif and the Hessian Basin. Tectonophysics, 195, p. 291 - 297, Elsevier.

SCHRÖDER, B. (1976): Saxonische Tektonik im Ostteil der Süddeutschen Scholle. Geol. Rundsch, 65, p. 34 - 54, Stuttgart.

STRÁNÍK, Z. et al. (1993) :The contact of the North European epivariscan platform with the West Carpathians. Journal of the Czech Geological Society, 38, 1 - 2, p. 21-29, Praha.

STRÁNÍK , Z. - BUBÍK ,M. - ČECH, S. -ŠVÁBENICKÁ, L. (1996): The Upper Cretaceous in South Moravia. Věst. ČGÚ, 71, 1, p. 1 - 30, Praha.

SUK, M. (1995) : Regional geological division of the Bohemian Massif. Exploration Geophysics, Remote Sensing and Environment. 2, 2, p. 25 - 30, Brno.

SUK, M. et al. (1984): Geological history of the territory of the Czech Socialist Republic. ÚÚG, Praha, 396 pp.

SUK, M. - ĎURICA, M. - OBSTOVÁ, V. - STAŇKOVÁ, E. (1991): Deep boreholes in the Bohemia and Moravia and their geological applications. Gabriel, 171 pp., Praha. (in Czech, Eng.summary.)

SVOBODA, J. et al. (1966) : Regional geology of Czechoslovakia. Part I, The Bohemian Massif.Academia, Praha, 668 pp.

SUMMERFIELD , M. (1991): Global geomorphology. An introduction to the study of landforms. Longman, Harlow, 537 pp.

ŠKVOR, V. (1983): Thermal regimes and the geological development of the Bohemian Massif. Sbor. geol. věd, Geol., 38, p. 41 - 70, Praha,

ŠŤOVÍČKOVÁ, N. (1973): Deep-fault tectonics and its relation to endogenous geological processes. Academia, Praha, 198 pp. (in Czech, English summary)

THOMAS, M. F. (1994): Geomorphology in the tropics. Wiley, Chichester, 460 pp.

TYRÁČEK, J. (1995): Stratigraphy of the Ohře River terraces in the Most basin. Sbor. geol. věd, Anthropozoikum, 22,p. 141 - 157, Praha.

TRÜMPY, R. (1973): The timing of orogenic events in the Central Alps. In: K. A. de Jong and R. Scholten (eds.) Gravity and tectonics. Wiley, p. 229 - 251, New York.

VACHTL, J. et al. (1968): Lagerstätten der cenomanischen Tonsteine in Böhmen und Mähren. IV Teil, Ostböhmen und Nordwestmähren. Geotechnica, Praha, 162 pp. (in Czech, German summary)

VALEČKA, J. (1988): Sedimentology of the Upper Cretaceous in the Králíky Graben (NE Bohemia). Sbor. geol. věd, G, 43, p. 147 - 191, Praha. (in Czech, English summary)

VALEČKA, J.- SKOČEK V. (1990): Lithoevents in the Bohemian Cretaceous Basin. Věst.ÚÚG, 65, 1, p.13 - 28, Praha. (in Czech, English abstract)

VRÁNA, S. (1990): The Pelhřimov volcanotectonic circular structure. Věst. ÚÚG, 65, 3, p. 143 - 156, Praha.

VRÁNA, S.- ŠTĚDRÁ, V.eds. (1997): Geological model of western Bohemia ralated to the KTB borehole in Germany. Sbor. geol. věd., Geologie,47, Praha, 240 pp.

VYSKOČIL, P.- ZEMAN, A. (1980): Recent movements of the Earth´s in the region of the Bohemian Massif and its south-east border. Geodynamic Investigations in Czechoslovakia.Veda, p. 139 - 146, Bratislava.

WALCZAK, W. (1968): Sudety. PWN, Warsazawa, 383 pp. (in Polish)

WEISS, J. (1977): Basement of the Moravian block in structure of European platform. Folia přír. fak. UJEP v Brně, XVIII, 13, Brno, 64 p. (in Czech).

WILSON, M. (1997) Tertiary-Quaternary magmatism within Europe- the role of mantle plumes. Čas. České geol. spol. 42, 3, p.19 (MAEGS-1O Abstracts), Praha.

ZÁTOPEK, A. (1979): On geodynamical aspects of geophysical synthesis in Central Europe. Geodynamic Investigations in Czechoslova-kia. Veda, p. 91 - 104, Bratislava.

ZEMAN, J.(1978): Deep-seated fault structures in the Bohemian Massif. Sbor. geol. věd, G, 31, p. 155 - 185, Praha.

ZEMAN, J.(1979): Dynamic of the crustal blocks structure of the Bohemian Massif. Geodynamic Investigations in Czechoslovakia, p. 161 - 165, Bratislava.

ZEMAN, J. (1988): Character of the Krušné hory Mts. neotectonic morphostructure and its formation model. Věstník ÚÚG, 63, 6, p. 333 - 342, Praha. (in Czech, English summary)

ZULAUF, G. (1994): The tectonometamorphic evolution of the western part of the Tepla-Barrandian (Bohemian Massif, Czech Republic). Čas. České geol. spol., 39, 1 (Abstract volume), p. 125 - 126, Praha.

ZULAUF, G. - DUYSTER, J.(1977): Faults and veins in the superdeep well KTB: constraints on the amount of Alpine intra-plate thrustig and stacking of Variscan basement (Bohemian Massif, Germany). Geol. Rundsch., 86, Suppl., p. 28 - 33, Stuttgart.

ZULAUF, G. et al. (1997): Rheological collapse of a Bohemian Tibetan plateau: the Teplá - Barrandian unit (Central European Variscides). Čas. České geol. spol. , 42, 3, p.79, Praha.

ZWEIGEL, J. (1998): Eustatic versus tectonic control on foreland basin fill. Contributions to Sedimentary Geology, 20, Schweizerbart sche Verlagsbuchhandlung, Stuttgart, 140 pp.

Author´s address:

RNDr. Antonín Ivan, CSc.
Academy of Sciences of the Czech Republic
Institute of Geonics, Branch Brno
P.O. Box 23
CZ - 613 00 BRNO, Czech Republic
E-mail: ivan@geonika.cz

Reviewer:

RNDr. Břetislav BALATKA, CSc.

Errata

In the last number of the Moravian Geographical Reports (1/1999), the captions under photographs made by B. Balatka to the article by A. IVAN: Geomorphological aspects of late Saxonian epiplatform orogeny of the Bohemian Massif (Part 1) were accidentally confused both in the text of the article and on Page 3 of the cover. The correct readings are as follows: Page 26 Fig. 4 "The Western Krkonoše Mountains ...", Page 30 Fig. 5 "Sandstone towers in the rock city of Hrubá skála ...", Cover page 3 upper photograph "The NE part of the Tertiary Sokolov Basin ...", Cover page 3 lower photograph "The southern part of the Český les Forest ...". The mistake was made at assembling the pictures in the printing house.

We apologize both to our readers and to the author of the article and the author of the photographs.

Editors

BORDER REGION AND ITS DEVELOPMENT FROM THE SUSTAINABILITY PERSPECTIVE (CASE OF LOWER MORAVA RIVER REGION, SLOVAKIA)

Mikuláš HUBA, Vladimír IRA

Abstract

The Lower Morava River region (West Slovakia) is the border region which was affected by social, economic and political changes in the period after World War II. Some of these changes contributed to the partial marginalisation of the region. The changes after 1989 are a challenge to overcome this state. It is important to find a sustainable way-out from the long-term marginalisation and a certain deformation of the region's development. Reflections about the future development in the Lower Morava river region, a territory with the important natural-landscape and cultural landscape values, are included in the analysis of the sustainable development potential evaluated on the basis of subjective estimates by its population and local/regional decision and opinion makers.

Shrnutí

Pohraniční region a jeho rozvoj z perspektivy trvalé udržitelnosti (případová studie regionu Dolní Pomoraví, Slovensko)

Dolní Pomoraví (západní Slovensko) patří k hraničním regionům, které byly ovlivněny sociálními, ekonomickými a politickými změnami po druhé světové válce. Některé z těchto změn přispěly k marginalizaci regiónu. Změny po roce 1989 představují výzvu k překonání tohoto stavu. Jde o to, najít trvale udržitelnou cestu optimálních východisek z dlouholeté umělé marginalizace a určité deformace ve vývoji regionu. Úvahy o dalším rozvoji regiónu Dolního Pomoraví, území s důležitými přírodně krajinnými a kulturně krajinnými hodnotami, jsou obsaženy v analýze potenciálu udržitelného rozvoje, vycházejícího ze subjektivních hodnocení obyvatel regionu a též ze subjektivních hodnocení představitelů rozhodovací sféry místní a regionální, resp. osobností silně ovlivňujících veřejné mínění.

Key words: sustainable development, border region, subjective estimates, Slovakia

1. Introduction

1.1 Sustainable development of the region

The notion of sustainable development is understood (in consensus with the general Environmental Act) as a development, which allows only such a kind of satisfaction of the contemporary needs and demands, which does not compromise the satisfaction of basic needs of future generations, disturbs life-supporting systems or reduces biodiversity. In other words, it means a search for equilibrium among the environmental, social and economic dimensions of the development, which would work in cooperation, as opposed to competition, with each other. For example, the energy saving measurements are environment friendly since they reduce the use of raw materials, create new jobs, are cost-effective for business, and at the same time help to reduce taxes.

1.2. The state of the art - Sustainability issue research according to the Slovak literature

Despite the short history of sustainable development investigations, dozens of articles, studies, projects and even several monographs have been published on the sustainability issues and their implementation in Slovakia. The most comprehensive and extensive works are Towards Sustainable Slovakia produced by Society for Sustainable Living in the SR (Huba, M., Hanušin, J., Ira, V., Lacika, J., Szöllös, J. 1995), SCOPE Slovak National Committee Report on Sustainability in Slovakia (Eliáš, P., Izakovičová, Z., eds., 1995), Possibilities of Sustainable Development of the SE Part of the Levoča Mts. in Relationship to its Water Management Utilisation (STUŽ/SR, 1996), Post-November Slovakia from the Environmental and Sustainable Living Perspectives (Huba, M., ed., 1996), Landscape-Ecological Pre-conditions for Sustainable Development (Izakovičová, Z., Miklós, L., Drdoš, J., 1997) and The

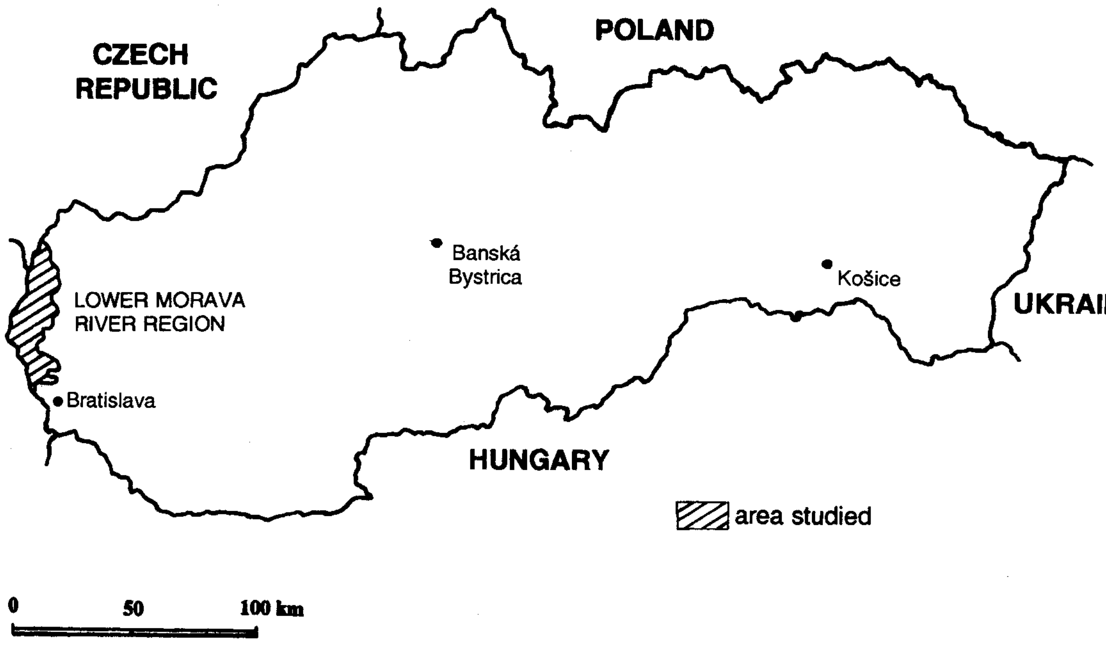


Fig. 1: Lower Morava River Region - geographical context

Sustainable Development Implementation (Izakovičová, Z., Kozová, M., Paudišová, E., eds., 1998). A positive role in this field has been played by the Global Environmental Facility Programme for Slovakia, concentrating on the formulation of the sustainable development strategy for selected border regions with the both unique natural and cultural heritage values (Sustainable Development Strategy for Eastern Carpathians, Lower Morava River and Tatras Regions - see Huba, M., Ira, V., 1998 a, b, c).

1.3 Sustainable development principles

Several different approaches exist to the definition, explanation and implementation of the sustainable development. On the other hand, these approaches have a prevailingly common character based on analogous sets of sustainability principles. We based our handling of the sustainable development concept in this study on the following principles (compiled by M. Huba, 1996): ecological principle, principle of self-regulating and self-supporting development, efficiency principle, adequate sufficiency principle, principle of precaution/prevention, principle of respecting needs, demands and rights of future generations, principle of intra-generational, intergenerational and global equity, principle of cultural and social integrity, principle of non-violence, emancipation and participation principle, solidarity principle, principle of acceptable mistakes, optimisation principle, and the principle of environmentally positive economic decision-making behaviour.

