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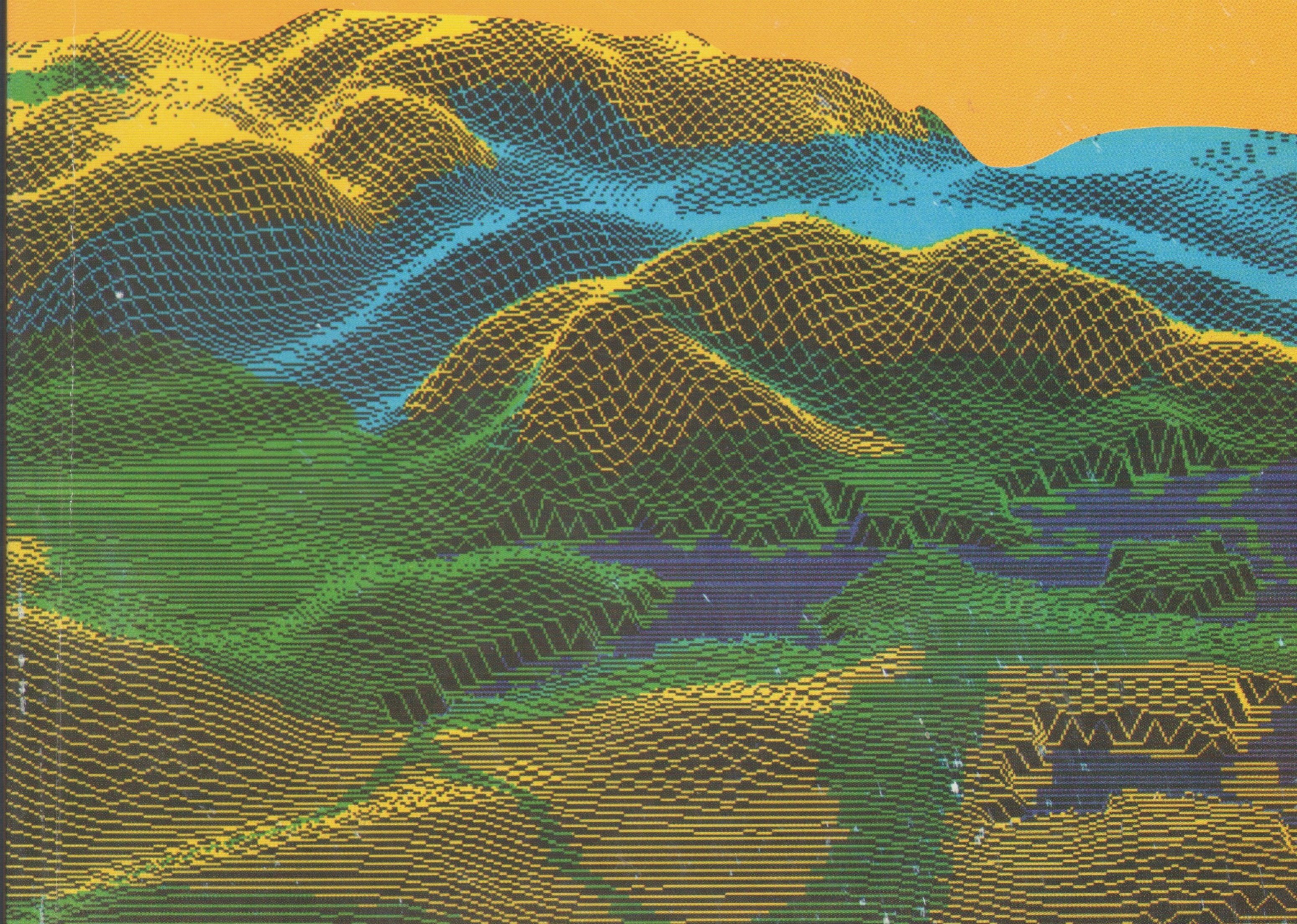
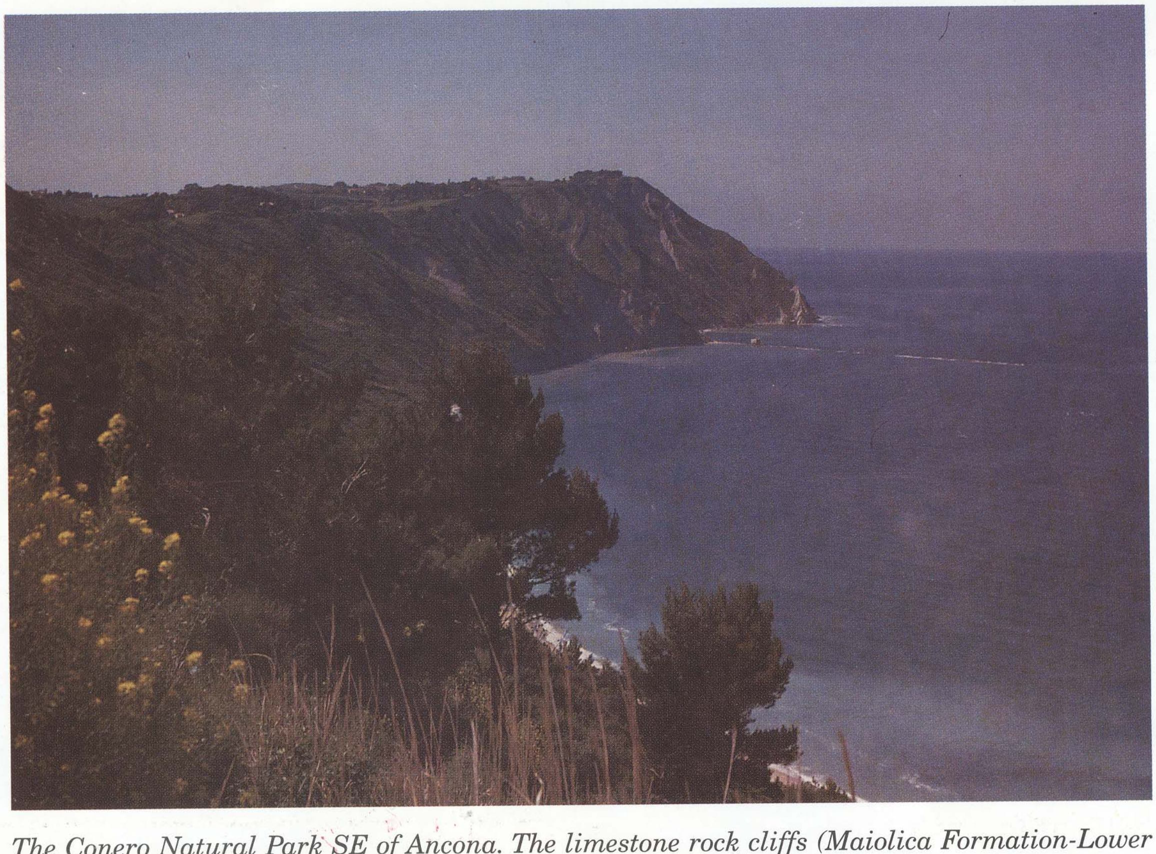


The Marecchia River. Floodplain SE of Rimini is typical of the river bed branching and shifting; the river gravel sands are very young and often resedimented.

Photo: K. Kirchner



The Conero Natural Park SE of Ancona. The limestone rock cliffs (Maiolica Formation-Lower Cretaceous) fall steep into the Adriatic Sea. The rock escarpments show signs of rock collapsing, landslides, block movements; the lower parts are impacted by intensive abrasion.

Photo: K. Kirchner

Illustrations to K. Kirchner´s, O. Krejčí´s and A. Ivan´s paper

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Articles

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THE ROLE OF FOREIGN DIRECT INVESTMENT IN THE CZECH REPUBLIC DURING THE 1990s

Francis William CARTER

Abstract

The demise of communism in 1989 left the Czech Republic, along with other countries of the former Eastern Bloc, trying to find their own way towards capitalism. Initially there was great hope, but the transition has proved to be somewhat problematic. Certain geographical factors have been important in this whole process; amongst them is the role played by foreign direct investment (FDI).This theme is explored in relation to the Czech Republic particularly its impact on the country's various administrative regions, west-east spatial changes over the period under review, the pattern of unemployment, and proximity of the EU boundary on regional FDI patterns. Questions are posed regarding FDI's future influence and what adjustments are necessary to ensure that further inflows continue.

Shrnutí

Úloha přímých zahraničních investic (FDI) v České republice v 90. letech 20. století.

Zánik komunismu v roce 1989 ponechal České republice i dalším zemím bývalého východního bloku možnost pokusit se o nalezení vlastní cesty ke kapitalismu. Na počátku byla velká naděje, nicméně tento přechod se ukázal poněkud problematický. V tomto celém procesu jsou důležité jisté geografické faktory a jedním z nich je úloha přímých investic ze zahraničí (FDI). Tato problematika je zkoumána ve vztahu k České republice, zejména pak její vliv na různé administrativní regiony v zemi, změny v západo-východním prostoru ve zkoumaném období, model nezaměstnanosti a vlivy blízkosti hranice Evropské unie na regionální modely přímých zahraničních investic (FDI). Položeny jsou otázky týkající se budoucího vlivu přímých investic ze zahraničí a úprav nutných pro zajištění jejich stálého přílivu.

Key words: *foreign direct investment, transformation process, regional pattern, unemployment, Czech Republic.*

1. Introduction: The Central-East European Setting

The northern tier of East European countries (the Czech Republic, Hungary, Poland and Slovakia) have dominated the foreign direct investment (FDI) market over the 1990s. Compared with South - East Europe they have attracted about four-fifths of the East European FDI total available throughout the period under review (Carter, 1999a; 1999b). This has been enhanced in recent years by the prospects of three of them (minus Slovakia) joining the European Union in the next stage of the latter's enlargement. Such an acceptance has been interpreted as a sign of their progress in the transition process and has had a positive effect on expectations concerning the future economic performance of each country. Furthermore, the prospect of EU membership may be seen as a guarantee of economic and political stability and so reassure foreign investors. These influences have been reinforced by the high share of FDI flows coming from EU countries, with most investment consistently going to the Czech Republic, Hungary and Poland during the first half decade (Krenzler, 1997).