2. Geographical characteristics of the Lower Morava River region and its development

The Lower Morava River region (Dolné Pomoravie) has been continuously settled since the Neolithic period (5-3 thousand years B.C.). From the 5th to the 8th century, this area was settled by Slavic tribes affecting the environment mostly by the agricultural activity. Until the 13th century, the population density increased mostly along the Morava River and the so-called Czech route. In the 17th and 18th centuries, new estates (manors) were established by landlords of the Pálffy family.

Industrialisation in the 19th century did not significantly affect the economy within the region and thus, at the end of the 19th and the beginning of the 20th century, a part of the population emigrated to the USA, Canada, France and Austria. The region studied preserved its agricultural character. Industry at that time was represented by sawmills, distilleries, sugar refineries, mills and brick-kilns in which the local resources were processed. The new political situation after World War I (new political boundaries) caused a strengthening of south - north interactions (Bratislava and northern hinterlands), but did not initiate an interruption of transboundary contacts with Lower Austria.

In the period after World War II, the rapid development of industry (namely in Malacky and Stupava) caused an increase of population. Collectivisation of agriculture caused a wide range of changes in the landscape. Some of these changes contributed to a worsening of the situation, especially in the natural environment. After the political changes in 1948, the transboundary interactions between the Slovak and Austrian parts were interrupted.

The region studied with the exception of three municipal parts is a hinterland of Bratislava and there are no large urban centres. Machinery and production of construction materials have a dominant position within the region´s economy. Electromechanical industry oriented to the production of cables and insulators, food industry, and oil extraction also play an important economic role. Favourable climatic conditions for agricultural production are limited by sand soils of lower quality. Apart from vegetable production supplying the city, wheat, barley, rye, and potatoes are widely grown there. The suitable climate, attractive landscape with man-made lakes and cultural and historical sites (Stupava, Malacky, Veľké Leváre) create good conditions for tourism. The transportation system is a sufficient basis for intra-national and intra-regional connections and for connections with the Czech Republic. A relatively long border with Austria has only one railway passage in Devínska Nová Ves and one occasional road passage in Moravský Svätý Ján. This situation does not enable sufficient transboundary contacts and it seems to limit the further transboundary co-operation. The geographical position, qualified labour, raw material basis, and well functioning transportation system (with the exception of the connection with Austria) are good starting points for transformation and orientation towards the sustainable development of the region.

The Lower Morava River region is a territory with the important natural-landscape and cultural landscape values. The Morava River alluvium belongs to the most significant wetland ecosystems of Slovakia and thus this territory is on the List of Ramsar localities. The natural values have been well preserved for more than four decades because the inundation area, as a protected belt of the "iron curtain", was not accessible to the public (1948-1990). This unfavourable political situation paradoxically helped to preserve the biological values of the area (Kalivodová, E., Račko, J., Růžičková, H., 1999).

The region studied (684 km^2) extends into three municipal parts of Bratislava (Devín, Devínska Nová Ves and Zahorská Bystrica), the town of Stupava, the villages of Zohor, Láb, Vysoká pri Morave, Záhorská Ves, Suchohrad, Jakubov, Plavecký Štvrtok, the town of Malacky, the villages of Kostolište, Gajary, Malé Leváre, Veľké Leváre, Závod, Moravský Svätý Ján, Sekule, Borský Svätý Jur, Kúty, and Brodské. It borders Austria in the west and the Czech Republic in the north (Fig. 2). The population density is 115 inhabitants per km2, but in most communities it does not reach the national average (110 inhabitants per km^2).

The analysis of the development of population in the post World War II period (1950-1997) shows that the most significant growth exists in urban territories (Devínska Nová Ves, Malacky, Stupava). Slight growth (index of population growth is up to 1.5) was recorded in the settlements along the railway and main road. The population of the settlements along the Morava river decreased by more than a half.

In most communities, the average age is between 34 - 38 years. The most favourable relations between the population from 0-14 years of age and those who are in the post-productive age are in Devínská Nová Ves (5:1) and in Malacky (2:1).

The population of the Lower Morava River region is relatively homogenous concerning ethnicity and religion. The share of Slovaks in the whole population varies between 93.6 and 99.0%. Roman Catholics are a dominant religious group.

The percentage of economically active people in the region is relatively high. A relatively high percentage of the economically active population daily leave their communities for jobs mostly in Bratislava. Social and demographic preconditions for the further development vary according to the situation of several indicators by particular communities. Figure 2 shows certain demographic preconditions for the development based on three selected demographic indicators.

The social and economic changes after 1989 created a new phenomenon - unemployment. On March, 31, 1997, the unemployment rate in the district of Bratislava IV was relatively low (3.4 %), while in the district of Malacky, it reached 9.8 %, and in the district of Senica 11.1 %. The rate of unemployment did not reach the national average in the above mentioned districts. In the first three months of 1997, the average monthly salary in the district of Bratislava IV was 10,124 SKK (22 % higher than the national average), in the district of Malacky 7,794 SKK (93.9 % of the Slovak average) and in the district of Senica 7,358 SKK.

3. Subjective Estimates of Potential for Sustainable Development

3.1 Subjective estimates by local population

Reflections about the sustainable development in territories with important natural-landscape and cultural landscape values led us to analyse the sustainable development potential on the basis of subjective estimates by its population. We have chosen the method of questionnaire as it reliably supplies the information for a desegregated analysis. The data collection was done in the summer of 1996. The basic set consisted of the inhabitants of the Lower Morava River region. The respondents were people older than 15. The selected set was gathered by a quota selection with randomisation at the final step. Aside from the basic structural characteristics (sex, age), territorial proportionality (rate of population in a single community) was included into the control variables. The questions were

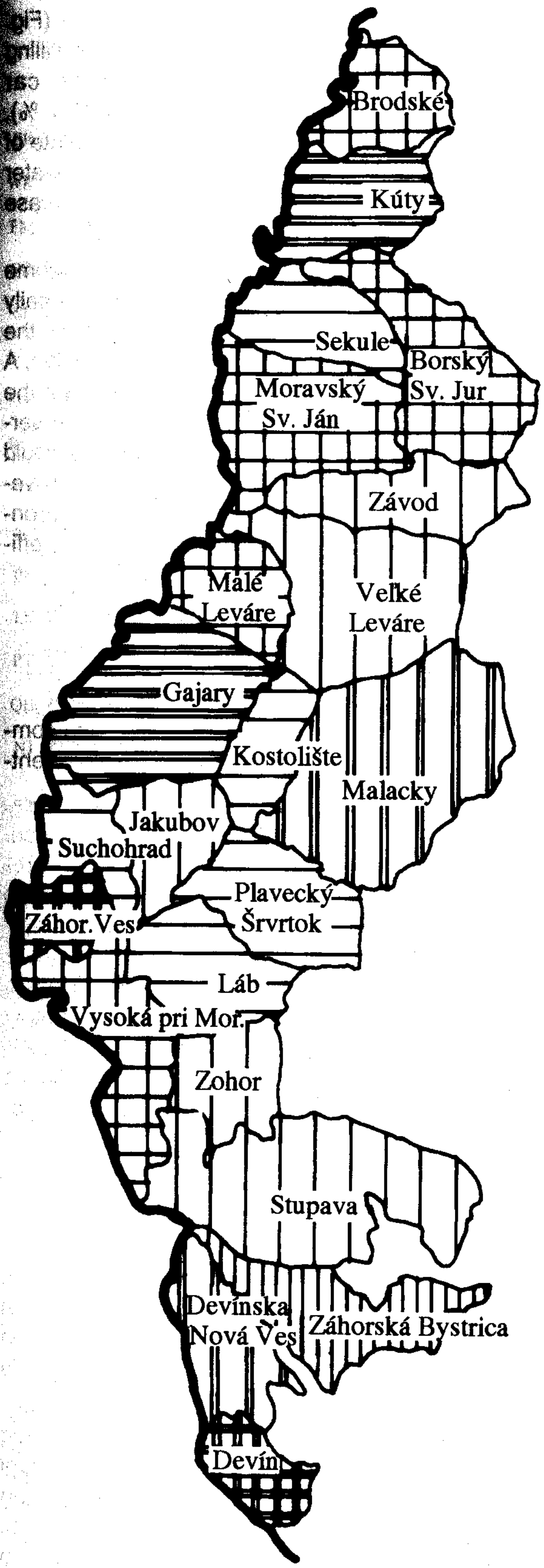


Fig.2: *Selected demographic preconditions for sustainable development*

share of population under 15 from the population of pensionable age and over - ***(0-14/PA+)***

share of economically active population from the total population - ***(EAP/TP)***

share of economically active labour commuters from the economically active population - ***(LCEAP/EAP)***

1 - *(0-14/PA+) ≥ 1, (EAP/TP) ≥ 0.5, (LCEAP/EAP) ≥ 0.5*

2 - *(0-14/PA+) ≥ 1, (EAP/TP) ≥ 0.5, (LCEAP/EAP) < 0.5*

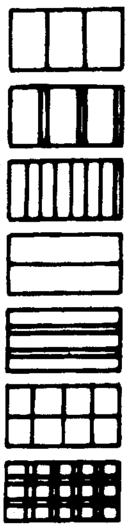
3 - *(0-14/PA+) < 1, (EAP/TP) ≥ 0.5, (LCEAP/EAP) < 0.5*

4 - *(0-14/PA+) ≥ 1, (EAP/TP) < 0.5, (LCEAP/EAP) ≥ 0.5*

5 - *(0-14/PA+) ≥ 1, (EAP/TP) < 0.5, (LCEAP/EAP) < 0.5*

6 - *(0-14/PA+) < 1, (EAP/TP) < 0.5, (LCEAP/EAP) ≥ 0.5*

7 - *(0-14/PA+) < 1, (EAP/TP) < 0.5, (LCEAP/EAP) < 0.5*



focused on the perception of environmental problems in the particular community, evaluation of the perceptions evoked by the community's environment, estimation of the social infrastructure accessibility and quality and relations among the community's inhabitants. A portion of the questions were oriented to evaluating the willingness of inhabitants to contribute to the sustainable development of their community. The concluding part of the questionnaire concentrated on the evaluation of the opinion about the programme of economically, socially and environmentally balanced (i.e. sustainable) development of the community.

In spite of the fact that in the area studied, the natural and man made environment is not strongly affected by human activities, the environmental quality is not considered good. The respondents estimate the damaged forest growth (60.5 %), surface water pollution and impaired or neglected housing (50.7 %) as the most pressing environmental problems. According to the opinion of the representative sample of the local population, the priority of the local government should be to correct the inadequately approached problems of waste management, surface and ground water pollution. The inhabitants themselves (76.6 %) and transportation were tagged as the most important sources/agents of environmental deterioration.

In the light of the opinion of more than one third of the respondents, the care for environment has improved during recent years.

Transportation is one of the most important components affecting the life quality of the inhabitants. The analysis of transportation modes shows a relatively good structure from the sustainability point of view.

Estimates of willingness to participate in the improvement of environmental quality and sustainable development activities has been summarised as follows (Fig. 3) : more than one half of the respondents were willing to walk or bike instead of driving a car (64.9 %), to separate the household waste (58.7 %), participate in events that help to improve the state of the environment, to conserve energy (51.5 %), water (51.5 %), and the alert the responsible authority in case of threats to the environment (50.4 %).

In order to collect the information for a programme of economically, socio-culturally and environmentally balanced (i.e. sustainable) development (Fig. 4), the respondents were required to express their opinion. A majority of them (more than four fifths) said that the programme should contain activities aimed at preservation of the natural values. More than two thirds would support programmes devoted to job creation, improvement and creation of new service facilities, environment friendly use of water resources, and more efficient use of energy and raw materials.

3.2 Subjective estimates by local/regional decision and opinion makers

Interviews consisting of 100 questions were completed in May, 1996 - November, 1997 with represent-

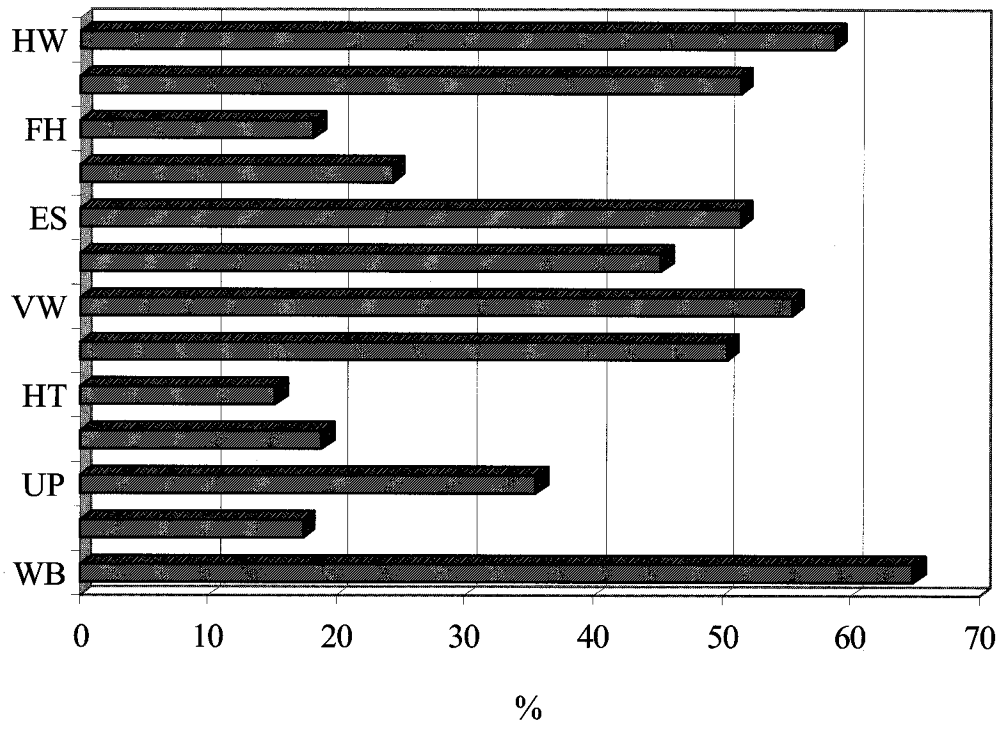


***Fig. 3:** Willingness to contribute to the sustainable development*

HW - separation of household waste, SW - saving drinking water, FH - environment friendly heating, TI - thermal insulation of house, ES - energy savings, FS - environment friendly shopping, VW - participate in voluntary works to improve environment, WA - warn the competent environmental authority, HT - pay higher tax to protect environment, GO - become a member of green organisation, UP - using unleaded petrol, PT - using mainly public transport, WB - walking and biking

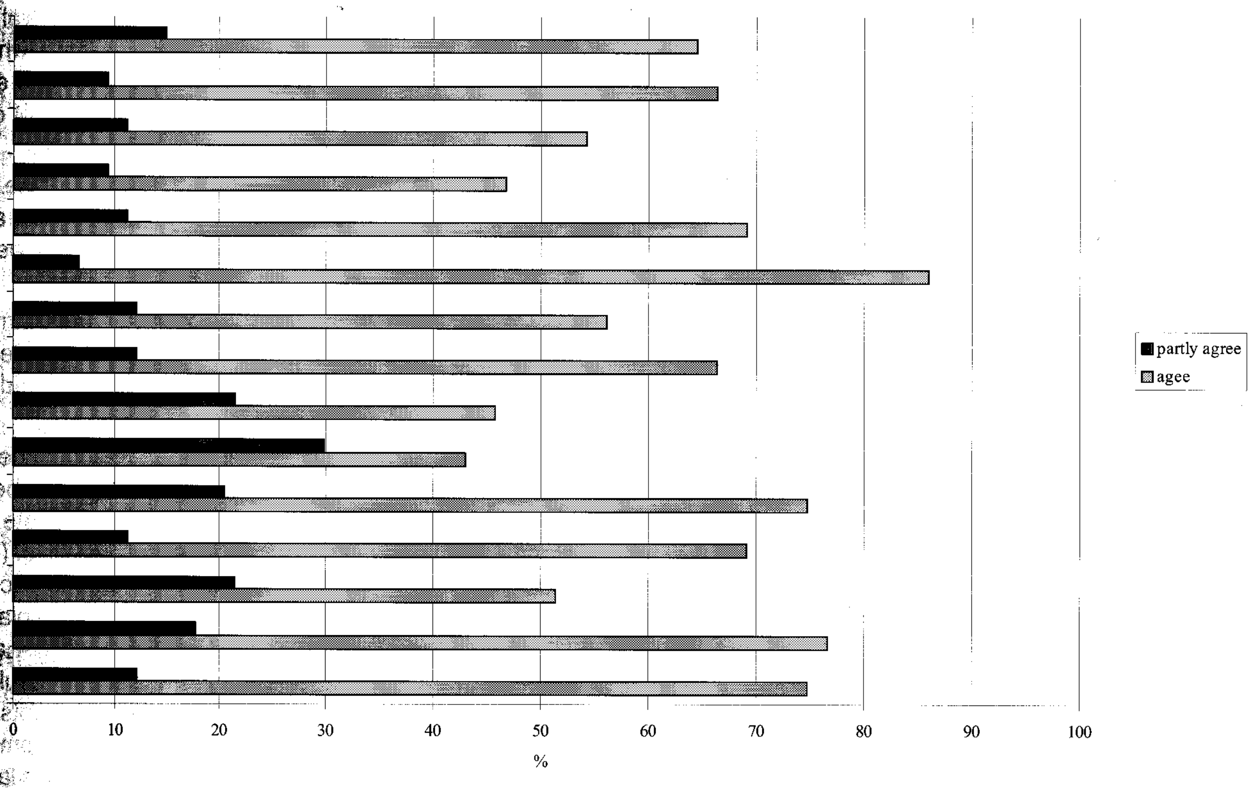


Fig. 4: Expected programme of sustainable development

ER - more efficient utilisation of energy and raw materials, WR - safeguarding water resources, FM - environment-friendly forest management, SQ - safeguarding soil quality and retention,

SE - improving quality of social environment, NV - safeguarding natural values, CH - safeguarding cultural and historical sites, RH - safeguarding and renewal of housing, EF - improving and building-up new education facilities, SF - improving and building-up new shopping facilities, PS - improving and building-up new public services, LF - improving and building-up leisure facilities, PT - improving public transportation, QE - improving quality of the environment, NJ - creation of new jobs

atives of the region, mostly with local mayors, local/regional state administrative representatives and local/regional personalities with a good overview of the local/regional issues.

The aim was to receive information on the contemporary state and perspective of the development of individual towns and villages in the region, as well as on the region as a whole, as related to the potential implementation and/or applicability of the sustainable development concept, perceived by the relevant decision and opinion makers.

More important than collecting the so-called "hard" statistical data was gathering reality the perception from respondents, their attitudes, comments, proposals, etc. The main motive was to find out advantages, priorities and challenges, and the main barriers influencing the implementation of the sustainable development concept, and also the potential level of its acceptance in the communities.

One portion of the interview was dedicated to problems, which can limit the implementation of the sustainable development concept. In the Lower Morava River region, the most important of these reflected problems were of an economic character (lack of subsidies, inadequate sharing fees). These economic issues have the highest average coefficient among all categories of problems.

The second most important category consisted of the problems of environmental character (waste management, public drainage and water purification).

Social issues are perceived by interviewed representatives as less important. The most important among them include the lack of jobs and the disturbed social behaviour of the population.

The activities compatible with the sustainable development concept that are being realised most commonly and to the largest extent are as follows: substitution of solid fuels with more environment friendly ones, assistance to socially and physically handicapped people, revitalisation of self-help and self-supply, and greening of public areas.

Activities with thesmallest extent and intensity of realisation were: elimination of transit transportation, utilisation of renewables, energy saving and energy efficiency improvement, and utilisation of traditional knowledge and skills of local people.

4. Conclusions - Outlines of sustainable development perspectives

On the basis of the analysis characterising the social, economic and environmental situations within the region, and on the analysis of subjective estimates by the local population and the local/regional decision and opinion makers from the region studied, we can define several preconditions for the future sustainable development in the region.

The first strategic precondition for the sustainable development oriented decision making in the Lower Morava River region is to understand the region as an important territory of Slovakia from both natural and cultural values perspectives. The importance of the region is proven by the existence of the protected areas (Landscape protected area Záhorie and several Nature Reserves), historical monuments, and the preservation of traditions, traditional skills like handcrafts and folklore. Another precondition is to stop the process of depopulation, especially in smaller villages along the Morava River, and to implement measures leading to the improvement of the demographic structure of rural seats. A special attention should be paid to the problems (living conditions) of the Romany population. Improvement of the situation within the region would be connected with the creation of sustainable jobs, improvement of both social and technical infrastructure, and the enlargement of cultural, social and sporting possibilities. An important precondition is to improve school facilities and the whole educational system with a possible introduction of the special education, addressing the sustainable regional development.

One of the key preconditions of the further qualitative development is the preservation (and renewal) of traditions, and spirit of the region ("genius loci"), which represents a cross-road of different religious and ethnic streams, which produces a wide spectrum of cultural (both spiritual and material) manifestations.

The border location should be used to develope the cross-boundary co-operation in the field of nature and landscape conservation, culture, sport, exchange of experience, common projects, etc.

The probably most important point on the path towards sustainability is to involve the local people as much as possible into the process of preparation, adoption a realisation of the decisions.

Among the most frequently mentioned weaknesses of the sustainable development concept has been its weak elaboration and applicability for concrete regional conditions. At the same time the system of (political, legislative, economic, etc.) tools able to secure practical implementation of this concept is not in place. Thanks to the UN Conference on Environment and Development in 1992, and the work that has resulted from it, there are now several strategic documents for the implementation of the sustainable development concept at the global level. Similar documents are lacking at the national, and especially regional and/or local levels. By our definition, a sustainable development strategy means a set of strategic approaches and measures making the sustainable development concept applicable in practice with special respect to the reality of the area studied. Among these strategic tools for the Lower Morava River region renaissance and future sustainable development should be the preservation of both natural and cultural values, systematic solution of environmental problems, promotion of activities compatible with the sustainable way of living, strengthening of local communities, support of decentralisation and implementation of the principle of subsidiarity and the general development of civic society which would respect human rights and responsibilities on one hand, and sustain the life-supporting systems on the other.

References

ELIÁŠ, P. - IZAKOVIČOVÁ, Z. (1995): SCOPE Slovak National Committee Report on Sustainability in Slovakia, SNC SCOPE, Bratislava.

HRNČIAROVÁ, T. et al. (1997): Landscape Carrying Capactity - Methodology and Aplication on 3 Beneficial Territories, MoE SR, UKE SAV, Bratislava (In Slovak).

General Environmental Act, Slovakia, No. 17/1992, Bratislava

HANUŠIN, J. - HUBA, M. - LACIKA, J. - SZÉKELY, V. (1996). Possibilities of Sustainable Development of the SE Part of the Levoča Mnts. in Relationship to its Water Management Utilisation. STUŽ/SR, Bratislava (in Slovak)

HUBA, M. ed. (1996): Post-November Slovakia from the Environmental and Sustainable Living Perspectives. STUŽ, Bratislava (in Slovak)

HUBA, M. (1996): General principles, criteria and indicators of sustainable development for principal development concepcions. In: M. Kozová et al.: Strategic Environmental Assessment as a Tool for Implementation of Environmental Policy and Strategy of Sustainable Development in the Slovak Republic, Centre of EIA Comenius Univ., MoE SR, Bratislava (In Slovak).

HUBA, M. - HANUŠIN, J. - IRA, V. - LACIKA, J. - SZŐLLŐS, J. (1995): Towards Sustainable Slovakia. National Report. SSL/SR, Bratislava

HUBA, M. - IRA, V. (1998): Sustainable Development Strategy for Eastern Carpathian Regions (manuscript), GEF Slovakia, Bratislava

HUBA, M. - IRA, V. (1998): Sustainable Development Strategy for Lower Morava River Region (manuscript), GEF Slovakia, Bratislava

HUBA, M. - IRA, V. (1998): Sustainable Development Strategy for Eastern Carpathians, Lower Morava River and Tatras Region,(manuscript), GEF Slovakia, Bratislava

IRA, V. - KOLLÁR, D. (1994): Behavioural-Geographical Aspects of Environmental Quality. GeoJournal, 32, 221-224

IUCN, UNEP, WWF (1991): Carying for the Earth - A Strategy for Sustainable Living. Gland.

IZAKOVIČOVÁ, Z. - MIKLÓS, L. - DRDOŠ, J. (1997): Landscape-Ecological Pre-Conditions for Sustainable Development. VEDA, Bratislava (In Slovak).

IZAKOVIČOVÁ, Z. - KOZOVÁ, M. - PAUDIŠOVÁ, E. (1998) The Sustainable Development Implementation, SNC SCOPE, Bratislava (In Slovak).

KALIVODOVÁ, E. - RAČKO, J. - RUŽIČKOVÁ, H. (1999): Evaluation of Ecological Carrying Capacity of the Morava River Alluvium (Hodnotenie ekologickej únosnosti nivy rieky Morava). Životné prostredie, 33, 21-25 (in Slovak)

KOLLÁR, D. - PODOLÁK, P. - SZÉKELY, V. (1998): Die Slowakei der 90-er Jahre: Ausgewählte Sozial- und Wirtschaftgeographischen Aspekte. Geographische Jahrbuch Burgenland, 22, 11-48

KRIVÝ, V. - FEGLOVÁ, V. - BALKO, D. (1996): Slovakia and its Regions. Nadácia Médiá, Bratislava (In Slovak)

KOREC, P. - LAUKO, V. - TOLMÁČI, L. - ZUBRICZKÝ, G. - MIČIETOVÁ, E. (1997): Regions and Districts of Slovakia: New Administrative Division. Q111, Bratislava (In Slovak)

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (1992). AGENDA 21, A/Conf. 151/4.

This paper was supported by Science Grant Agency (VEGA) of the Slovak Academy of Sciences (grant No 4068) and by GEF Biodiversity protection Project, Slovak Republic.

Authors´ addresses:

RNDr. Mikuláš Huba, CSc.
Institute of Geography
Slovak Academy of Sciences
Štefánikova 49
814 73 Bratislava, Slovakia
huba@savba.sk

Doc. RNDr. Vladimír Ira, CSc.
Institute of Geography,
Slovak Academy of Sciences
Štefánikova 49
814 73 Bratislava, Slovakia
ira@savba.sk

Reviewer:

RNDr. Antonín VAISHAR, CSc.

AGRICULTURAL LAND USE - CLASSIFICATION IN THE LOVER MUR VALLEY (AUSTRIA) - AN INTERPRETATION BY MEANS OF A MULTITEMPORAL ANALYSIS OF SAR-DATA.

Walter ZSILINCSAR

Abstract

The paper discusses the application of ERS-radar data to agricultural land use classification in the lower Mur-valley (Styria/Austria) by means of different classification-algorithms (object-based classifications, maximum-likelihood and threshold based classification). The advatages of (radar) satellite images as compared with traditional earthbound monitoring are mainly a large-scale information potential, automated data processing, multitemporal survey and the independence from the weather situation during the survey. The greatest disadvantages besides relatively high costs are a still coarse spatial resolution (12.5 - 13.0 m max.), the high the amount of mixed pixels in the case of small-scale field patterns and, besides others, the distorted reproduction of the actual morphological (landscape) structures.