Since they engage in export/import ventures, foreign investors are more likely to facilitate the host country's integration into the world market (Franko, 1996).Their companies are also more predisposed to awarding higher returns on capital and proffer higher wages compared with host companies which suffer from limited capital. These phenomena in smaller economies like Slovakia, have a greater comparable impact on the trade balance than larger economies such as Poland. Another significant difference in Central-East Europe is that domestic enterprises in the Czech Republic and Poland are larger in terms of employment totals than their foreign-owned equivalents. More positively, several case studies in the region have depicted the benefits that FDI brings, including access to foreign markets, changing attitudes to skill levels and ethical approach by workers and their managers, raising an enterprise's international profile, introduction of new/ better quality merchandise, and the advantages of technology transfer (Anon, 1997a).

By 1996, the Czech Republic offered the most investor friendly regulations, followed by Hungary and Poland. Investment risk was by then the lowest in Central-

East Europe, although those of Hungary, Poland and Slovakia were not far behind, see Tab. 1.

Clearly, Hungary was the leading country for FDI during the first half of the 1990s, with the highest cumulative and per capita index (Schwartz, Stone-van der Willigen, 1994). This mainly resulted from the role FDI played in the Hungarian privatisation process, were over two-thirds of manufactured exports came from part or completely owned foreign companies. The cumulative inflow was followed by Poland which had four-fifths of the Hungarian total. Only in 1994 did Poland replace Hungary at the head the FDI list only to lose it again in 1995. Since then Poland has reasserted itself in pole position. The Czech Republic had just under half the Hungarian sum total reflecting its slow start, but it has gradually reduced some of this cumulative FDI gap on the other two countries. Slovakia trailed well behind the others in its quota of cumulative FDI over the period under review, with only 6 % of the Hungarian amount. This was largely due to external judgements on the country's political instability, together with the official policy of favouring domestic investors in the privatisation process (Williams -Balaž- Zajac, 1998).

During the second half of the 1990s it became increasingly apparent that to attract continuing amounts of FDI to these countries three important problems had to be solved (Carter - Sader -Holtedahl, 1996). Firstly, there was a need for each country to adhere to certain basic tenets. These included greater caution in fiscal and monetary policy, so vital for continued economic recovery and growth; the creation of a wide spectrum of institutional reforms to support macroeconomic stabilisation; the establishment of a sound institutional framework so crucial for privatisation success; (Hunya, 1998) reform of the banking system because of it integral part in the transition process; and finally, reduction of the marked income inequalities of individuals arising from the transition process (Lyle, 1999). Secondly, efforts had to be made to grasp the nettle of one of the most controversial aspects in the transition process, namely the privatisation of previously state-owned enterprises. Thirdly, improvements in the privatisation process were dependent on the strict enforcement of a rule of law and nurturing a respect for a framework of law, regulation and codes of good practice. All these factors were significant if a sound market economy and institutions were to emerge within individual countries. The success rate would be reflected, amongst others, in the ability to attract FDI.

Tab. 1: *Central - East Europe: FDI by countries 1989 - 1996 (USD)*

Country	Risk rating (1=low)	Cumulative FDI inflow per capita (USD)	Cumulative FDI inflow (USD bil.)
Czech Republic	1.11	700	7.2
Hungary	1.28	1,450	15.0
Poland	1.44	300	12.0
Slovakia	1.76	170	0.90
Average	1.39	655	8.77

Source: EBRD, Transition Report 1995; H-P. Lankes - A. J. Venables (1996): Foreign direct investment in economic transition; the changing pattern of investments. Economics of Transition, Vol. 4, No. 2, Tab. 2, p. 335; Business Central Europe, April, 1997.

2. Early Evidence of FDI in the Czech Republic

In spite of uncertainty over the country's impending dissolution, FDI in the Czech Republic's part of the former Czechoslovakia doubled in 1992 to reach USD 1.2 bil. (Blum, 1993). In that year the USA was the largest FDI contributor with 39.5 %, followed by France (20.2 %) while Germany was in third place with 15.6 %. Over the period 1989-1992 however, Germany remained the largest total investor with two-fifths (39.9 %) of all FDI, then the USA with a fifth (21.1 %) and France (14.6 %). Austria (6.6 %) and Belgium (5.8 %) were also both represented. The ‚Velvet Divorce' of January 1993 was achieved without bloodshed, creating two new successor states, the Czech and Slovak Republics (Wolf, 1998). They are now much more ethnically homogeneous, giving greater internal stability. This helps to explain why the government opened up the economy, curbed inflation to a 2 % annual growth rate, and began the privatisation process. The Czech Republic, like the rest of east-central Europe plunged itself headlong into reform efforts, and both large and small Czech firms were forced, almost overnight, to adapt to the demands of a market economy. Obviously, this elicited various industries and specific companies to respond to the challenges of privatization in differing ways (Fogel, 1994; Hrnčíř, 1994; Kopačka, 1994). From the outset the Czech Republic adopted its own independent economic pattern of development which led to it achieving the most rapid transition in east-central Europe by mid-decade (Myant et al, 1996). As a result foreign capital inflows and direct investors became very eager to be involved in the Czech economy. This even led to a debate at governmental level on whether too much foreign money would overheat the economy. In the end, the Klaus administration continued to support the influx of FDI. (Tab.2)

obligations in the Czech Republic (Fisher - Genillard, 1992).

Clearly, the major sources came from neighbouring Germany (a third), and the U.S.A. (a quarter), which together provided the Czech Republic with over half its FDI total, while other European countries contributed a further third. Most FDI went into the transport sector, followed by the food processing, service and construction industries (Dziemianowicz, 1993). Thus, the main sectors attracting overseas capital were vehicle assembly, transport equipment, building construction, consumer goods, alcohol and tobacco. On a more negative FDI note, prospects for economic development in the Czech Republic depended on investment decisions taken

Tab. 2: *Czech Republic: Origin of Foreign Investment, 1990 - September 1994 (USD bil. + %)*

Country	Amount FDI	% FDI
Germany	790.0	29.3
U.S.A.	650.9	24.1
France	339.0	12.6
Austria	200.9	7.4
Belgium	187.7	7.0
Switzerland	125.5	4.9
Italy	82.1	3.0
Others	314.7	11.7
TOTAL	2,690.8	100.0

Source: Anon (1995): Foreign investment floods. In: The Times (Supplement: Czech Republic), 2/5/1995, p. 10.

Between 1990 - 1994, the Czech Republic attracted considerable FDI totalling over USD 2.6 bil. placing it above many other central European countries. Several reasons contributed to this situation: there was a pool of highly skilled workers in the Czech Republic, who could be easily trained; low labour costs at less than a tenth of German wages; the country's central location in Europe provided an ideal footing for export both to the east or west; the main consideration for investors was access to western markets, because the Czech Republic's small domestic market of 10 million inhabitants was rather constrained by a low per capita income; finally, the appeal to foreigners of favourable currency exchange rates encouraged the import of necessary construction equipment from the West. These factors enticed large companies like Volkswagen, Siemens and Mercedes - Benz to commit themselves early to heavy financial

outside the country. These could be influenced by such factors as a lack of financial inducements (e.g. tax relief) for foreign investors in the Czech Republic and the need for outside help in technology transfer in order to overcome local deficiencies in such areas as the poorly developed telecommunication network and inadequacies in the country's economic infrastructure.

Improved economic efficiency through privatisation was a key factor if more FDI was to be forthcoming. The privatisation process was to prove most effective in the retail trade and service sector and least constructive in industry. The former group tended to be rather small in size and their shares more affordable for the general public; conversely industry suffered from complex corporate governance problems which harassed large enterprises and heavy industries making the privatisation procedure more difficult. Following the political changes in Europe after 1989, the Czech Republic had a particular problem concerning the reduction of armaments production. The considerable size of the country's defence sector forced the government to engage in a massive conversion programme parallel with its privatisation plans. In 1991 it established a special conversion fund whereby armaments factories were either liquidated or converted for consumer goods production (Sabela, 1994). Large armament factories were privatized, most becoming limited companies covered partly by the new voucher system. These included ‚Aero' Prague, the ‚Czech Armoury' at Český Brod, ‚Meopta' in Přerov, and engineering factories at Polička, ‚Sellier and Bellot' at Vlašim, ‚Tesla' Prague, and ‚Synthesia' at Pardubice. The ‚Vlárské' engineering works at Slavičín was subject to direct sale while ‚Tesla' factory at Pardubice was sold through public tender. Overall by December 1993, the state still owned a third (32.1 %) of all the country's enterprises, while the remainder under private control had over a quarter (28.1 %) financed by the new voucher system.

By 1994, the largest and most crucial foreign investor was Volkswagen through its 31 % share in the Škoda car company. Other major investors included Philip Morris, BSN and Nestlé. Philip Morris which spent USD 420 million acquiring four-fifths of ‚Tabák', the Czech tobacco monopoly, began modernising production at its Kutná Hora factory. Meanwhile Nestlé bought up a Czech confectionary company, ‚Čokoládovny'. Another large investor was ‚ABB', the Swiss - Swedish company which located in Brno to produce a range of power engineering and electronics products. Substantial investment in the fast food and consumer goods sector came from US multinationals, but smaller concerns were also involved like ‚Ivax' which obtained control of ‚Galena', the country's second largest pharmaceutical company (Boland, 1994).

Foreigners had thus pushed more than USD 4 bil. into the Czech Republic by 1995, USD 3.1 bil. of it directly. They had been encouraged to do so by an inflation rate below under 10 %, a government committed to privatisation, and a country that was relatively stable politically (EIU, 1995). Yet there were some disappointments. Foreign firms would have liked to won business in the plan to renovate and develop Prague airport. The project valued at USD 200 mil. was abandoned due to disputes with the Czech government over financial conditions; a bitter joint-venture struggle between ČSA, the national airline, and Air France ended with the Czech government purchasing the French carrier; an American group of industrialists were forced to retire from the board of the languishing Czech ‚Tatra' lorry company, supposedly failing to improve performances. The construction of a new motorway from Prague to Nuremburg via Plzeň also attracted foreign interest. Although foreign companies bid for these projects, the Czech government took over the schemes and replaced them with local investors, tending to reflect the power held by a nationalist lobby which favoured doing things the „Czech way" (Anon, 1995). Indecision by the government concerning the privatisation of the Czech ‚SPT Telecom' proved to be a key issue facing the state in 1995. This complicated transaction would provide foreign investors, like PTT Telecom Netherlands and the Swiss PTT, with an important indication of what the government's future privatisation policy would be.