Shrnutí

Klasifikace zemědělského využití země v dolní části údolí řeky Mur (Rakousko) na základě multitemporální klasifikace radarových dat (SAR)

V příspěvku jsou diskutovány možnosti aplikace radarových dat (SAR) pořízených satelitem ERS-1 pro klasifikaci zemědělského využití země v dolní části údolí řeky Mur (Štýrsko, Rakousko). Byly použity rozdílné metody klasifikace (objektově založené klasifikace, metoda maximální pravděpodobnosti „maximum likelihood“ a postklasifikační úprava „thresholding“). V porovnání s tradičním pozemním výzkumem krajiny mají satelitní radarové snímky řadu výhod, neboť poskytují velkoprostorové informace, jsou vhodné pro automatizované zpracování, umožňují pozorování v časových řadách a jejich získání je nezávislé na atmosferických podmínkách v průběhu pozorování.

Největší nevýhodou, kromě relativně vysoké ceny radarových snímků, je stále malé prostorové rozlišení (max. 12.5 - 13.0 m), obsahují též velké množství pixelů, které nelze spolehlivě klasifikovat v případě, že objekty jsou příliš malé a kromě jiného se jedná i o zkreslení skutečných morfologických (krajinných) struktur.

Key-words: data-collection, multitemporal survey, object-based-classification, maximum likelihood-classification, geometric resolution

1. Introduction

Regional prosperity and sustainability do not only depend on material prerequisites such as physical-geographic conditions, economic and social foundations, infrastructural advantages or disadvantages, but also on the political situation, culture, minds and education of the population. A highly sophisticated documentation of regional development and change is the basis not only for analysing the reasons and backgrounds for the past but also for the future evolution.

To reach this goal until recently a comparative study of historical documents (maps, photographs, books, statistics, etc.) seemed inevitable. The rapid development of remote sensing, however, and the remarkable improvement of data accuracy, data processing, and data interpretation provided regional planners and geographers with an interesting new tool for monitoring changes of land use and landscape structure.

At the Department of Applied Geography of the University of Graz/Austria the application of satellite imagery to regional land use and planning studies is put increasing attention to. One such investigation shall be presented here very briefly (Ziegler, 1997).

2. Classification Methodology

For reasons of strategic planning normally groundtruth is desired. The traditional data collection methodology (earth-borne and air-borne) is time consuming and costly especially in the case of a permanent or repeated survey. Therefore several attempts have been made to find means that would be easier to handle and cheaper in the long run. Space-borne imagery might be the answer to this problem as far as the ground resolution can be improved so that the data processed meet the requirements and average standards of planning boards and decision-makers. It has also to be noted that not always the data accuracy of 100 % seems necessary depending on the various goals of the local or regional analysis.

After the comparative evaluation of various land use classification methods by means of ERS- and SAR-data from literature it turned out quite clearly that an average classification accuracy of around 80 % as it can be achieved from the optical data can hardly be reached from SAR-data. Mangolini and Arino (1996) executed a multitemporal classification of a test-site in the USA using 20 ERS- scenes achieving an accuracy of 70 %, in combination with Landsat-TM-data an accuracy of even 79 % depending on a special consideration of soil conditions, soil humidity, date of exposure and filtering of the speckle-effect.

In 1993, Kellndorfer, Schadt and Mauser tested various methods of multitemporal classification on a small-structured test-site in Freiburg (Germany) on behalf of their reliability. By means of the maximum-likelihood-classification method the achieved accuracies for forested areas reached 70 %, for water features 67 %, for wasteland 53 %, for grain growing areas 32 % and for buildings 21 % only. On the second step by using a "majority filter" they could significantly improve most of the results. The classification accuracy for the water features and forests reached 100 %, that for the buildings 74 % for the wasteland 52 % and for the grain growing areas 26 %. An additional forest mask raised the classification accuracies for the buildings to 75 % and those for the grain growing areas and wastelands to 53 % each.

Weydahls (1993) classification achieved an accuracy of 86 % for the cropland also using the maximum-likelihood-method, coming close to the results of an object-based classification of Ziegler (1997) for the same purpose.

3. Land use Classification in the Lower Mur Valley

The reliable land use classification according to maximum-likelihood of the attachment of each single pixel to a specific object class makes the preparation of at least thirty test-sites for each class necessary (Albertz, 1991). This presupposition could hardly be achieved in this investigation due to the poor data base for test-sites in the investigation area (cf. Fig. 1), the land use classification of 1995 hardly to be controlled and a small-scale structure of the cultural landscape which, after puffering, significantly reduced the number of the reliable test-sites.

In the first attempt towards the classification all mapped land use classes were being chosen as train-

Fig. 1: *The situation in the area under study*

ing areas. The actual situation of land sub-division as a consequence of the traditional heritage system in this part of Styria (giving each successor an equal share on the land property of the undivided estate) led to relatively small sizes of the single plots of cropland. In many cases their width does not even reach 10 meters. Considering the ground resolution of 12.5 m with radar data means that ground truth of land use could hardly be achieved. Therefore a reduction of cropland classes to 3 classes of arable land (1. root and oil crops including truck crops and strawberries, 2. cereals and 3. corn) and only one for green space (meadows, pastures, clover, etc.) was inevitable.

3.1. Object-based Classification and Threshold-based Classification

The classification followed the MLC ++ classification method using a c4.5-inducer with an "automatic parimeter" option. The evaluation of accuracy was implemented by means of a cross-validation. This method is based on data from training areas which enable the investigator to set up a classification rule which is proved by validation data. For a cross-validation the classifier himself selects data from training areas and validation during seven steps.

Seven classes of each training and validation data were chosen as follows:

1. root and oil crops (e.g. sugar-beet, soya, potato, pumpkin)
2. cereals (mainly wheat and rye)
3. unproductive areas
4. corn
5. greens (meadows and green fallows, house-gardens)
6. virgin forest
7. mixed forest

Seven channels were used for the test-sites (neglecting the September data) during the first step. The accuracy which could be achieved with the cross-validation reached 55.5 % (confidence range +/- 3.8 %).

During the following steps, the class structure was changed. Some of the test-areas for soya, wheat, corn and wasteland had to be eliminated from the data base because of mixed-pixel structures, transformation or classification mistakes. Furthermore the classes of various types of cropland were put together in order to achieve a higher accuracy and the aspect of multitemporal surveying was added.

It could be shown that the selection of adequate surveying dates and the combination of as many data as possible provided the best results. Special attention was paid to the development of the vegetation cover since the various growth periods of different plants, especially when cultivated in succession, can be accurately monitored only through a time series of surveying data.

The final integration of cereals, corn, root and oil crops together with truck crops and strawberries into one single class "cropland" yielded the best classification results (using thresholds). Tab. 1 shows the results of the object-based classification reconsidering the medians of the training-area and validation data.

Tab. 1: *Results of the object-based classification of the training areas in the lower Mur-valley (classification accuracies)*

Class	Cassification Accuracy (in %)	Misinterpreted Areas (in %)
Root and oil crops (incl. truck crops and strawberries)	70.6 %	corn (23.4 %), virgin forest (5.9 %)
Cereals		root and oil crops (incl. truck crops and strawberries), virgin forest, greens (8.3 % each)
Wasteland		root and oil crops (incl. truck crops and strawberries), corn, virgin forest (33.3 % each)
Corn		cereals (11.1 %), root and oil crops incl. truck crops and strawberries (5.6 %)
Greens		virgin (young)-forest (25 %)
Virgin forest	100.0 %	
Mixed forest	88.9 %	root and oil crops incl. truck crops and strawberries (11.1 %)

Source: M.Ziegler, 1997, p. 60

By means of an object-based classification considering the median-data of the training areas and validation the negative variation-effect can be eliminated. When recalculating the data to all pixels (via the threshold-classification), however, the advantage of the object-based classification gets lost. On the other hand the areas without the GIS-implementation can be integrated into the classification system. Another difficulty results from a relatively small number of adequate training and validation areas due to the small-scale field pattern of the investigation area.

All in all, the classification results of the medians used have reached the satisfactory accuracy rates between 70.5 and 100 % although the confidence ranges of classification results turned out quite high (+/- 10 %). This made a comparison with the results of a maximum-likelihood classification unrealistic.

3.2. Maximum-Likelihood Classification

The differentiation of land use classes according to Tab. 1 by means of ERS-data and their application to the maximum-likelihood-classification turned out impossible. Neither even an approximative field pattern could be achieved nor did the distribution and structure of land use classes prove realistic.

Only the water areas, virgin and mixed forests could roughly be classified due to their grey levels clearly different from those of cultivated land and the green spaces. The frequency of mixed-pixels along the limits of adjacent fields of various land uses additonally worsens the classification results.

The first comparison with traditional terrestrial monitoring procedures showed that namely those single plots cultivated with the root and oil crops, truck crops and strawberries hardly ever contained pixels classified as "corn" or "cereals" but could be identified quite clearly as belonging to the "root and oil crop" class. Therefore, three classes of the cropland were distinguished: (1) root and oil crops (incl. truck crops and strawberries), (2) cereals, (3) corn, and one class of the grassland (green).

In the second step, additional classes were added: spaces for transportation, virgin forests, mixed forests, water spaces, wasteland (bare soil), densely built-up areas and loosely built-up areas. During this classification step the puffered training areas could be used. The classification results turned out quite reliable apart from some difficulties with the classes of "corn", "water spaces", "densely" and "loosely built-up areas". Especially "corn" was over-classified despite the fact, that it is by far the most frequent crop in the investigation area. Standing waters could be easier identified than the running ones (e.g. the Mur River). The problem of monitoring the built-up areas will not be discussed further in this context (cf. Sulzer and Zsilincsar, 1993; 1996). The highest accuracy rates by maximum-likelihood classification could be achieved in the following classes: water-surfaces (89 %), wasteland (85 %), corn fields (82 %), spaces for transportation (67 %), green spaces (66 %), virgin forests (65 %) and cereals (65 %). The classification results of mixed forests (47 %), root and oil crops (42 %), densely built-up areas (30 %) and loosely built-up areas (10 %), on the other hand, proved unsatisfactory.

Main reasons for the misinterpretation and classification inaccuracy can be listed as follows:

- wrong geo-coding
- inadequate choice of filters to eliminate speckle effects
- wrong choice of image combinations as to multitemporal surveying data
- too few surveying data
- inadequate choice and number of representative test-sites (min. 60 per class)
- inadequate puffering between the monitored test-sites to avoid mixed pixels
- insufficient possibilities to use the control data

4. Discussion of Classification Results

The comparison of the classification results based on ERS-data (maximum-likelihood classification) with a Landsat-TM scene brought the following results [1]:

- Water bodies could be equally well detected with both methods due to the special type of reflexion from water surfaces
- Separate forested areas within the investigation area proved good classification results, the Landsat-TM classification being slightly better than ERS. Nevertheless, both procedures showed too big areas as compared with reality. Gallery forests along rivers could be very well classified.
- Green spaces and grassland supplied equally good results with both data bases.

The most significant difference between the ERS- and Landsat-TM based classification could be seen with settlements. Whereas Landsat-TM made at least a rough detection of built-up areas possible the results from ERS classification were completely unsatisfactory. Tab. 2 shows the differences in accuracy between the maximum-likelihood and object-based (median related) classifications in the lower Mur valley (cf. also Fig. 2).

---

[1] It has to be noted that there is a time difference between the ERS-data (1995) and the Landsat-TM-data (1996) which did not allow a comparison concerning the cropland

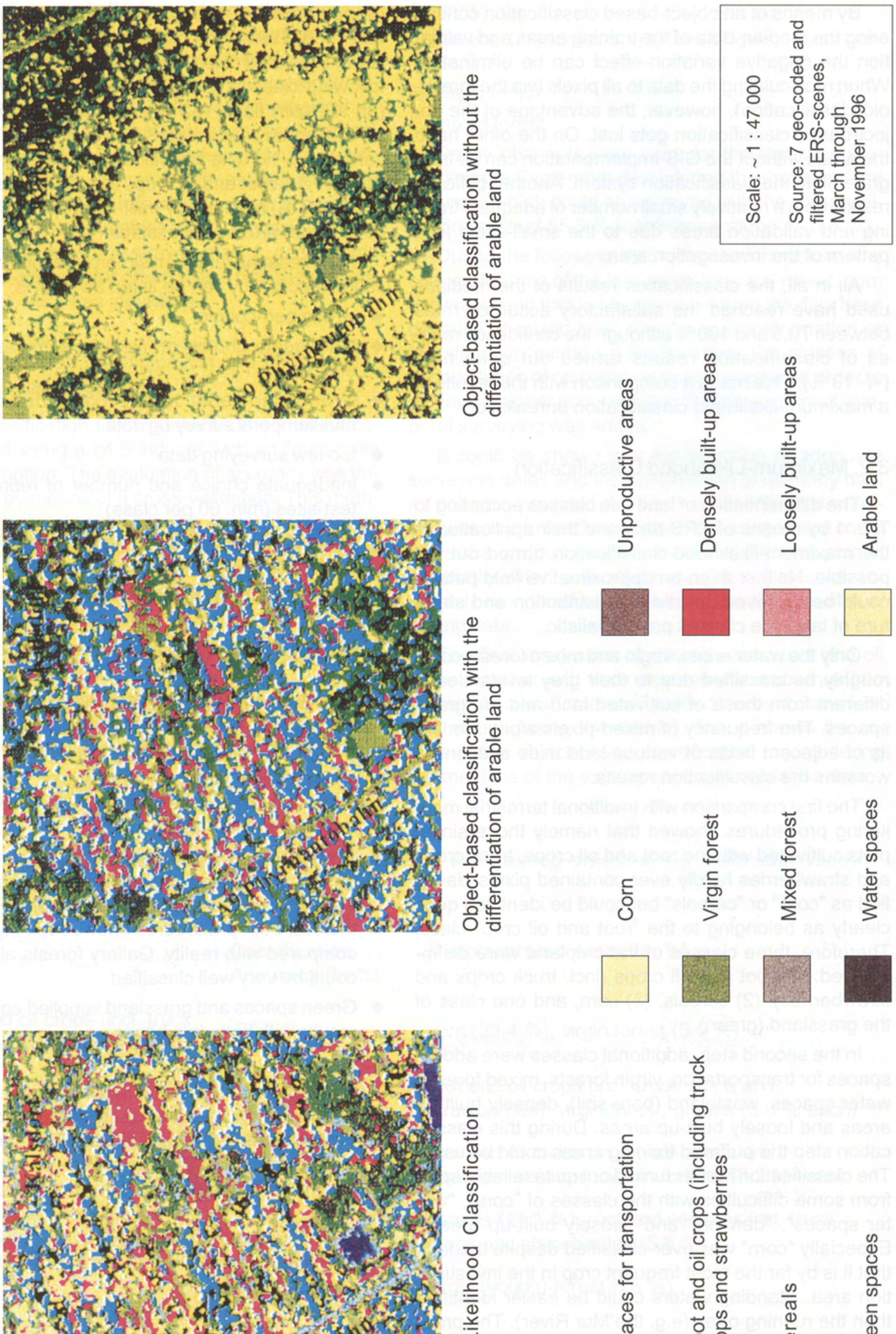


Fig.2: A Comparison between the Maximum-Likelihood Classification and the Object-Based Classification (Examples from the Investigation Area)

Tab. 2: Differences in accuracy between the maximum-likelihood (M-L-C) and object-based (O-B-C) classification in %

Class	M-L-C	O-B-C (medians)
Spaces for transportation	67.3	-
Root and oil crops (incl. truck crops, strawberries)	42.0	70.6
Cereals	64.9	75.0
Greens	65.8	75.0
Corn	37.8-82.0	83.3
Virgin (young) forest	65.1	100.0
Mixed forest	47.3	88.9
Running water	61.6	-
Standing water	65.3	-
Wasteland	85.3	0.0
Densely built-up areas	29.5	-
Loosely built-up areas	9.5	

Source: M.Ziegler, 1997, p.101

4.1. Possible Fields of Application, Advantages and Disadvantages of Radar-Based Multitemporal Land Use Mapping.

The possible fields of application of ERS 1 and ERS 2 radar satellite images for monitoring agricultural land use changes are still limited as far as the maximum ground truth is required according to their geometric resolution of 12.5 to 13 m.

Offering a repetition rate of 35 days for surveying, the ERS-data can give a remarkable support to various levels of regional and local planning, landscape restructuring, agricultural monitoring, hydrological planning, forestry, etc. One has to be aware of the limitations, however, inherent in the radar data analysis. With the investigation presented the most significant disadvantages were as follows:

- no detailed monitoring of all crops cultivated in the investigation area possible (problem of ground resolution), best results from scenes of May till October,
- differentiation of forest-, cropland- and greenland classes in hilly terrain makes difficulties due to radar-specific effects (layover, foreshootening, shadowing)
- distorted reproduction of actual surface structure demands a special adaptation of the interpretor´s eye
- sufficient time-related resolution necessary (data from the whole vegetation period if possible in monthly intervals required).

Despite these and a few more deficiencies of the present radar images, this type of surveying material offers new possibilities for permanent monitoring of agricultural landscape changes. Since a better SAR-resolution can be expected in the future, the range of applications of the radar-based satellite data to physical and landscape planning will be markedly improved.

References

ALBERTZ, J. (1991): Grundlagen der Interpretation von Luft- und Satellitenbildern. Eine Einführung in die Fernerkundung. Darmstadt, 204 pp.

BORGEAUD, M. - NOLL, J. - BELLINI, A. (1994): Multi-Temporal Comparisons of ERS-1 and JERS-1 sar Data for Land Applications. In: IGARSS 94. California. p. 1603-1605.

KELLNDORFER, J. - SCHADT, R. - MAUSER, W. (1993). The Use of Multitemporal ERS-1 SLC Data for Land Use Classification. In: IGARSS 93. Better Understanding of Earth Environment. Tokyo, p. 1608-1610

KRAMMER, H.J. (1996): Observation of the Earth and Its Environment, Survey of Missions and Sensors. p. 107-115.

KRAUS, K. (1990): Fernerkundung. Bd. 2. Bonn, p. 301-614.

LEBERL, F.W. (1988): Some Mapping Applications for Digital SAR-Imagery. In: Remote Sensing: Towards Operational Cartographic Application (Eds. M.F. BUCHROITHNER and R. KOSTKA). Graz, p. 109-114.

LÖFFLER, E. (1994): Geographie und Fernerkundung. Stuttgart, 251 pp.

MÜLLER, U. et al. (1993): Suitability of ERS 1 SAR PRI-Data for Multitemporal Agricultural Land use Mapping, ESA Sp.-361, Vol. 1. Proceedings of the second ERS-1 Symposium. Hamburg, p. 69-74.

RAGGAM, J., BUCHROITHNER, M.F., MANSBERGER, R. (1988): Operational Relief Mapping Using Non-Photographic Spaceborn Imagery. In: Remote Sensing: Towards Operational Cartographic Application (Eds. M.F. BUCHROITHNER and R. KOSTKA), Graz, p. 99-107.

SULZER, W. ZSILINCSAR, W. (1993): The Applicatin of Remote Sensing in Local Planning Illustrated by the Alpine Town of Schladming/ Austria. In. Proceedings Int. Symp. "Remote Sensing and Global Environmental Change". Ann Arbor. Vol II, p. 489-500.

SULZER, W. ZSILINCSAR, W. (1996): Fernerkundung und Kleinstadtforschung am Beispiel von Schladming und Feldbach in der Steiermark. In: Berliner Geogaph. Studien (Festschrift B. HOFMEISTER), Bd. 44, Berlin, p. 95-109.

WEYDAHL, D.J. (1993): Multitemporal Analysis of ERS 1- SAR Images Over Land Areas. In: IGARSS 93. Better Understanding of Earth Environment. Tokyo, p. 1459-1461.

ZIEGLER, M. (1997): Multitemporale Landnutzungsklassifizierung für den Raum Grazer und Leibnitzer Feld mit Hilfe von SAR-Daten (ERS-1 und ERS-2). Dipl. Arb. Abt. f. Angewandte Geographie, Univ. Graz, Graz, 138 pp.

Author´s address:

Prof. Dr. Walter ZSILINCSAR
Dpt. of Applied Geography
University of Graz
Heinrichstraße 36
A-8010 Graz/Austria
e-mail: walter.zsilincsar@kfunigraz.ac.at

Reviewer:

Doc. RNDr. Miroslav VYSOUDIL, CSc.

REGIONAL CONCERNS OF ENVIRONMENTAL POLICY AND SUSTAINABLE DEVELOPMENT

Istvan FODOR

Abstract

The deepening ecological crisis and the environment deterioration are typical at the end of the 20th century. The philosophy of sustainable development describes the consequences of the interrelationship between the socio-economic and physical environments and the directions of change. The actual integration of these relations, however, has not been implemented yet. In the presented paper the author attempts to outline a particular method to adjust requirements of the sustainable development to the regional development. The underlying research is still going on in the Centre for Regional Studies of the Hungarian Academy of Sciences and at the Department of Environmental Geography of Janus Pannonius University.

Shrnutí

Vztah regionální environmentální politiky a udržitelný rozvoj

Prohlubující se ekologická krize a zhoršování životního prostředí jsou pro konec 20.století typické. Filozofie udržitelného rozvoje popisuje důsledky vzájemných vztahů mezi socio-ekonomickým a přírodním prostředím, jakož i trendy změn. Skutečná integrace těchto vztahů však nebyla dosud realizována. V tomto příspěvku se autor pokouší načrtnout dílčí metodu odhadu požadavků na udržitelný rozvoj v regionálním kontextu. Takto zaměřený výzkum je předmětem současné spolupráce Centra pro regionální studia Maďarské akademie věd a katedry environmentální geografie Univerzity J.Pannonia v Péczi.

Key words: sustainable development, regional aspects, Hungary

Introduction

Regions have played a crucial role in the spatial control of sociol economic processes in the second half of the 20th century, especially at the turn of the millennium. The Fifth Action Plan of the European Union very definitely outlines the regional concerns and tasks of the environmental policy in countries with developed economies, as well as in Eastern-Central European and developing countries (Progress Report 1995). The document is unique and especially significant, since it deals with the problems of environmental policy in the context of sustainable development considering the strict criteria of shared responsibility and subsidiarity. Consequently, the regional concerns of the environmental policy are much different in the countries with developed economies, in East-Central Europe and in developing countries (Action: Step Towards a Local Agenda; Environmental Protection, 1996; Our Common Future, 1987).

In this respect, the position of the East-Central European countries is special. On the one hand, the major focus of the regional policy in these countries is to minimise negative effects triggered by the economic transition (such as unemployment, increasing difference in incomes, dissimilarities in living conditions). On the other hand, the regional policy is also to tackle obstacles to innovative economic activities. Associated EU countries among them Hungary face much more significant regional differences as far as the directly or indirectly related burdening of the environment and health damages caused by environment pollution are concerned (Our Common Future, 1987; Pomazi, 1988). Therefore, it is important to assess the regional consequences of structural transition in the period of preparation. Estimation, analysis and assessment of the changes in the burdening of the environment in certain regions and the impacts of new environmental conflicts must get a special emphasis. In order to best solve these problems we need to know how the strict criteria of an environmental index system could be integrated into the regional development (Kerekes and Szlavik, 1996; World Development Report, 1992). Our research within the Hungarian context aims to seek an answer to these questions, too .

Creation of the environmental index system of sustainable development

The creation of the environmental index system of sustainable development entails the following steps:

1. establishment of interventions (gathering information, selecting methods);
2. formulation of index systems;
3. survey of the measurable and comprehensible indices and features;
4. evaluation of the condition and use of the environment.

1. The establishment of the interventions starts with the gathering of information, knowledge. We have to define what we want to achieve, why, how, at what price. This activity involves a statement of the objective and strategy, definition of the task, tools, and method, consideration of the limits, effects, risks, advantages and disadvantages etc. Having gathered the adequate basic data and information, the second step is the creation of a planning system and methods: the setting up of rules, procedures and models. Finally, the forecasting and controlling methods are worked out, including potential changes, expected effects etc.

2. The second main step is a creation of an index system which consists of the following:

- *what we want to measure?* Which are those elements and qualitative characteristics of the system which are the target of our measurements?
- *how can we measure?* It means the selection of indicators and indices. The characteristics of different types have to be harmonised, and the measurements of the elements have to be compared with the measurements of whole systems.
- *what can we use it for?* What is the aim of the survey? Can we use the results in regulation, operative measures, interventions or comparisons?

3. The next important step is the listing of measurable and appreciable indices and features. If we look back at the topics of the surveys, in connection with the *issue of openness and closedness*, we have to emphasise the concepts of the materials and energies, and the mobility, the commuting of the population. As regards the *strain on and pollution of the environment*, the quality and condition of the elements of the environment can be taken as an index on the one hand, the volume of the emissions, the land use and the proportions within that, on the other. Looking at the *use of hazardous materials, activities hazardous for the environment,* both the quantitative and the qualitative features are dominant indices, also, the risk factors have to be taken into consideration. With respect to the issue of *environmental awareness*, the extent of dependence and the index of that have to defined, both in economic and social aspects. In addition, the principles of the environmental policy, which promote the realisation of the conditions set as an objective, and finally the existence, quality and efficiency of the environmental administration are elements that can be listed among the indices. Also in connection with the environmental awareness, we can examine the number of those families that changed their lifestyle in order to pay more attention to the environment, or the number of businesses that switched to producing environment friendly products (both at the level of production and distribution).

4. The 4[th] main point is the evaluation and comparison of the condition and use of the environment. After having collected the information and defined the desired condition, we can survey the former condition, strain, pollution etc. of the environment and compare it to the condition that is defined as desirable. This includes a survey of 4 categories: first we have to examine the *quality and state of the environment*: what is the actual and the desirable condition? Looking at the *burden-bearing capacity*: what are the characteristics of the potential and of possible, tolerable strains? As regards the *emission* of pollutants and the method of the *use of the environment,* again we have to compare the volume of the actual and desirable emission and use. Finally, we have to examine whether there are threats and risks concerning the environment within the given examined system.

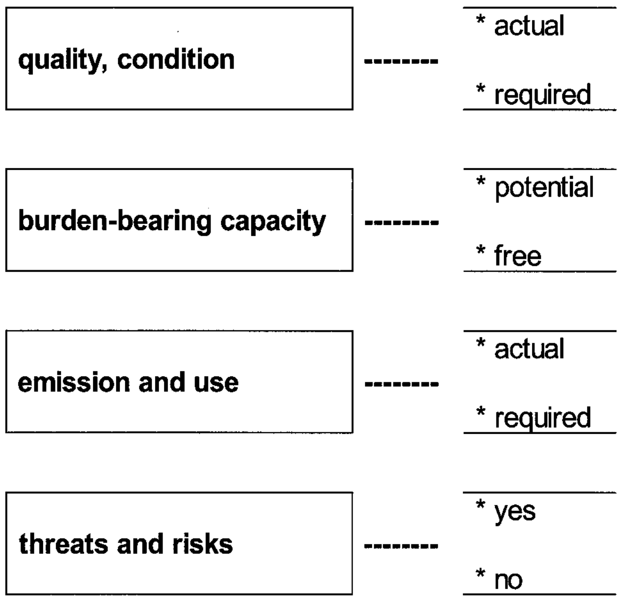


Fig. 1: The assessment of the condition and use of the environment

Looking at the state of the environment, with the use of the sustainable development index system - i.e. a development leading to the desired condition -, we can define a method for the environment-based activities and investments. As regards the state of the environment, the desired and defined activities can be as follows:

- preservation and maintenance of the natural systems;
- decrease of the environmental pollution;
- elimination, closing down of activities damaging the environment;
- introduction of economic and social developments, new, environment friendly means of use not harmful to the natural environment and civilisation.