In spite of such problems, the vehicle components industry became one of the main attractions for FDI in the Czech Republic and accounted for over a fifth (22.5 %) of the country's total by 1995. More than 40 joint-ventures were established in this industrial sector using existing Czech suppliers, together with 20 new greenfield site factories. Initially, the main motivation for west European components companies was to extend their existing links into the Czech Republic via the Volkswagen company. They quickly realised the potential of a low cost source for supplying parts to other West European vehicle manufacturers as well as other Volkswagen group subsidiaries. These circumstances also attracted other western components manufacturing groups; for example, TRW, ITT, Johnson Controls, General Motors and Ford from the USA; Bosch, Kolbenschmidt, Hella, Varta and Continental from Germany, together with Lucas and T&N (Goetze) from the United Kingdom. However, the restructuring of the Czech components sector remained far from ideal, although Volkswagen/Škoda made significant progress. For example, of the 134 component factories analyzed by them in 1993 and 1995, only two reached the coveted „A" grade in 1993 but rose to twenty seven in 1995; the 84 in the lowest „C" category in 1993 were reduced to 19 two years later. Clearly, the elimination of least competitive domestic suppliers was an ongoing process which would have to continue during the second half of the decade (Done, 1995).

3. The Later Years

According to the EBRD, the Czech market still appeared the most attractive in Central-East Europe by 1996, with the EU responsible for over for two-thirds and OECD countries over four-fifths of the Czech Republic's total FDI during the first half of the 1990s. Nevertheless, the general consequences of FDI had a rather restricted influence on restructuring the Czech economy. This was partly due to the dominance of several large companies. For example, the 1.32 USD bil. spent by foreigners for a 27 % stake in the state monopoly SPT, Škoda, the International Oil Consortium and Philip Morris. Between them they contributed three-fifths of all FDI during the first half decade, but employed less than a twentieth of the labour force (Pavlínek, 1998).

Turnover could have been much higher given Czech market capitalization, given that it was a country perceived a model of political stability, one of the few Eastern bloc countries not to have ex-communists still in power, whilst its economy was as secure as any of its post-communist neighbours. A major reason for the failure to attract even more FDI relates to the Czech market. This had been rapidly organised to handle the mass privatisation programme; hundreds of state enterprises were disposed of for nominal sums to Czech citizens. The rapidity of this action, while commendable, did turn the country's capital market into a paradise for privileged local insider dealing at the expense of ordinary state investors (Anon, 1996a).

absenteeism which, over time, they hoped would be cured and the difficulty of locating acceptable domestic suppliers capable of distributing components on time and of the right quality. Despite these drawbacks, ‚Matsushita' estimated that it could produce TV sets in Plzeň at 10 % lower costs than in countries like the United Kingdom. By 2000, it planned that the factory would be producing a million sets annually, and providing employment for over 1,000 people. Production was to be largely export orientated (95 %); a third was planned for the West European market, a third for CIS countries and the remainder supplying eastern Europe, including the Czech Republic (Done, 1997).

Tab. 3: *Czech Republic: FDI by sector, 1990 - June 1997 (USD mil.)*

Sector	FDI	%
Transport & communications	1,551.9	20.6
Consumer goods & tobacco	1,077.3	14.3
Vehicle prod.	1,047.2	13.9
Trade & services	678.0	9.0
Chemical ind.	617.7	8.2
Banks & insurance companies	617.7	8.2
Others	1,943.6	25.8
TOTAL	7,533.4	100.0

Source: Czech Invest (1997): Foreign Direct Investment in the Czech Republic, 2nd Quarter, Prague.

In spite of such problems certain foreign investors were not deterred. One of Japan's leading consumer electronics groups, ‚Matsushita', decided to invest USD 66 mil. in the Czech Republic, to build its first television plant in central Europe. The industrial city of Plzeň in western Bohemia was chosen production began in April 1997 only a year after the greenfield site had been purchased. The company's research department had examined 27 possible locations in Poland, Hungary and Slovakia, before they chose Plzeň. It was adopted thanks to several advantageous location factors: firstly, because of its central Europe position midway between Madrid and Moscow and secondly, the advantageous infrastructure of the site together with a well-educated local labour force. Wider attractions included the country's political/economic stability with lower inflation and interest rates than the neighbouring countries analyzed, together with it having a more liberal foreign exchange regime, than most other countries in the region. Negative factors included the problem of

In the Czech Republic prior to 1997 foreign capital, wholly or partly from joint ventures, had proved a major growth beneficiary. Total FDI infused into the Czech economy between 1/1/1990 and 30/6/1997 reached USD 7.5 bil. From a sectoral viewpoint, a fifth of foreign investment went into transport and communications (20.6 %), followed by consumer goods/ tobacco manufacture (14.3 %) and vehicle production (13.9 %), see Tab. 3.

As previously found, Germany provided a substantial part (27.8 %) of that FDI total and was unquestionably the Czech Republic's major partner. In this context, while FDI is generally considered to be only one element in a market economy, it does also activate economic integration at various economic levels; in the Czech case, Germany helped the country infiltrate into the wider European economy. Through economic diffusion, FDI helped create links between the Czech Republic and more successful west European border countries; in the opposite direction, the latter's financial decisions were

***Tab. 4:** Czech Republic: Origin of FDI,1990 - June 1997 (USD mil.)*

Country	FDI	%
Germany	2,094.3	27.8
Netherlands	1,114.9	14.8
U.S.A.	1,099.9	14.6
Switzerland	851.3	11.3
France	549.9	7.3
Austria	534.9	7.1
Others	1,288.2	17.1
TOTAL	7,533.4	100.0

Source: Czech Invest (1997): Foreign Direct Investment in the Czech Republic, 2nd Quarter, Prague.

influenced by the Czech Republic's favourable geographical /geopolitical location (Anon, 1997b). Nevertheless, a large FDI gap existed between Germany and the next largest European partner the Netherlands (Wackermann, 1997), followed by the USA, Switzerland and France, see Tab. 4.

However, a recent OECD report stated that the most serious problem in the Czech economy was posed by the sluggish nature of its industrial restructuring and privatisation of the banking sector. Certainly, if a healthy FDI environment is to continue, the government has to help industrial firms grapple with restructuring and cushion any of their growing debts (Anon, 1999a).

During the first half of 1997 most FDI went into banking and insurance but by the end of that year, an increasing number of smaller foreign firms were entering the consumer goods industry, trade and services. Also in 1997 there was considerable activity in the power industry. Western power engineering giants directly invested in some of the country's power generating companies; these included Brno District Heating Plant Co., the North Moravian and Central Bohemian Power Engineering Works, Prague Power Engineering Co., and that city's Gas Works. Only in the last quarter of 1997 did a British investor provide FDI for the Opatovice power station. Some new greenfield sites attracted FDI including places such as Kouřim, Pohořelice, Prague suburbs and Vyškov. Surprisingly, the currency crisis of 1997, which resulted in a collapse of domestic demand, did not deter FDI during the year; it remained at the same level (circa USD 850 mil.) as in 1996 (Pisková, 1998).

Nevertheless, it has to be admitted that the Czech Republic's manufacturing industry has continually remained overstaffed. This may help to explain why, in the past, the part played by foreign-owned companies in manufacturing production only totalled about a tenth of FDI. It may also be the reason why restructuring the manufacturing sector has remained rather restrained. Also the voucher-system, previously regarded by Czech market propaganda as in the vanguard of popular capitalism has, more recently, been ironically identified as the major hurdle in restructuring Czech industry. This implies that if the reform process is to be a success continued FDI is vital for the manufacturing sector (Andor - Summers, 1998).

Surprisingly, foreign investors do continue to provide a much needed boost, in spite of frustrations created by a persistently limp economy. For instance, FDI manufacturers have created employment in 56 of the country's 77 administrative districts (okres), at an average rate of six new jobs per hour net. Equally imposing is the impact of indirect employment; in both the manufacturing and services sectors, foreign investors support an estimated 10,000 Czech-based suppliers providing employment for a phenomenal half a million people, or a tenth of the labour force. Besides direct employment, foreign manufacturers indirectly provide salaries for nearly a third of the workforce in Czech manufacturing. Estimates suggest that by December 2001, major foreign manufacturing companies will have seen a rise in number from 800 to 1,000 firms; more than 320,000 workers will be directly employed while, indirectly, supplier links will secure a further 600,000 employment places. A recent poll by the Czech Invest Institute revealed that nearly a third of FDI firms wanted to enlarge their number of local suppliers. This may be enhanced by the funding of a new three year programme costing USD 117 mil., to identify such potential stockists and would help generate the trickle-down impact of FDI (EIU, 1999a).

An important signal for the Czech government appears to be that FDI is more helpful than harmful. This is perhaps significant at a time when Czechs are confronted with economic stagnation under Miloš Zeman's weak minority government (EIU, 1999b). At the end of 1998 industrial output had declined by over 9 % compared with the previous year and if the 1999 recession continues it will render an overall 3.5 % government budget deficit along with a -0.5 % GDP growth. As the economy dips there is increasing pressure to hasten privatisation (Marcinein - Wijnbergen, 1997) and reform the banking system, which is suffering from huge losses (Anon, 1999b). Clearly, bank privatisation will attract western interest; the role of such financial institutions, as well as the importance of bank credits, leasing facilities, handling of overdue payments and financing through home and foreign capital sources (e.g. FDI) is so vital (Chvojka, 1997). It was originally estimated that with improved investment incentives and ongoing EU enlargement talks could help the Czech Republic pull in FDI worth 1.6 bil. in 1999 (EIU, 1999b), providing it could overcome the current deep recession (Anon, 1999c). In spite of this problems, there was a strong FDI inflow during the first half of 1999 rising from USD 227 mil. to USD 608 mil. According to latest data this amount has been surpassed placing it above Hungary in Central-East Europe, but well behind the leader Poland. Nevertheless this figure, along with FDI stock of USD 12.8 bil. in July 1999, may bode well in helping the ailing economy to pull out of recession (Anon, 1999d), see Tab. 5.