Index numbers of ecological sustainability

A basic idea of the sustainable development is ecological sustainability. The preservation of the systems supporting life and the mainenance of bio-diversity are basic principles of the sustainable development. For the protection and preservation of bio-diversity, we can define index numbers in the following fields:

1. prevention of pollution;
2. rehabilitation and maintenance of eco-systems;
3. creation of a comprehensive system of protected areas;
4. protection of the species and the genetic assets.

1. Prevention of pollutions

- annual emission of sulphur-dioxide, methane, CFC-s, nitrogen-oxides: total, per capita and per GDP unit
- quality of the rivers: solved oxygen concentration, nitrate concentration
- sewage treatment: percentage of the population served by (primary, secondary and tertiary) sewage treatment plants
- industrial accidents: their number, number of deaths, per GDP unit

2. Rehabilitation and maintenance of the eco-systems

- how many per cent of the examined region is natural, transformed, cultivated, built-up or deteriorated
- as a continuation of the above-said: the percentage of forested areas, including natural, transformed and planted forests
- proportion of natural and transformed eco-systems and vegetation types e.g. in breakdown by areas larger than 10 000 hectares

3. Creation of a comprehensive system of protected areas

- proportion of nature protection areas in each ecological region

4. Protection of the species and the genetic assets

- number of species, percentage of those on the brink of extinction, percentage of the species with a stable or growing population and the proportion of those species whose population is decreasing
- number of endemic species, within that the proportion of those jeopardised by extinction, and the percentage of those living in protected areas
- the proportion of endangered species ones which have viable populations in the ex situ conditions
- index of domesticated species (number of versions and species in the regions, for all domesticated plants and animals, in percentages of the figures recorded 10 or 50 years ago)
- uniformity index of the grown plants and domestic animals (relationship of the plant versions and the animal species)
- percentage share of the ancient (traditional) versions in the ex situ collections
- index of the gene bank situation (percentage of the collections renewed in the last 15 years)

Use of the renewable / non-renewable resources

The objective in connection with the resources is the sustainable use of the renewable resources and the minimum use of the non-renewable resources. A detailed analysis of this issue reveals the below correlations.

1. Significance of the income producing sector (total value) and employment

The definition of the total value of contribution by the sector provides a basis for the calculation of the changes in the resources and ecological infrastructure of the sector.

2. The situation of the resources of the sector

The resources of the sector are natural assets which are directly used by the sector : trees in the case of the wood processing industry, or water power, crude oil, natural gas, coal and wood in the case of the energy sector.

3. The situation of the ecological infrastructure of the sector

The ecological infrastructure of a sector means the ecological processes sustaining the sector, and the biological diversity: e.g. soil, water, genetic diversity of the vegetation or domestic animals in the case of agriculture.

In the case of the sectors based on the *living resources* (wood processing industry, fisheries and aquaculture, other harvesting sectors, agriculture and horticulture, tourism and recreation, and a few energy producing sectors), the following parameters have to be measured: hydrological cycle (quality, quantity and stability, reliability of water assets), soil structure and fertility, air quality ; also, surveys are needed in connection with the climate, the eco-system necessary for the long-term production, the diversity of the species and within the species.

In the case of the sectors based on the *non-living resources* (most of the mining and energy sector), quality, quantity and stability of water assets need to be measured, air quality and climatic changes.

4. The compatibility and conflicts of the sector with the sustainability of other sectors

Items 2 and 3 indicate what can be called the internal sustainability of the sector. The external sustainability has to be measured, too: its effects on other sectors, business life apart from the polluting sectors, human health and infrastructure, also, the integrity of the ecosystem or bio-system of the Earth.

5. The main socio-economic factors influencing the sustainability of a sector

There are several factors which promote or block the sustainability of a sector. The most important of these are as follows:

- *The share of the benefits compared to the given part of the resources.* One way to achieve sustainability is to increase the benefits deriving from the same amount of the resources. Vice versa: the decrease of the benefits deriving from the same amount of the resources is the sign of non-sustainability. There are two benefits that can be examined: the increase in the number of jobs and the increase of total (company, personal, municipal, regional) revenues. The indices contain the trends of earnings and production, number of jobs and their proportion within the income production, and the changes of the values compared to the unit of the resource.
- *The volume of the contributions by the users of the resources to the total costs of the measures taken by the society.* The indices here involve the development and protection contributions paid by the industry, government and others (including future generations), the net value of taxes paid by the sector and subsidies, i.e. the total taxes minus the total subsidies.
- *The actual participation of communities and interested groups in the decisions most directly concerning them.* Do the communities depending on the given sector have a real influence on how the protection and development activities of the sector are planned and managed?
- *The following of a trend in the decision-making which tries to foresee and prevent the problems.* To what extent are the correlations and conflicts with the other sectors and interest taken into consideration?

Keeping the ecosystem within the limits of burden-bearing capacities

In ecology, the supporting capacity of a given territory is the population which the territory is able to support without being damaged. Theoretically we can raise a question of how many people are provided favourable conditions of living by the supporting capacity of the Earth and how long the ecosystems can be kept within their limits of tolerance? The theory of sustainable development fits into the ideas of the traditional thinking of economics, no change of paradigm is needed. The sustainable development does not require a restriction of our needs, it only stimulates us to try to satisfy them by using less materials and energy (which might entail the decreased consumption) and to minimise the polluting effects of the producing activities.

The following indicators can demonstrate the efficiency of the actions aiming at the decrease of consumption and stabilisation of the population:

- per capita use of food, water, wood and minerals;
- use of energy per capita and per GDP unit;
- communal waste produced per capita and per GDP unit;
- industrial waste produced per capita and per GDP unit;
- radioactive waste produced per capita, GDP unit and energy unit;
- population trends;
- rate of population increase;
- population density.

References

Progress Report from the Commission on the Implementation of the European Community Programme of Policy and Action in Relation to the Environment and Sustainable Development: 'Towards Sustainability' (Com(95) 624 final 1995)

Action: Step Towards a Local Agenda (http://WWW.agenda21.ee/english/material/toolbox2eng.html)

Environmental Protection Programme of Hungary (1996). A General Implementation Plan. Budapest.

Our Common Future (1987). Oxford University Press. Oxford, New York.

Pomazi, I. (ed) (1988): Az átmenet irányítása a fenntartható fejlődés felé. Az OECD kritikus szerepe. (The Management of Transition towards the Sustainable Development. The Key Role of OECD.) Szemelvények az OECD környezetpolitikájából. Ministry of Environment and Regional Development, Budapest.

Kerekes, S. and J. Szlavik (1996): A környezeti menedzsment közgazdasági eszközei (Economic Tools of Environmental Management). Közgazdasági és Jogi Könyvkiadó, Budapest.

World Development Report 1992, Development of the Environment, Oxford University Press, New York.

Author´s address:

Prof. Dr. István FODOR
Centre for Regional Studies
P. O. Box 199
H - 7601 Pécz, Hungary
e-mail: fodor@dti.rkk.hu

Reviewer:

RNDr. Oldřich MIKULÍK, CSc.

THE PAST AND FUTURE OF GEOGRAPHY IN THE JAGIELLONIAN UNIVERSITY IN CRACOW

(THE 150th ANNIVERSARY OF THE FIRST GEOGRAPHY CHAIR IN POLAND)

Barbara OBRĘBSKA-STARKLOWA

On 23-24 April 1999, in the Institute of Geography of the Jagiellonian University (JU) in Cracow was held the "Polish Geography Congress" to co-memorise the 150th anniversary of the first Geography Chair in the territory of Poland. Initiating the jubilee, the JU Institute of Geography organised a methodological session "Polish Geography at the turn of the third millennium" in Zakopane in November 1998. The session was devoted to the state-of-the-art and to the past of the Polish Geography, possibilities of its development, and relations to other branches of science and to practical application of geography results. These Poland-wide scientific meetings were given a special importance as they are a part of the 600th anniversary of restoration of Cracow Academy jubilee to be celebrated in 2000 and that is under patronage of the Parliament of the Polish Republic. On the occasion of the jubilee the staff of the Institute of Geography published four volumes of "Geography at the Jagiellonian University in 1849-1999". This paper draws upon the above volumes.

Lectures in geography in the Cracow University were given for the first time some 500 years ago. During the Enlightenment in the 18th century, the time of a great reform of the University, these lectures were taught as "cosmography" and played a complementary role to the subjects of history, physics and statistics. The foundation of a meteorological station in the astronomical observatory of the University owing to Prof. Sniadecki's efforts in 1792 was a weighty event in the research programmes improvement during the reform. The establishment of the Geography Chair in 1849 took place during the partitioning of Poland, i.e. during the period unfavourable for the Polish science development. Yet, it was an outcome of numerous circumstances that contributed to the realisation of the Chair concept. The idea of the Geography Chair came from Prof. Wincenty Pol, a poet and enthusiastic examiner of the nature and man in the motherland. Prof. Pol was given backing from the Philosophy Department of the Jagiellonian University. Prof. Pol deserves a credit for introducing changes in perceiving the geography tasks. He understood geography as an independent science studying a nature of the Earth and environment in which a man lives. Moreover, Prof. Wincenty Pol contributed to the development of didactics by bringing in to the Chair the newest atlases and maps as well as handbooks in the field of geography and nature (mainly German and French publications). Among others professor lectured regional geography and organised, together with naturalists and geologists, research excursions to the Tatras and surroundings of Cracow. Prof. Pol's scientific conception was developed under the influence of Prof. Alexander Humboldt and Karl Ritter of Berlin. This promising Geography Chair development was interrupted in January 1853 due to its closing down and Prof. Pol's dismissal by a decision of the Austrian authorities. The break of activities lasted until 1877 when Prof. Czerny-Schwarzenberg was called to the chairman post. He was a professional historian who additionally studied geography under the supervision of Oskar Peschel and Edward Suess and ethnography in Vienna and Leipzig. Yet the geography lectures at the Cracow University were reactivated not earlier than in 1882 on a special request of intellectuals. In his activity prof. Czerny drew upon German geography. His scientific achievements include the first Polish handbook on trade geography (1889).

In the 150-year long period of the Cracow geography development, Kortus et al. (1999) distinguished the following stages:

- The so called, Wincenty Pol's period which initiated geography as a science in Poland and played an important role in the development of patriotic attitude of the Polish society. The Geography Chair founded in Cracow by Pol was the second one in Europe (after the University in Berlin) and the preceded foundation, i.a. of the Geography Chair at the Jan Kazimierz University in Lvov under the leadership of Prof. Antoni Rehman, a known researcher and geobotanist. Relations between Lvov and Cracow became reinforced due to the collaboration in the field of educating research staff who became employees of the Cracow research centre in the following years,

- The period of dynamic development of geography at the Jagiellonian University in 1917-1939 during the era of Prof. Ludomir Sawicki and Prof. Jerzy Smoleński. The first of them graduated from the University of Vienna and wrote his habilitation thesis at the Jagiellonian University in 1917. He chaired Geography after Prof. Czerny-Schwarzenberg and became a founder of a modern geography study, which gained the status of the Institute of Geography in 1918. In 1922 the second Geography Chair under the leadership of Prof. Smoleński (geological studies and habilitation at the Jagiellonian University and additional geographical studies in Berlin) was called into being. In the period between WWI and WWII, the activities of Prof. Sawicki (until his death in 1928) and Prof. Smoleński (died in Sachenhausen concentration camp in 1940) focused on the consequent and solid development of a strong geography centre in Cracow, one of the greatest centres in Poland - apart from Lvov, where Prof. Eugeniusz Romer acted, Warsaw (Prof. Stanisław Lencewicz) and Poznan (Prof. Stanisław Pawłowski). Professors Sawicki and Smoleński concentrated around themselves gifted and creative assistants among whom were: Dr Mieczysław Klimaszewski, Dr Stanisław Leszczycki, Doz. Wiktor Ormicki, Dr Antoni Wrzosek. Among the Cracow geography alumni of the inter-war period there were many outstanding scientists who led later numerous university and research institutes after the WWII. The most intensively developing branches of geography in the inter-war period were: geomorphology based on field studies in the Carpathians and Spitsbergen (M. Klimaszewski works), which was establishing its position as a Cracow geomorphology school, and anthropogeography including geography of settlements and population, economic geography and tourism geography just coming into existence. Dr. Leszczycki created this last branch, due to establishing the post-graduate studies of tourism in 1936. Related multi-facet studies were undertaken in the Carpathians, both in the field of physical geography (measurements of solar radiation and snow cover conducted by Dr. W. Milata in the Tatras) and in economic geography.

The Cracow geographers took an active part in international geographical congresses and in meetings of Slavic geographers and ethnographers as well as in the International Geographical Congress in Warsaw in 1934. French (E. de Martonne) and English (W.M. Davis) geography had the largest impact on shaping the Polish geography in the described period. Yet the collaboration with other geographic centres in Poland was most often limited to giving and taking some specific courses and lectures there. For instance, Doz. Ormicki lectured economic geography at the Warsaw University, in the Silesian Pedagogic Institute in Katowice, at the Vilnus University and at the Department of Law and Economy at the University of Lvov.

- The period of the Nazi occupation in 1939-1945 made research and didactics at the Jagiellonian University impossible. In concentration camps died: Prof. Smolenski (Sachsenhausen), Doz. Ormicki (Gusen), Prof. Walenty Winid. Doz. Szaflarski and Dr. Leszczycki taught in the underground educational system while Dr. Leszczycki, Dr. Klimaszewski and Dr. Wrzosek participated in the resistance movement.
- The period after 1950 is a time of comprehensive development of the Cracow geography both quantitative (as to the staff and number of institutions) and qualitative consisting in a systematic collaboration with the world geography.

After WWII the first director of the JU Institute of Geography was Eugeniusz Romer, Professor emeritus of Lvov University, who was a supervisor of habilitations of future professors, i.a. M. Klimaszewski and S. Leszczycki , in 1946-1954. Prof. Klimaszewski was director of the JU Institute of Geography in 1949-1978 while Prof. Leszczycki moved to the Geography Institute of Warsaw University in 1948. There he was a head, and then he organised, from the very foundations, the Institute of Geography of the Polish Academy of Science, which he directed until 1977. In the first years after WWII geography alumni of the Jagiellonian University worked in various universities and branch research institutes. In Cracow - as in the whole Poland - geography split into specialised branches: physical and economic geography with developing sub-disciplines. Professors

Klimaszewski and Wrzosek supervised the development of the geography branches at the beginning. Later, their graduate students were in charge of particular disciplines' progress. The geographical research maintained specific characteristics of the inter-war period, which were as follovs.

- field work and empirical studies as a background, and undertaking laboratory experiments later,
- dynamic approach in the studies on physicol-geographic and sociol-economic processes,
- permanent improvement of the study methods from the traditional field mapping to the application of aerial photographs and satellite images, GIS and statistical methods using computer techniques.

The most important achievements of the geographic university centre in Cracow in the past 50 years are as "follows:

- elaboration of the fundamentals of geomorphologic and hydrographic mapping (based on genetic-chronology principles) at various scales by Prof. Klimaszewski; because of that Poland had an outstanding position in the world geomorphology in the 1950s and 1960s;
- elaboration of a quantitative model of climatic vertical zonality in mountains of a temperate zone by Prof. Hess;
- implementation of a tourism geography as a geography discipline and didactic specialisation for students by Prof. Warszynska by the end of the 1970s;
- development of geography of religion as an independent branch of science in Poland in the 1980s - owing to that pioneering works in the Polish and foreign literature were issued under the supervision of Prof. Antoni Jackowski.

In the discussed period of the development of the JU Institute of Geography, research contacts with other geography centres in Poland were vivid thanks to the geographers' meetings organised by the Polish Geographic Society. Yet, the travelling abroad became possible from the 1960s, and the collaboration with the foreign partners was limited, initially, to the communist countries. Starting from the 1970s, however, employees of the Institute benefited from the bilateral direct contracts between the Jagiellonian University and other universities of the world on a short-term training or, more rarely, on a long-term scientific exchange. Initially, within the framework of this exchange a dozen foreign students visited Cracow. In the 1980s the scientific exchange invigorated. So, thanks to the direct exchange, and to the individual invitations, scholarships and participation in conferences up to 30 persons of the Institute had an opportunity to acquaint with the centres abroad each year. In the 1990s an international collaboration was also undertaken under the framework of TEMPUS, the Baltic Sea University Programme, West-East Linked Laboratories GIS.

The pre-war tradition of participation in research expeditions, which were also developed by Prof. Sawicki (to Asia and Africa in 1923 and 1925) and Dr. Klimaszewski (the Spitsbergen in 1938) found their enthusiasts. Most popular were the following expeditions: Mongolia (Chantey and Changay Mts., Gobi Desert and mid-Mongolia steppes), the Spitsbergen, the Alps, Afganistan, and the Peruvian Andes. Outcomes of these expeditions were valuable publications and graduate works at various levels.

The scope of research carried out by the Institute varied in different periods depending on current trends in the Polish and world geographies. In the present decade the main research directions in the Institute are as follows:

- climate and bioclimate of mountains and uplands;
- present-day tendencies to climatic changes;
- structure, functioning and changes in the natural environment of the Carpathians and their foreland;
- dynamics and spatial differentiation of surface and ground water regime;
- dynamics of the environment and its resistance to human impacts;
- comparative studies on relief dynamics in selected mountain regions,

- differentiation and protection of mountain soils;
- mapping, GIS and remote sensing in the studies on geographic environment changes;
- importance of tourism in functioning of a region;
- organisation and dynamics of a social-economic realm in Poland during the shift to market economy;
- demographic, social and functional changes in large cities and rural areas;
- functioning and changes in the industry under the new economic system;
- natural, historical and socio-economic ground of the development of a tourist and spa functions;
- socio-economic functions of pilgrimage migration.

The above field of interest is realised within the framework of the Institute research programme and thanks to the grants from the National Committee for Scientific Research, international exchange and thanks to collaboration with national and foreign partners. Many interesting studies are carried out in research stations of the Institute in Lazy and Gaik-Brzezowa and in the Cracow historical meteorological station. The Institute of Geography has sufficient computer facilities and possesses the hydrochemical and soil laboratories in Lazy. Moreover, a publishing studio was formed in the Institute that significantly improved the editorial tasks, especially in the area of publishing the research results, student workbooks and periodicals (continuation of "Prace Geograficzne" or "Peregrinus Cracoviensis", devoted to geographical aspects of the pilgrimage movement).

In the Institute structure there are 11 departments and 3 laboratories which perform both research and didactic tasks. Most important is to educate professionals in various disciplines of geography. In 1882-1998 from the Institute of Geography graduated: 72 doctors in physical geography, 61 doctors in social-economic geography, 4 in cartography and mathematical geography and 8 in history of geography and historical geography. The doctoral programme was developed for three years. In the field of students' education, starting from the 1950s, the rigorous system of study was obligatory. Within this system the majority of taught subjects were imposed by the syllabus of the ministry to which the University was subdued. From 1970s there was a propensity to introduce innovations to the courses offered within the diurnal studies associated with the specialisations being developed in the Institute of Geography. A radical change in the system of studies took place in the academic year of 1990/1991 when each student was offered a possibility of an individual programme of the studies supervised by a tutor. The students can choose not only from the courses offered by the JU Institute of Geography but also by other departments of the Jagiellonian University and by other universities in Cracow. The Institute offers intramural studies, functioning within the framework of an obligatory system, from 1973. The intramural studies give an opportunity to specialise in the field of physical or socio-economic geography. Moreover, the Institute offers also post-graduate studies in the field of protection and management of environment from 1994 and in the field of tourism - from 1998. An important collaborator in didactic tasks is the Circle of Geographers of the Jagiellonian University existing since 1881. The Circle is an initiator of various forms of self-education (i.a. research expeditions in Poland and in the world), scientific meetings and workshops and social gathering of students and alumni.

References

Kortus, B. - Jackowski, A. - Krzemień, K. (1999): Dzieje Katedry i Instytutu Geograficznego uniwersytetu Jagiellońskiego. In: Geografia w Uniwersytecie Jagiellońskim 1849-1999, Instytut Geografii Uniwersytetu Jagiellońskiego, T.1, Kraków.

THE 3RD MORAVIAN GEOGRAPHICAL CONFERENCE CONGEO '99: REGIONAL PROSPERITY AND SUSTAINABILITY, SLAVKOV U BRNA, SEPTEMBER 6-10, 1999

Antonín VAISHAR

The Brno Branch of the Institute of Geonics, Academy of Sciences of the Czech Republic organized the 3rd Moravian Geographical Conference at Slavkov u Brna from 6 - 10 September, 1999. The Conference topic was Regional Prosperity and Sustainability. Apart from the organizing institution, the Conference was attended by 30 experts from Belgium, Bulgaria, Czech Republic, France, Italy, Canada, Hungary, Germany, Poland, Portugal, Austria, Sweden, U.S.A. and Great Britain, who presented 25 papers and took part in lively discussions.

The Conference was opened with papers presented by F.W. Carter (London) on the role of direct foreign investments in the regional development of central and south-eastern Europe, B.Greer-Wootten (York, Canada) who introduced the conception of sustainable life, and I. Fodor (Pécs) on the regional conception of environmental policy and sustainable life.

Other contributions of the first Conference day were those of A. Kerényi and P. Csima (Debrecen/Budapest) concerning the carrying capacity and sensitivity of Hungarian landscapes, M. Volk (Leipzig) on the interaction between the landscape equilibrium and the area utilization in the region of Dessau, M. Czerny (Warsaw) about the policy diversification in eastern Poland in the period of transformation, P. Hlavinková (Brno) on the Czech state policy in the sphere of environment, Z. Roca (Lisbon) on functionaries and initiatives of local development, W. Sulzer (Graz) on the utilization of satellite photographs to monitor environment conditions, Z. Dlugosz and S. Kurek (Cracow) on the demographic aspects of regional development, M. Pásková (Prague) on the possibilities of using the sustainable tourism for regional development, and G.W. Shannon (Lexington, U.S.A.) on the role of telecommunications at modifying the conception of the region.

The second Conference day started with a Hungarian block of papers. A. Kerényi and G. Szabó (Debrecen) summarized the main environmental problems of central and

Photo: P. Hlavinková

Photo: P.Hlavinková

eastern Europe, G. Kiss (Debrecen) informed about the nature protection in borderland regions of Hungary, A. Székely (Szeged) mentioned the EU programmes for across-the-border regional cooperation, and G. Horváth (Budapest) concentrated on the problems of landscape values in the region of Medves.

M.F. Gaunard (Metz) informed the Conference about the role of euroregions in the sustainable development of regions, A. Vaishar (Brno) about the regional context of disastrous floods in the Morava River catchment in 1997. Other three contributions (C. Collis-D.Noon, Q. Botchway-D.Noon and M. Dahlström) were devoted to the problems of restructuring the old industrial districts of Coventry and Birmingham. F. Miani (Parma) presented the results of a comparative analysis into the environment of towns in northern Italy, M.N. Oliveira-Roca (Lisbon) discussed the problems of Alto Minho, a rural region in northern Portugal, and F. Orban-Ferague (Namur) raised a stormy discussion concerning the problem whether the too fast urbanization can ever be sustainable, which was documented on an analysis of the regional plan worked out for the Philippine region of Cagayan de Oro-Illigan-Corridor.

At an excursion, the Conference participants got acquainted with the historical and geographical problems of the Slavkov battlefield (Austerlitz - 1805), with the problems of transformation in rural region (Kunštát na Moravě), in the small Moravian town (Boskovice), and in the city (Brno). The presented papers were published in the Conference Proceedings.

The objective of the 3rd Moravian Geographical Conference was in the first place to strengthen, extend and establish the contacts among geographers from different European countries. In addition to direct discussions, there may be concrete projects of scientific cooperation in the future. This is the reason why the conferences are organized in the friendly and cosy environs of a small Moravian town. Thirty to forty participants from a great number of countries have a good opportunity to meet informally and the conference need not be divided into sections.

Responses from the foreign guests indicate that there are many who would be interested in attending the 4th Moravian Geographical Conference "Nature and Society in Regional Context" to be held by the Brno Branch of the Institute of Geonics AS CR in one of smaller Moravian towns in September 2001.

CZECHIA = BOHEMIA + MORAVIA + SILESIA

Jan MUNZAR, Milan V. DRÁPELA

It appears that the adjective of "Moravian" in the title of our periodical does not use to be sometimes correctly understood in foreign countries. Therefore, it should be explained that it derives from the name of a historical land of "Morava" (Moravia in Latin and English; Morava in Czech; Mähren in German, Moravie in French, Morawy in Polish), situated in the estern part of the Czech Republic.

The Preamble of the Constitution of the Czech Republic, which came in force on 1 January 1993, mentions three historical lands in its territory in a following way: "We, citizens of the Czech Republic in Bohemia, Moravia and Silesia, at the time of restoration of the independent Czech state, loyal to all good traditions of the long-standing statehood of the lands of the Czech Crown and the Czechoslovak statehood, determined to build, protect and develop the Czech Republic in the spirit of inviolable values of human dignity and freedom ... , adopt this Constitution of the Czech Republic ...".

The historical lands mentioned in the Constitution are well evident from the administrative division of the territory in 1920 (Fig. 1). Bohemia (with the capital of Prague), Moravia (with its capital of Brno) and Silesia (with its capital of Opava) - together with Slovakia and Sub-Carpathian Ukraine- constituted Czechoslovakia that came into existence after the end of the Habsburg monarchy in 1918. Silesia as an independent land was abolished on 1 January 1928 and annexed to Moravia in order to constitute the Moravian-Silesian land (with Brno as a capital).