Further evidence shows also signs of economic resuscitation fuelled by a series of bank and industrial privatisations which could help the economy and repair deep structural problems, but any short term internal growth is only likely through demand-driven conditions (Mastrini, 1999).

4. The Regional Impact in Central-East Europe

In a recent survey of locational and incentive factors affecting FDI in Eastern Europe, ‚geographical location' scored highly amongst western respondents when questioned about the Central-East European countries (Pye, 1997). Geographical location was defined in the questionnaire as proximity to potential export markets including buyers and/or suppliers. The western investor also wished to be active in every country of the region, while the host country's overall geographical location was also significant (Tarzi, 1999). Survey respondents gave a list of the major advantages that the ideal FDI location should offer; the dominant factor was market forces followed, almost equally by strategic economic position and investment climate. In relation to market forces, mention was frequently made to growth potential and market share/capture of the local market; the strategic position was often referred to regarding first mover advantages, the significance of customers/ clients, and the necessity to profit from international markets; investment climate considerations were mainly related to a country's overall stability, evidence of former historical trade links and a government's general attitude towards FDI.

5. FDI Regional Pattern in the Czech Republic

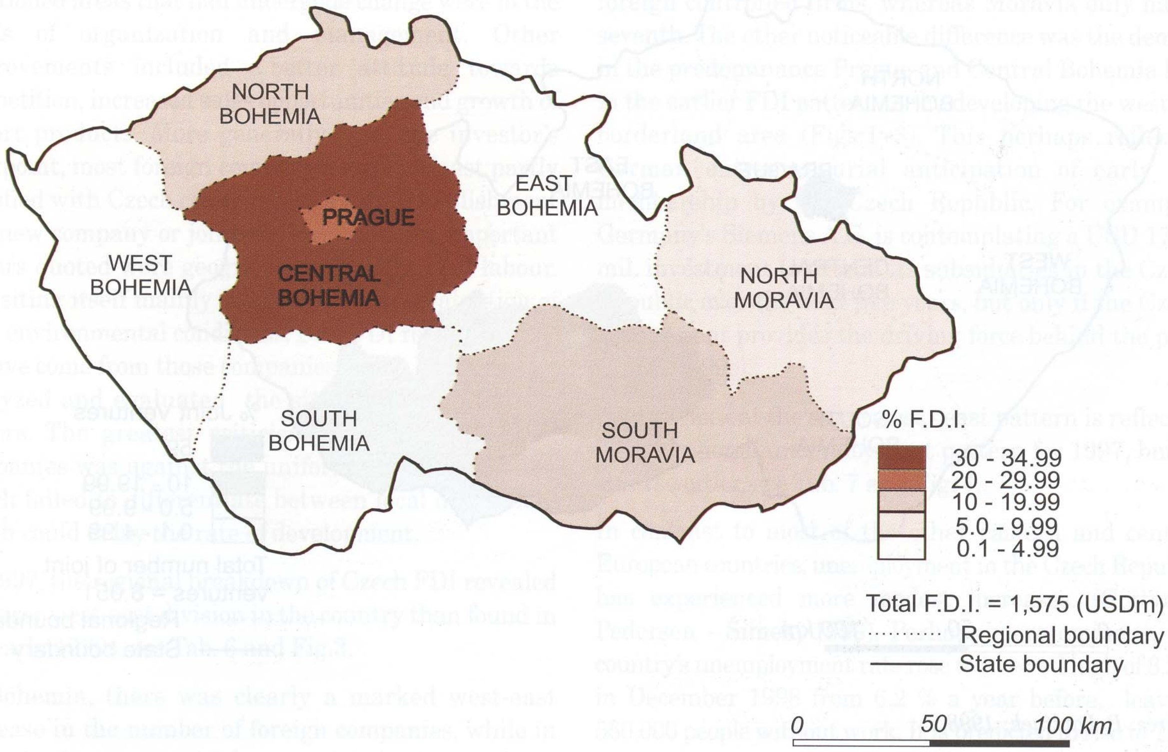
5.1 1990-1995

The regional consequences of FDI in the Czech Republic were rather limited during the very early 1990s. Prior to communism the Czech Republic had always been part of west European markets; for example Prague, geographically is located farther west than Vienna. Even so, in the former Czechoslovakia, the Czech Republic

Tab. 5: Central-East Europe: FDI inflows during 1999

Country	Amount USD mil.	%
Czech Republic	2.830	23.37
Hungary	1.100	9.08
Poland	7.930	65.48
Slovakia	250	2.07
TOTAL	12.110	100.0

Fig. 1: Czech Republic: Percentage of Foreign Direct Investment, 1992, by Region



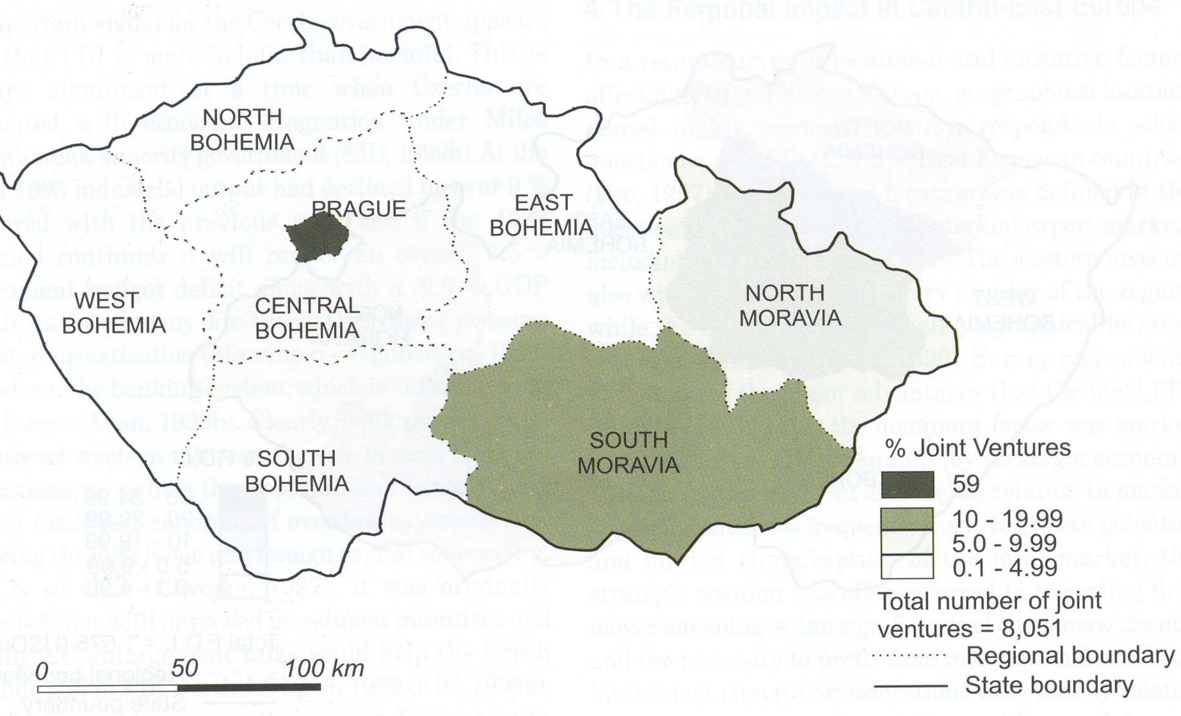
Source: P. Pavlínek, 1998.

attracted only 10 % of the FDI flowing into Central - East Europe during 1990 - 1991; some would argue this poor showing was one of the reasons Slovakia pushed for independence believing, erroneously as it turned out, that alone they might attract more FDI (Slay, 1992; Pavlínek, 1995; Whitehouse, 1992).

By 1992, the former capital of Czechoslovakia and its surrounding region attracted most FDI (Fig 1.). This pattern was influenced considerably by German capital which was prevalent in two Czech regions (kraj), predictably Central Bohemia containing 48 % and Prague 44.1 % (Dubská, 1992). The former was influenced by heavy investment from Volkswagen into the Škoda enterprise, while the latter attracted attention largely for its capital city functions. These included the presence of major political institutions, especially those concerned with economic restructuring (Murphy, 1992; Uhlíř, 1995a). Surprisingly, South Moravia fared well in the early stages of FDI, largely thanks to proximity with Austria. In 1991, Austrian investors exploited opportunities offered by cross-border links, particularly in Brno its largest city and major industrial centre. The regions of North Bohemia and North Moravia also enticed FDI inflow probably as a result of their heavy industrialization during the communist period. North Bohemia's closeness to Germany encouraged investment into industrial centres such as Děčín and Ústí nad Labem as well as towns like Liberec (Kara, 1994).North Moravia's industrial /mining legacy, especially around Ostrava and Karviná, also brought forth some FDI interest but was less than the previous regions due to it having no joint border with a west European country.

The regional pattern of joint ventures in 1992 partially mirrored that of FDI. Prague clearly dominated the pattern with three-fifths of all joint-ventures (Fig.2). This was not surprising, because many foreign investors smaller FDI sums took the opportunity to establish themselves in the capital in order to have a presence in the country, from which it could expand probably eastwards in the belief that the Russia would become a major market. The percentage of joint-ventures in Central Bohemia did not reflect its FDI significance, largely because they were few in number but financially wealthy, e.g. Volkswagen. Southern Moravia's position after Prague reflects the significance of it Austrian links during this early period, particularly from the large number of small joint-ventures (Emadi-Moghadam, Emadi-Coffin, 1995).The other four regions (East, West, North and South Bohemia) contained very few joint ventures which, unlike Central Bohemia, contained no

Fig. 2: Czech Republic: Percentage of Joint Ventures, 1992, by Region



Source: P. Pavlínek, 1998.

large wealthy FDI companies. The paucity of joint-venture presence in Western and Southern Bohemia bordering on Germany and Austria, reflects their predominantly agricultural character, never a strong attraction for FDI. Foreign investment here was to come later with the growth of cross-border trade.

By 1995, the economic situation had somewhat improved due, not only to privatisation, but also the introduction of transborder export-based/ employment - intensive industries like electronics. This attracted foreigner investors through the presence of lower wage costs and reasonably productivity employees (Uhlíř, 1995b, 1997), but in this local area proved to be territorially disembedded providing a sort of capitalism without capitalists (Grabher, 1994).Many small transborder companies began to concentrate along the Austrian/German border in the West and South Bohemian regions. Although fewer larger firms located themselves on the Czech-German border region they did include the German Siemens A.G., which established a factory in 1993 at Stříbro and another later on in Plzeň, for making BMW car parts, utilizing mainly cheaper unskilled female labour.

A second type of FDI was also used in the Czech Republic, which aimed at integrating an established company's operations into new local economic networks, which helped activate local suppliers and absorb more investment (Dicken - Forsgren - Malmberg, 1994; Larsson - Malmberg, 1999).Some such foreign firms entered the Czech Republic took over previously state-owned producers and integrated (embedded) themselves in the local/ regional economy. This proved beneficial for the new entrants as they could capitalise on the former state producer's existing networks. It also meant the newcomers did not have to create new industrial concentrations for themselves. A typical example of this latter form of FDI involved the Volkswagen company. In 1991, it bought a third of the shares in the Škoda car plant located in Mladá Boleslav, Central Bohemia, along with the promise of providing further investment (Pavlínek, 1998; Pavlínek - Smith, 1998). Unfortunately, in 1993, Volkswagen had to withdraw a DEM 1,4 bil. loan at the last minute, due to the ill-fated German recession and ensuing company management changes, but it did agree to maintain its earlier investment obligations. Less traumatic scenarios were experienced with FDI inflows into the consumer goods and tobacco industries. For example, they included the huge buy-out deal of the Czech tobacco enterprise (‚Tabák') by the US tobacco giant Philip Morris, and the ‚Rakona' washing powder company in Rakovník by Proctor and Gamble.

5.2 1996-2000

A recent study of 163 FDI industrial plants operating in the West and North Bohemian regions has been made (Anon 1997b). Analysis of questionnaire responses revealed the most frequent reason for FDI involvement by a foreign company was mutually beneficial co-operation. Another significant justification given in over two-thirds of the replies was the local enthusiasm for the presence of foreign capital. The most frequently mentioned areas that had undergone change were in the fields of organization and management. Other improvements included a better attitude towards competition, increased sales opportunities and growth of export products. More generally from the investor's viewpoint, most foreign company's were at least partly satisfied with Czech co-operation. In the establishment of a new company or joint-venture the most important factors quoted were geographical location and labour. The siting itself mainly resulted from an evaluation of local environmental conditions. Best FDI results appear to have come from those companies which had correctly analyzed and evaluated the siting and employment factors. The greatest criticism made by these FDI companies was against the uniform Czech tax system which failed to differentiate between local differences which could delay the rate of development.

By 1997, the regional breakdown of Czech FDI revealed a clearer west-east division in the country than found in the early 1990s, see Tab. 6 and Fig.3.

In Bohemia, there was clearly a marked west-east decrease in the number of foreign companies, while in Moravia there was a higher number in the southern region with its proximity to Austria, an EU member state; regionally Northern Moravia and East Bohemia, located farthest in distance and influence from the EU border, had the least number of foreign companies. This situation had arisen in spite of efforts to adapt to changing post-1990 conditions in some areas, for example, Lanškroun, in the East Bohemian region (Uhlíř, 1998). More significant overall was the west-east balance of FDI companies. Bohemia had a quarter of the foreign controlled firms, whereas Moravia only had a seventh. The other noticeable difference was the demise in the predominance Prague and Central Bohemia had in the earlier FDI pattern to the developing the western borderland area (Figs.1+3). This perhaps reflected German entrepreneurial anticipation of early EU membership by the Czech Republic. For example, Germany's Siemens A.G. is contemplating a USD 174.4 mil. investment to extend its subsidiaries in the Czech Republic over the next five years, but only if the Czech government provides the driving force behind the plan (Anon, 1999e).

To some extent the same west - east pattern is reflected in the regional unemployment pattern for 1997, but in reverse order, see Tab. 7 and Fig. 4.

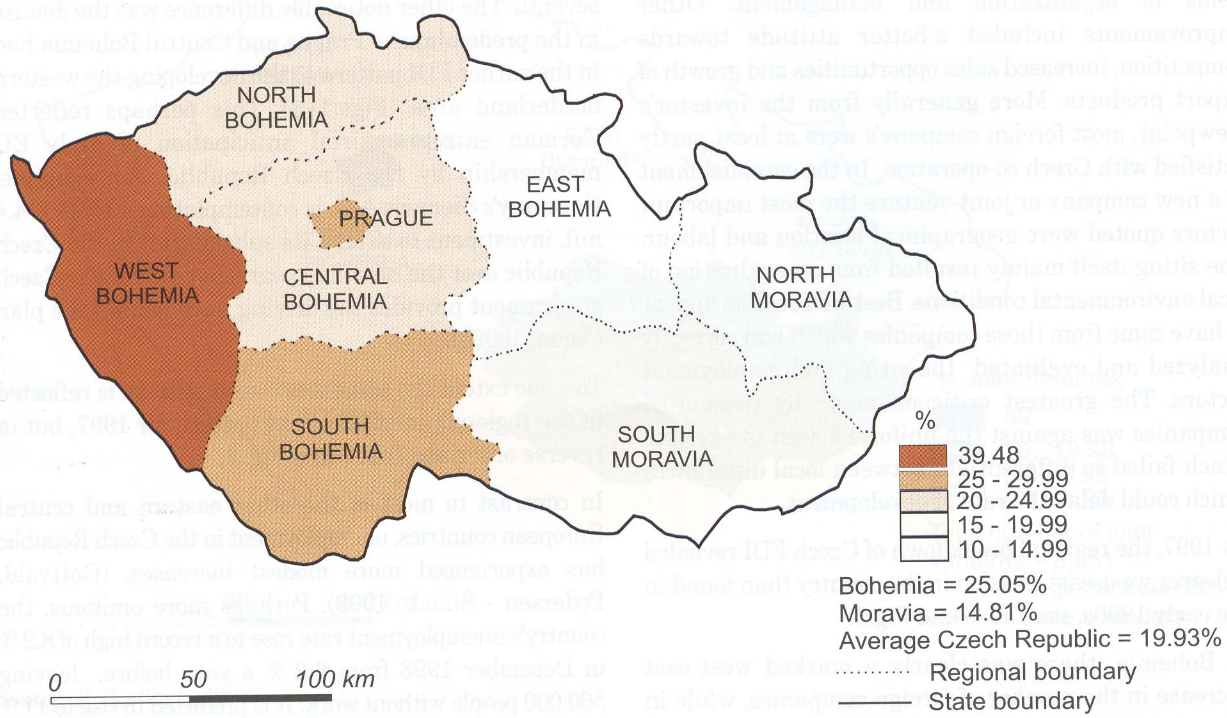
In contrast to most of the other eastern and central European countries, unemployment in the Czech Republic has experienced more modest increases. (Gottvald, Pedersen - Šimek, 1999). Perhaps more ominous, the country's unemployment rate rose to a record high of 8.2 % in December 1998 from 6.2 % a year before, leaving 560,000 people without work. It is predicted to rise to 11 % in 2000 (Anon, 1999f). This resulted from stricter monetary policies, in addition to worsening recession with enterprises increasingly dismissing employees. It is feared that a tenth of the labour force may be unemployed in the year 2000 (Anon, 1999g).

Tab. 6: *Czech Republic: Private enterprises / corporations, and foreign control, by region in 1997*

Admin. region	Total private	of which for. control	%
Prague	56,302	15,242	27.07
C. Bohemia	14,225	3,035	21.34
S. Bohemia	10,385	2,771	26.68
W. Bohemia	13,853	5,469	39.48
N. Bohemia	18,566	4,081	21.98
E. Bohemia	17,326	2,132	12.31
N.Moravia	22,106	2,872	12.99
S. Moravia	34,894	5,568	15.96
Total Bohemia	130,657	32,730	25.05
Total Moravia	57,000	8,440	14.81

Source: Česká národní banka; Č.S.Ú, Aktuality.

Fig. 3: Czech Republic: Private Enterprises/ Corporations under Foreign Control by Region in 1997



Source: Česká národní banka, Č.S.Ú., Aktuality

In Bohemia between 1995 - 1998, Prague continued to have the least unemployment problems while, with the exception of North Bohemia, other regions were below 7 %. For example, Mladá Boleslav, Central Bohemia, the home of the Volkswagen/Škoda Auto company helped to reduce unemployment in 1998 to 2,25 %. However, in early 1999, there was an overall decline in Škoda cars sales largely due to a drop in demand on the domestic market (Anon, 1999h), but since then sales have begun to improve. North Bohemia's high rate resulted from industrial and environmental problems, particularly those associated with brown-coal mining, for example in Most (Pavlínek - Pickles-Staddon, 1994). Moravia had higher unemployment levels, particularly in the north with its ageing steel industry and coal mining e.g Karviná. Moreover, Tabák a.s., the Czech unit of Philip Morris, has recently announced it will close its Nový Jičín plant, one of four factories it owns in the Czech Republic. This results from a decline in export demand for cigarettes, mainly from CIS countries, and it is anticipated that 326 employees will lose their jobs (Anon, 1999i). However, in southern Moravia areas like the Brno region have been more successful industrially in adapting to the changing economic climate since 1990 (Kunc, 1999).

6. Conclusion

The Czech Republic has experienced considerable radical industrial modernization during 1990 -2000, in which FDI has proved a crucial element in this process. The question remains as to why the Czech Republic does not attract even more foreign manufacturing companies, given that they are already motivating the economy? A ready explanation may be the slack economy; perhaps a deeper reason is that the country has not appreciated nor welcomed foreign investors enough (EIU, 1999a).

In order to maximise the future potential of FDI the Czech Republic must take measures to attract more investment. This involves both government and public administration undertaking measures to improve the very foundations of the Czech economy. In the past the Czech Republic has adopted a rather regulatory approach to FDI designed to prevent foreign domination, while at the same time continuing to harvest its benefits.