One of the first steps made by a new Communist government in 1948 was the abolishment of the provincial pattern in the country, probably in order to suppress the historical awareness, to the date of 31 December 1948. This means that to the date of 1 January 1949, there were four counties constituted in the territory of Moravia and Silesia, which however did not respect the historical regional borders; the fifth county with the administrative centre in Jihlava was then consisting of approximately a half of the

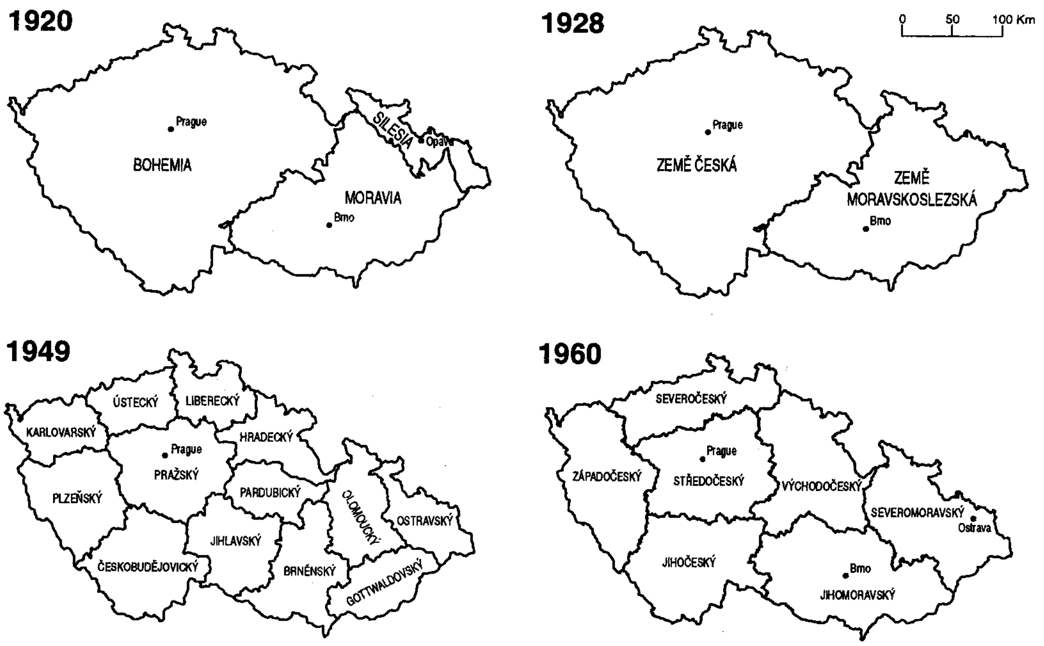


Fig. 1: *The history of dividing the Czech Republic in the context of Czechoslovakia.*

south-western Moravian territory and a half of the south-eastern part of Bohemia on the other side.

In 1960, the number of counties in the Czechoslovak Socialist Republic was reduced in such a way that there were only two in the Moravian-Silesian territory: the North-Moravian county with the capital of Ostrava, and the South-Moravian county with the capital of Brno. The borders between the two counties were again alligned to suppress the identity of the individual territories; for example the traditional SW Moravian area (region of Dačice) was annexed to the South-Bohemian county with the centre in České Budějovice. The two "Moravian" counties were cancelled -together with other five counties in the territory of Bohemia- to the date of 31 December 1990. At the present time, there are no higher territorial-administrative units. The basic units for the time being are 76 districts with the capital of Prague having the status of an independent district.

Moravia as an administrative unit ceased to exist de facto as long as 50 years ago. However, its historical area of 26 095 km^2 became a part of the Czech Republic (78 864 km^2) since 1993. The country's name derives from the Slavonic tribe of Moravians, first mentioned in 822. In the 9th century, Moravia became a core of the first early feudal formation - the Empire of Great Moravia. After the Empire had been destroyed by Hungarians in 907, the centre of the state's development was gradually transferred to Bohemia. The first time that Moravia was acquired under the sovereignty of the Bohemian dukes was the first half of the 10th century and then definitively in 1029 - 1031. In 1182, Moravia was bestowed the status of an independent Margraviate of Moravia.

Moravia is plotted in a so called Ebstorf map (Fig. 2) as early as at the beginning of the 13th century. The authorship of this largest circular map of the world with the diameter of 356 cm is being attributed to the provost of the Benedictian monastery at Ebstorf near Hannover, Cervasius of Tilbury (1150 - 1235). The map is considered to have been made in about the year of 1234, or even as early as in 1214 and contains the name of Moravia as well as the course of the Morava River - Macha fl. According to the text of the Ebstorf map (after the Hamburg Church Cronicle of 1072 written by Adam of Bremen), the Elbe and Odra Rivers spring not far from each other on the forested Moravian slopes; however, they flow in opposite directions with the Odra River turning to the North and the Elbe

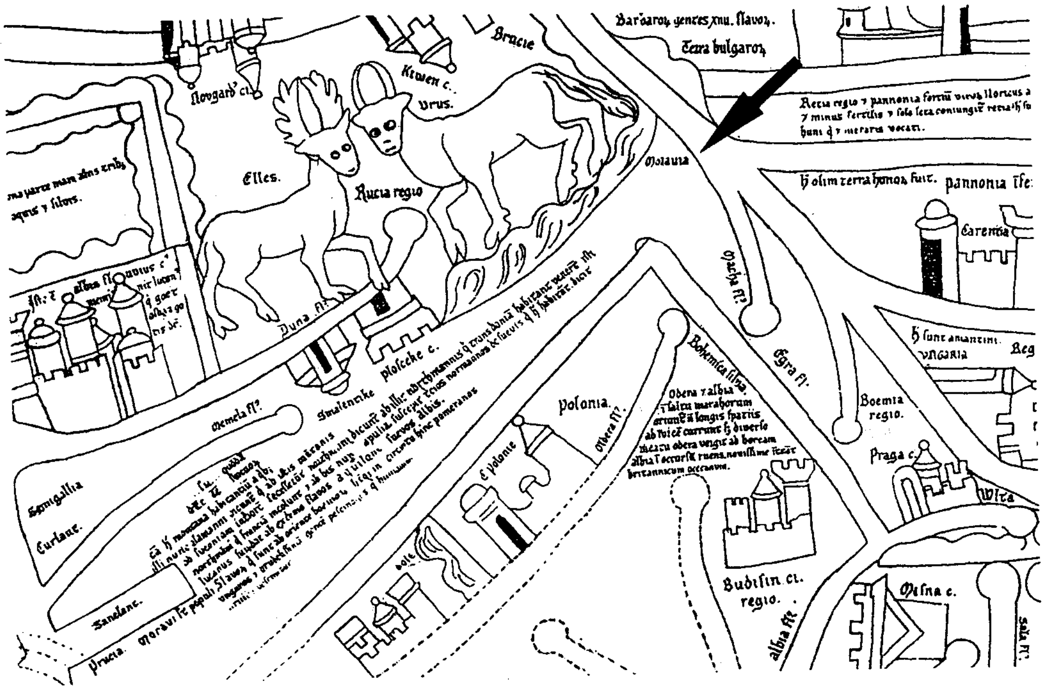


***Fig. 2:** A section from the so called Ebstorf Circular World Map of the 13 th century with the first plotting of Moravia.*

River turning to the West and flowing into the British Ocean. Inhabitants are mentioned as Moravians being the Slavonic tribes living to the east of Boemes and neighbouring with Pomeranians on the one side, and with Hungarians and the most atrocious tribe of Pecenegians who fed on human flesh. It must be added at this place that the original of the Ebstorf map was unfortunately not preserved - having been destroyed at the bombing of Hannover in 1943.

As to the third historical land mentioned in the Constitution of the Czech Republic as Silesia (Silesia in Latin and English; Slezsko in Czech; Schlesien in German; Silésie in French), it is in fact only a small southern part of a historical territory in Central Europe bearing this name and belonging in its greater part to Poland. After the constitution of Czechoslovakia in 1918, the Silesian land occupied as much as 4 458 km^2 of the country's area .

Shortly after the coming into existence of the Czech Republic six years ago it appeared necessary, among other also in connexion with the prepared entry of the country into the European structures, to come into terms with the common practice of referring to the new state by a single-term official geographical name. Its equivalents in different languages are included in the UN Geographical List of Terminology - Czech Republic (1993) where the English, French, German, Spanish and Italian names of the country are Czechia, Tchéquien, Tschechien, Chequia and Cechija, respectively.

The Ministry of Foreign Affairs of the Czech Republic recommends to use the official two-term name of the country of the Czech Republic only in official documents and texts (laws, contracts, treaties, notes, etc.) of a special significance, in the names of important national institutions and in official speeches. At translating the name of the country into foreign languages it is in the first place necessary to respect its orthographical norms and the logical context. Provided that the principle is observed, it is tolerable -and in some cases even desirable- to translate the name of the "Czech Republic" into its single-term equivalent such as the "Embassy of Czechia in ..." in English.

It can be concluded that the relation of the Czech Republic and its historical lands in the Preamble of its Constitution can be simplified into the above equation: Czechia = Bohemia + Moravia + Silesia. It is therefore not correct that the name of the Czech Republic is sometimes substituted by the name of Bohemia which is in fact the name of only the western part of the country.

References:

DRÁPELA, M. V. (1994): Development of Moravian cartography (in Czech). Second Doctorate, Masaryk Univ. in Brno, 220 pp.

FELIX, J. (1995): To the name and state symbols of our country (in Czech). Dějiny a současnost, Vol. 19, No. 5.

FELIX, J. - JELEČEK, L. - RUBÍN, J. et al. (1998): The standpoint of geographers, linguists, historicians and experts in other scienitific branches to the issue of a single-term geographical name for the Czech Republic (in Czech). Geografie-Sborník České geografické společnosti, Vol. 103, No. 2, p. 120-122.

HONZÁK, F. et al. (1997): Europe in the transformations of centuries (in Czech). Libri, Prague, 767 pp.

CHROMÝ, P. (1998): Discussion on "The standpoint of geographers, linguists, historicians and experts in other scientific branches to the issue of a single-term geographical name for the Czech Republic" (in Czech). Geografie-Sborník České geografické společnosti, Vol.103, No. 1, p. 50.

UN Geographical Lists of Terminology - Czech Republic: Names of States and their Territorial Parts. Český úřad zeměměřičský a katastrální, Prague 1993.

JELEČEK, L. - CHROMÝ, P. (1997/1998): Development of the Czech state in terms and dates (in Czech). Geografické rozhledy, Vol. 7, No. 2, p. 43-45.

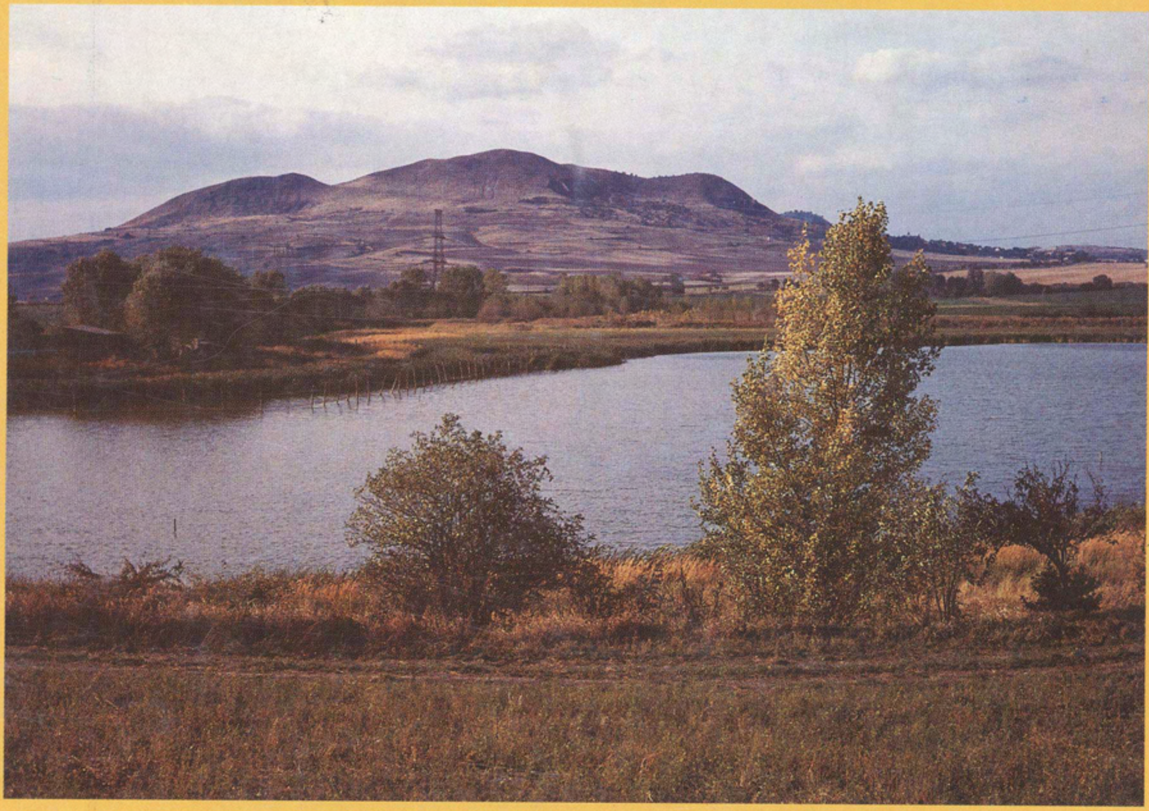
MILLER, K.(1896): Monialium Ebstorfensium Mappamundi quae a Belmoto quodem videtur pieta A.D.1284 hannoverae nunc adservantur, editit Conradus Miller, Stuttgart /facsimile 2/7 original size/.

The Constitution of the Czech Republic. Constitutional Law No. 1/1993 Gaz. passed by Czech National Board on 16 December, 1992.

Czech Republic: Its national emblem and colours, historical lands and the single-term name in different languages. In the national emblem, Moravia is represented by the red-white spread-eagle in the upper right corner and Silesia by the black spread-eagle in the lower left corner. (A postcard issued for the Czech Geographical Society, ©M. Holeček-Editors, J. Felix 1998)

The emblems of Moravia and Silesia, their towns and bishop's residences. (Postcard)

Illustrations to J. Munzar's and M. V. Drápela's paper



The structural ridge of Raná Mt. (457 m) in the SW of the České středohoří Mts. A vein of the olivine nephelinite prepared from the Upper Cretaceous marlstones.

Photo: B. Balatka

The highest eastern part of the Krkonoše Mts.: a view from the SW across the Elbe river valley towards the Luční hora Mt. (1547 m).

Photo: B. Balatka

Illustrations to A. Ivan's paper