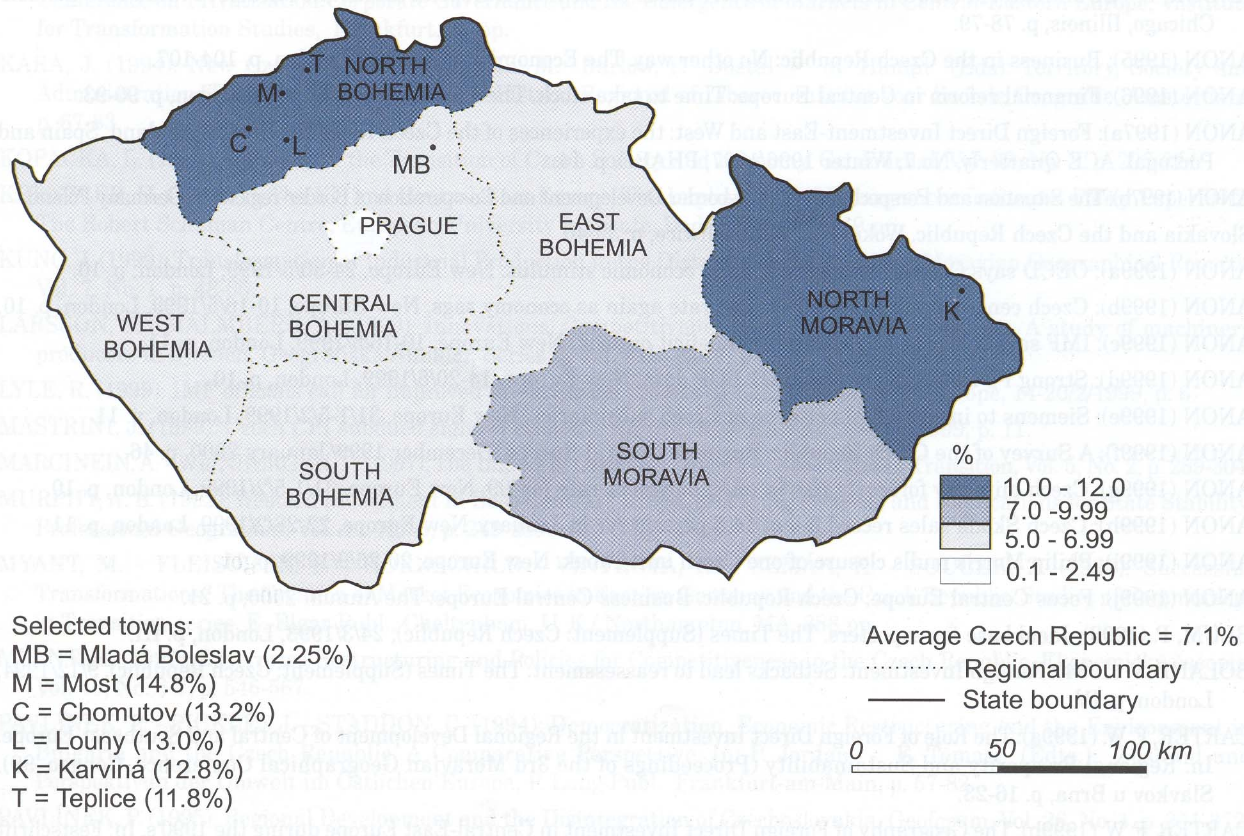
Even so FDI inflows to the Czech Republic have proved advantageous in many ways. For example, greenfield investment has created thousands of new jobs in the Czech manufacturing and service sectors since 1989. It

Tab. 7: Czech Republic: Unemployment 1995 - 98 (% of labour force)

Region	1995	1996	1997	1998
Prague	1.8	3.8	2.7	2.3
C. Bohemia	3.4	3.0	3.9	6.0
S. Bohemia	2.1	2.7	4.1	5.6
W. Bohemia	2.8	2.8	5.1	6.4
N. Bohemia	6.0	7.0	9.9	11.4
E. Bohemia	2.7	3.2	4.2	6.3
N. Moravia	4.7	5.7	8.2	11.0
S. Moravia	2.9	3.1	4.4	7.7
Total Czech Republic	3.4	3.8	5.4	7.1

Source: Statistická Ročenka České Republiky '98. Č.S.Ú, Prague 1998, p. 312; Č.S.Ú, Aktuality; E.I.U. Country Report, 4th Quarter, 1998, p. 23.

Fig. 4: Czech Republic: Unemployment by Region in 1998 (% of labour force)



Source: Č.S.Ú., Aktuality, EIU Country Report 4th Quarter 1998, p. 23.

has generated not only traditional branch plant or low-level service jobs, but also high-wage, high-skilled professional and management positions. FDI is also transferring modern technology to Czech industry. This has enabled Czech firms to modernize production facilities as well as formerly inaccessible technology, which supports the view that transnational companies provide an important vehicle for diffusing technology from more to less well-advanced countries.

There has also clearly been a strengthening of the west east split in the dispersion of FDI over the past decade. The early pattern concentrated on the capital city and its immediate surrounding region, but later developments have revealed a shift of concentration towards the western border regions with their stronger FDI links with Germany and Austria, both E.U. members. It is noticeable that the farther the region is from the EU boundary the less FDI is being obtained. Also more recently the spectre of unemployment is becoming more apparent, partly because domestic enterprises are larger employees than foreign owned companies.

In sum, FDI inflows to the Czech Republic have proved advantageous in many ways. It remains to be seen if the initial benefits from restructuring /technology transfer will continue to have any future influence. If enterprise restructuring and structural change is to be a success, then the key participants will be the growth of small enterprises and the activity of foreign investors (Myant, 1997; Zemplinerová, 1997).

FDI has undoubtedly proved a crucial element in the Czech Republic's continued economic development, nevertheless the question remains as to whether the Czech Republic will receive sufficient FDI to replace investment shortfalls in other parts of the economy? Predicted annual FDI inflows for 1999 and 2000 are USD 2,830 mil. and USD 2,530 respectively (Anon,1999j), but it is obvious that if future potential is to be maximised, more FDI is needed to drive the economy towards greater maturity which, in turn, will influence future EU membership objectives. First however, the country must escape from economic depression if it is to attract higher FDI inflows in future.

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POTENTIAL HIGH-SPEED RAILWAYS IN THE CZECH REPUBLIC: TERRITORIAL PREREQUISITES AND LIMITATIONS

Bohumír TRÁVNÍČEK

Abstract

Efforts to find a solution to the present unsatisfactory situation in the field of fast and top-quality transport in the Czech Republic became a stimulation to finally resolve the problem. The work sets up corridors of the potential high-speed railways which correspond with conurbations in the Czech Republic and in neighbouring countries, taking into account the specific character of the Czech topography. The variants for the development of high-speed railways are worked out with regard to possible alternatives of the future development. With its size and geographical position, the Czech Republic appears a possible junction of transit high-speed railway lines in the N-S and E-W directions.

Shrnutí

Potenciální železniční rychlodráhy v České republice - územní předpoklady a bariéry

Snaha nalézt řešení neuspokojivé situace v oblasti rychlé a kvalitní železniční dopravy v České republice se stala podnětem pro řešení tohoto problému. V této práci byly stanoveny koridory potenciálních rychlostních železnic korespondující s aglomeracemi v ČR a v sousedních státech. Tyto koridory zohledňují rovněž terénní předpoklady ČR. Varianty rozvoje rychlostních železnic jsou zpracovány s přihlédnutím k možným alternativám budoucího vývoje. Česká republika se tak vzhledem ke své velikosti a zejména poloze vyprofilovala jako možná křižovatka tranzitních vysokorychlostních tratí ve směru sever-jih a východ-západ.

Key words: *high-speed railway, gravitation model, Central Europe, Czech Republic*

1. Introduction

1.1 The beginning of railway up-grading in Europe

The European railway network was developing spontaneously in the territories of individual countries since the 30's of the last century – at first for regional needs. Only later, the isolated sections were interconnected into a continual railway network of the respective countries and included also some international connections. Different technical standards, directives and practices resulted in differences which still complicate the border crossing.

These facts put brakes on the global development of railway system in the integrating Europe and this is why attention should be paid to their elimination. The efforts should result in a unified European railway system that would facilitate fast and comfortable connections between towns and city conurbations, linking up well with the regional public transport. This is the only way how to prevent the ever-growing use of individual cars and the consequent impacts on the environment.

A primary impuls to consider possibilities of up-grading the railway traffic are the increasing prices of fuels in the 70's and 80's and the negative effects of the developing road and air transport at that time (Kinský, 1997; Machek, 1997). The negative effects of the road traffic on the environment are notoriously known. A disadvantage of the transport by air at shorter distances (about 1,000 km) is the fact that the total time of transportation must be added – in addition to the flight itself - the time spent at the airport and the transportation between the city centre and the airport terminal. In some cases, the time loss can be so great that it really does not pay to travel by air, especially as compared with the high-speed railway which can be much more efficient in terms of time consumption.

According to Kinský (1997), the main limiting factors for building the high-speed railway lines include natural conditions on the one hand and socio-economic conditions on the other hand. The present technologies make it possible to get over the natural obstacles. Which means that it is the economic factors that get into the limelight – such as building costs and their returnability. This is closely related to socio-economic conditions such as the population density, the size of towns and their mutual distance. All these factors condition the population mobility and demands for goods service.

1.2 High-speed railway: The definition

High-speed railways can be considered:

- the classical high-speed railway tracks enabling the running speed over 200 km.h^{-1};
- the magnetic tracks.

It must be pointed out at this place that regarding the fact that the magnetic railways are at their initial stage of development in the world, this contribution will discuss the high-speed railways (HSR) and will not include the issue of the magnetic railways.

The contemporary high-speed railway network in West Europe consists both of tracks newly built for the running speed of about 250 km.h^{-1} and higher, and of tracks reconstructed or up-graded to speeds of about 200 km.h^{-1}. Modernized railway tracks with maximum speeds ranging from 160 to 200 km.h^{-1} which form connecting sections between the proper HSR are not an exception and probably will not be in the future. These railway tracks use to be included in the system of the high-speed railway tracks and form their special category. The present HSR are interconnected with the existing railway network which makes it possible to direct the trains also to centres not connected to the HSR system. An example can be the German Alpine centre of Garmisch-Partenkirchen as a destination of the ISE high-speed railways from Hamburg.

It follows that the railway track speed can be increased by the following ways (Tyc, Kubát, 1997):

- by up-grading the existing railway tracks for higher running speeds;
- by building new railway tracks with HSR parameters;
- by using special train units with tilting body casings which can increase the railway speed on the existing tracks by as much as 30%.

The HSR system can then be classified according to the line distinguished for either a segregated or a combined system of transportation. In the first case, the tracks are intended exclusively for the passenger traffic (such as those operated in France and Japan). In contrast, the tracks of the combined system are used both for the high-speed passenger traffic and for the goods service (Germany). Characteristics of the two systems are to be found in the following table.

After having assessed the pros and cons of the respective systems a statement can be made that the Czech conditions would rather call for the combined system of HSR operation, one of serious reasons being the fact that all neighbouring countries made the same decision, and another reason being the insufficient flows of potential passengers in the Czech Republic in contrast to France or Japan.

2. Up-grading railways in Europe

2.1 High-speed railway system development in Europe

As early as in the second half of the 50's, the West European countries and Japan started to up-grade their existing railway lines for higher running speeds and to study the new high-speed railway systems. France and Japan counted only with the high-speed lines meant just for the passenger traffic. However, the idea of railway Rennaissance in Europe were not so easy to force in, as mentioned by Kyncl et al. (1996). It was at the time of low fuel prices, relatively low measure of motor-car use, ie. at the time when the negative effects of traffic onto the environment just started to appear.

Towards the end of the 60's, the French government approved the construction of a high-speed railway track between Paris and Lyon (TGV Sud-est). The very first trains on this track, designed for the speed of 270 km.h^{-1} got in motion as late as in 1981. The original rail systems near Paris and Lyon, which were connected with the high-speed railway still remain preserved (Jelen, Sellner, 1997). A couple of years later, Paris was interconnected by a high-speed railway with Tours and

Tab. 1: Advantages and disadvantages of the HSR segregated and combined systems

	SEGREGATED SYSTEM	COMBINED SYSTEM
Advantages	Possible larger track grade and smaller track curve. Better track setting into terrain. Simple organization.	Efficient operation even at lower passenger flows. Fast goods service.
Disadvantages	Necessarily sufficiently large passenger flows. Need of good-quality existing railway network for high-speed goods service.	More demanding conditions for searching suitable localities to direct the HSR (necessary are larger track curves and milder grade. More demanding organization. Greater wear of rail superstructure.

Le Mans (TGV Atlantique). And finally, the high-speed railway track Paris – Lille was put into operation in 1993 with the linking high-speed railways to Egland (Eurostar), Belgium (Thalys), and Germany where it is led along the original railway tracks and should join the German high-speed railway system near Cologne. Another connecting line – this time with southern Germany - will pass Strassbourg to Freiburg (TGV Est).

The German decision on the high-speed railways was made several years later. The chosen method was different: a combination of newly constructed high-speed railway sections (with speeds up to 300 $km.h^{-1}$) and the existing track sections up-graded to the speed ranging between 160-220 km. h^{-1}. The system has been operated since 1991 and the high-speed ICE trains interconnect important German conurbations and some of them end in Zurich (Switzerland). Belgium and the Netherlands can make profit out of their location between the two principal high-speed railway systems.

Of other countries operating the high-speed railway traffic in Europe let us mention Italy and Spain whose high-speed railway systems also expect to be connected to the global European system. The list could end with Sweden and Finland where the maximum speed of the existing railway traffic ranges between 200-220 $km.h^{-1}$.

Although this chapter is to be devoted to the HSR in Europe, the specific characteristics of HSR call for mentioning the Shinkansen high-speed railway system in Japan.

The first HSR led from Tokyo to Ósaka (514.4 km). It was put into operation as early as in 1964 and its highest spped allowed was 210 $km.h^{-1}$ at that time (Jelen, Sellner, 1997). In 1997, the total length of railway lines with running speeds ranging from 230 to 275 $km.h^{-1}$ was 1835 km with other lines being under construction.

2.2 European policy of coordinating the HSR building

There is a number of agreements in order to interlink the respective high-speed railway systems in Europe and the issue is being handled by various European organizations. The coordination of construction works on railway lines which should connect the respective countries is important similarly as the solution of problems with the further up-grading of the railway infrastructure in the countries of Central and East Europe.

2.2.1 The European Agreement on Main Railway Lines (AGC)

(Accord européen sur les Grandes ligne internationales de Chemin de fer)

The principal ideas of the Agreement were put together by the Main Working Group for Railway Traffic, Committee for Domestic Traffic, UN European Economic Commission, which nominated in 1983 an iterim working group for the preparation of the AGC Agreement. Czechoslovakia joined the AGC Agreement on the basis of a government decree in 1990. To the date of 31 December 1994, the AGC Agreement was signed by the following 16 countries: Belorussia, Bulgaria, Czech Republic, Croatia, France, Italy, Yugoslavia, Hungary, Poland, Austria, Slovakia, Slovenia, Federal Republic of Germany, Turkey and Ukraine (Kyncl et al., 1996).

The mission of the Agreement consists in the easier and integrated development of the international railway traffic with the aim to create a coordinated procedure of building railways which would meet prospective requirements for the international railway transport. By signing the AGC Agreement the countries accept the draft for a railway network with main tracks being marked with Letter E including their main parameters and undertake to be prepared to fulfill the draft within their national programmes and in compliance with their legislations.

After the Czech Republic having come into existence, there were certain modifications made in connexion with the concept of up-grading the main railway transit corridors. At present, the AGC Agreement applies to the following railway sections in the territory of the Czech Republic:

E55 Děčín – Prague;

E 551 Prague – Horní Dvořiště;

E 61 Česká Třebová – Brno – Lanžhot;

E 65 Petrovice u Karviné – Ostrava – Přerov – Břeclav;

E 40 Cheb – Pilsen – Prague – Kolín – Česká Třebová – Ostrava – Mosty u Jablůnkova.

2.2.2 The International Railway Union (UIC)

(Union Internationale des Chemin de fer)

Another organization dealing with the mutual compatibility of individual railway networks is the International Railway Union (UIC) – Union Internationale des Chemin de fer. It was founded in 1922, and the Czechoslovak State Railways whose membership was passed on the Czech Railways after the split of Czechoslovakia were the member since the foundation. After the signature of the Treaty on the European Union in Maastricht in 1992, the organization has been paying a considerable attention to the issue of traffic networks (Kyncl et al., 1996).

There is a list of 26 traffic projects of European significance (often reaching over the EU boundaries), including the main principles for their funding. The EU financial support can only be extended to projects which are environment friendly. In the field of the railway traffic it is a set of high-speed and up-graded tracks, resolving in the majority of cases the mutual connection between the EU countries including the overcoming of terrain barriers (the connection of Germany and Italy via a new tunnel under the Alps, etc.). The newly constructed West-European high-speed railway tracks for 250 - 300 km.h^{-1} should be 12 500 km long in 2010, with the up-graded railway tracks for the speed of 200 km.h^{-1} and connecting railway tracks reaching 14, 000 km and 2, 500 km, respectively.

2.2.3 Conferences of the Ministers of Traffic (Prague, Crete and Helsinki)

The Trans-European network would not be complete without the connected EU high-speed railway to the lines of the remaining European countries. The issue was discussed by the 2nd Pan-European Traffic Conference on Crete. The Conference adopted a network of nine Trans-European multimodal corridors of the highest European significance for the countries of Central and East Europe (of which eight are road corridors and one is a water corridor), which is technically linkable and operationally interconnectable with the Trans-European networks (TEN) of the EU countries. The railway corridors are illustrated in Fig.1. Thus, the Czech Republic has an immediate interest in the modernization of a partial section of Corridor IV between the (Dresden) German border – Prague – Brno – Břeclav – the Austrian/Slovak border (Wien/ Budapest) and its Branch A between the (Nürnberg) German border – Prague. Other up-grading efforts will be developed on the connecting lines between Corridor IV and Corridor VI.

3. Up-grading railways in the Czech Republic and in the neighbouring countries

3.1 The situation in the Czech Republic

The approach to the issue of up-grading the Czech railways by building the HSR system in the Czech Republic follows out of the development experienced by the railways in the 80's and 90's. The first studies were made at the beginning of the 70's, but the questions raised in them were not seriously dealt with regarding the need of resolving problems consisting in the main tracks being overloaded with goods service. At the beginning of 1989, the then Czechoslovak government adopted a conception for the railway traffic development based on the need of further capacities in the directions of the main international lines. – Then, the works on a concept study of high-speed railway tracks in the Czechoslovak Federative Republic were started. The HSR concept study was discussed with the neighbouring countries and parallel works were launched to study the up-grading of the existing railway tracks included in the AGC Agreement.

However, the beginning of the 90's saw a reduced railway traffic in the Czech Republic, which resulted – together with the high demands for the project of building the HSR in the field of costs and complex negotiations with the neighbouring countries - in a newstudy named „Coordination of HSR with the up-grading of the existing railway lines". The project counted with several options (SUDOP Prague, 1995). In discussions with the neighbouring countries, other possibilities of improving the railway infrastructure on the railway tracks included in the AGC Agreement were investigated, too. The joint works resulted in the definition of a coordinated procedure with the decisive aspect for the option choice being economic factors.

After all existing studies have been valuated, the preference was given to the up-grading of the existing railway tracks whose network is identical with the present up-graded network of railway corridors. The issue of HSR construction was at that time postponed to approximately 2005; yet, regarding the changed situation as compared to 1990 (split of the state, additional drop in the railway traffic volume), the concept study of HSR in the Czechoslovak Federative Republic had to be up-dated.

3.1.1 Up-grading the transit railway corridors

During the political and economic changes in the Czech Republic and in Central Europe at all, the Czech political representation got aware of the need to at least partially improve the railway infrastructure. This partial improvement became an up-grading of the first of four transit railway corridors linked to the European railway network, and was started in 1993. There were the following four railway corridors which were given the priority (see Fig. 2), of which Corridor I and Corridor II are being up-graded at the present time (Kyncl et al., 1996):

I German border – Děčín – Prague – Česká Třebová – Brno – Břeclav – Austrian/Slovak border;

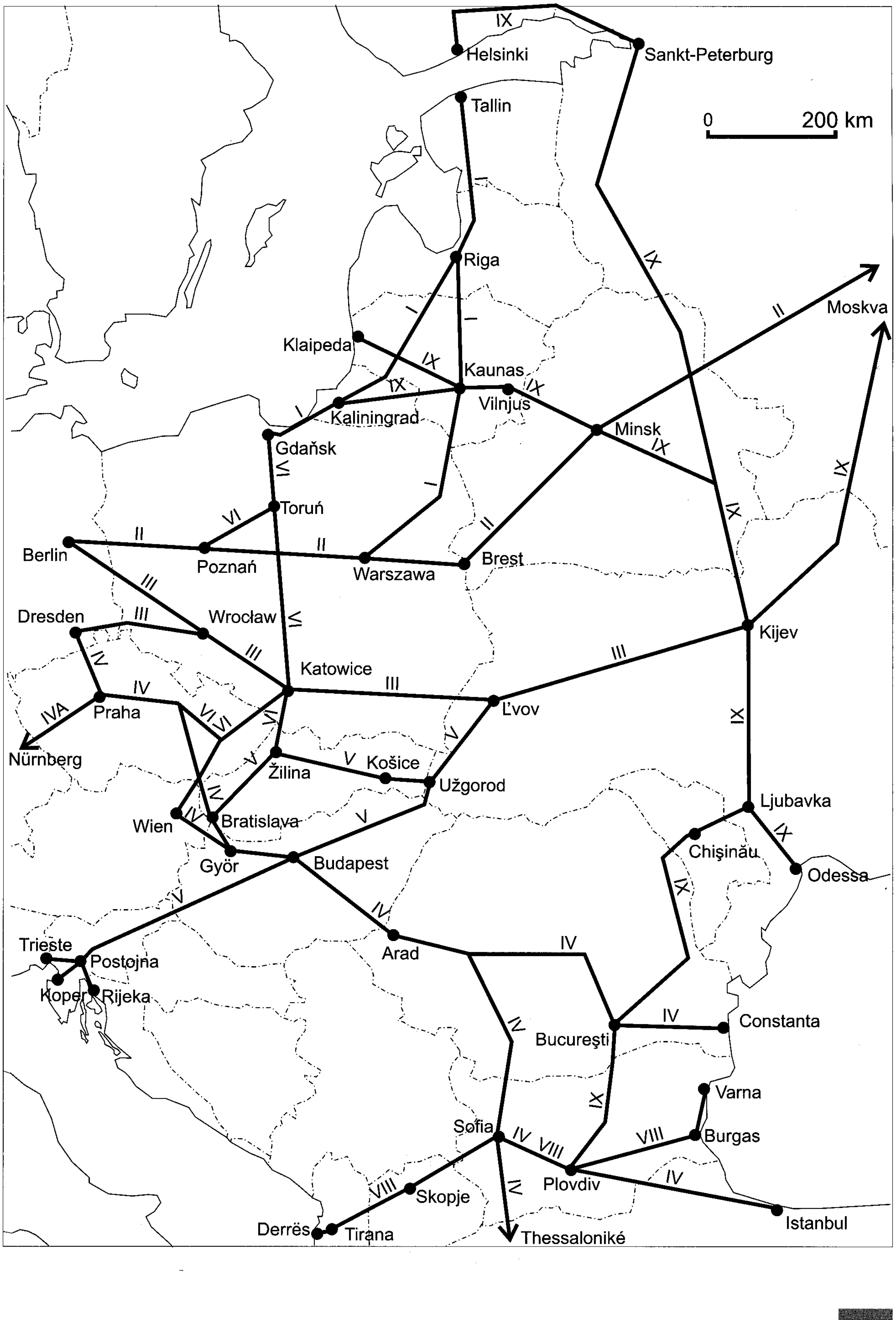
II Austrian border – Břeclav – Přerov – Ostrava – Petrovice u Karviné – Polish border with the branch line of Přerov – Česká Třebová;

III German border – Cheb/Česká Kubice – Pilsen – Prague – Olomouc – Ostrava – Polish/Slovak border;

IV German border – Děčín – Prague – České Velenice/ Horní Dvořiště – Austrian border.

The up-grading of corridors should ensure that the railway tracks can stand speeds up to 160 km.h^{-1} with temporary and permanent track limitations being eliminated without much of construction works. With respect to different possibilities of direction modes, the individual track sections were classified into two types of reconstruction: optimation and up-grading. The up-graded railway track sections also experience the

***Fig. 1:** The network of multimodal corridors*



displacement of rail axes exceeding the possibilities of the present track bed position. The optimation is meant to be a local improvement of railway track parameters such as the adjustment of rail geometrical position with no change to the line bed or the elimination of permanent restrictions imposed on the highest track speeds, etc. (Bittner, 1995). The reconstructed railway tracks should be operated by electrical units with the tilting casings which facilitate a faster motion in curves at the track parameters remaining common.

3.1.2 Assessing proposals for a possible solution of the HSR network in the Czech Republic

The mentioned up-grading of the transit railway corridors marks the further development of the railway infrastructure in the Czech Republic. At about mid-90's, a space turned up for various conceptions and proposals to situate the HSR in the Czech Republic. The issue was professionally tackled by SUDOP a.s. Prague and its branch office in Brno. The proposal was worked out to details and this is the reason why it deserves more attention.

There is a number of both domestic and foreign conceptions for possible directions of the HSR in the Czech Republic. However, in the great majority of cases they remain on the theoretical level only. Nevertheless, they can be a source of valuable stimulations to modify the proposed network.

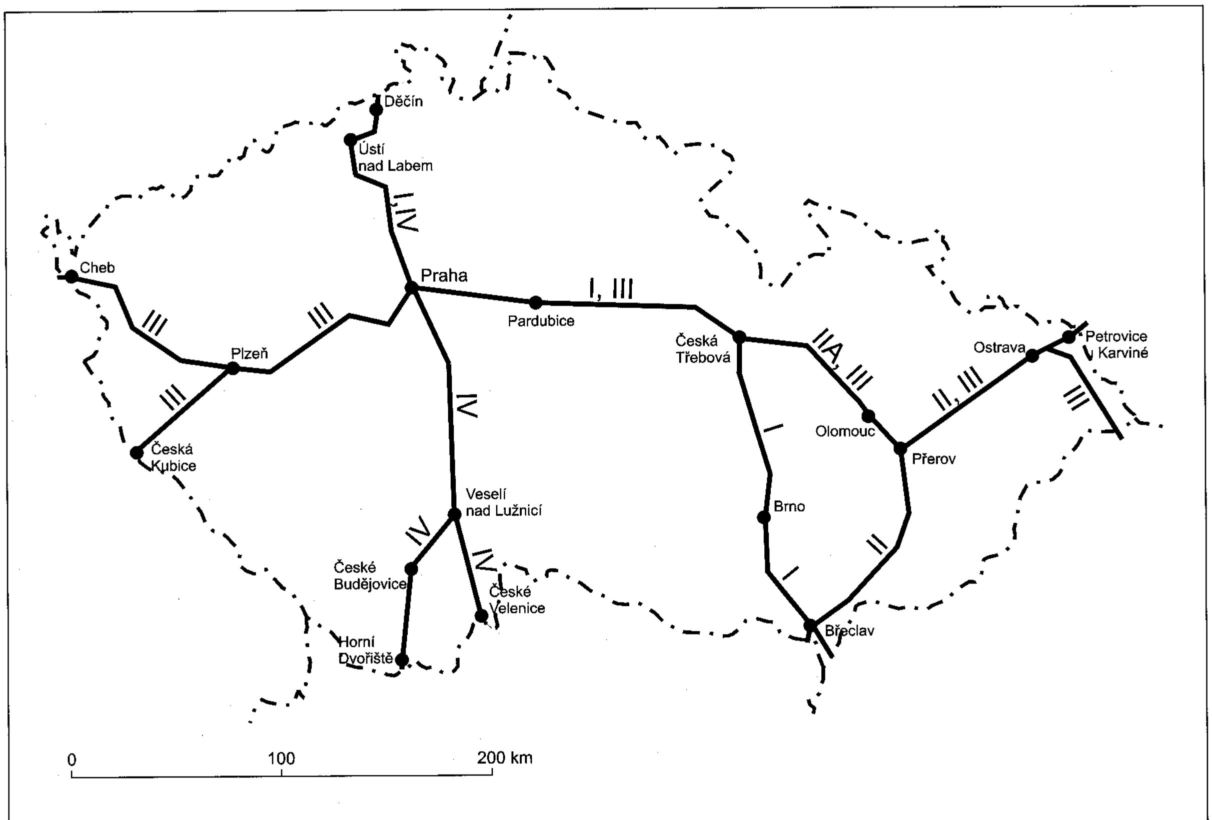
The conception proposals submitted by SUDOP Prague a.s.

The study of this firm is based on a prerequisite of the Czech Republic being connected to the West-European high-speed railway network with the cities of Prague, Brno and Ostrava included. The result is a presented network of in the future constructed higt-speed railway tracks for running speeds above 200 km.h^{-1}. The whole network proposed for the Czech Republic is thoroughly worked out with a precise course of the proposed tracks plotted in a series of maps at a scale of 1:50000 which makes it possible to ensure the protection of properties that would be cut through by the railway.

The proposed HSR system passing the Czech Republic copies the so called multimodal Corridor IV (see Fig. 1) and the branches of Corridor VI. At the same time, it is identical with the up-graded tracks of the transit railway Corridors I, II and III (see Fig. 2). The Kolín – Brno – central Moravia section which would link up with the reconstructed transit corridors of Czech Railways is recommended for the first stage of the project. The general conception can also be understood as a construction of individual HSR railway sections, which would closely link up with the up-graded tracks.

The issue was resolved in variants and the resulting proposals divided into recommended and alternative. The basic conclusions concerning the direction and

Fig. 2: Czech Railways transit corridors



operation of the railway tracks can be summarized into the following ideas and parameters:

- The HSR corridors should form an integrated system together with the up-graded existing tracks of the railway network operated by Czech Railways;
- The highest speed of the (passenger) train is 300 $km.h^{-1}$;
- The lowest speed of the (freight) train is 120 – 160 $km.h^{-1}$;
- The recommended track curve radius is 7,000 m;
- The minimum track curve radius is 5,100 m;
- The greatest longitudinal grade is 12.5%;
- The exceptional maximum grade is 18.5%.

The proposed HSR network is divided into the following routes: Prague-north, Prague-west, Prague-Brno, Brno-south, Brno-north, with the Prague and Brno junctions having a specific solution of their own. The situation is illustrated in Fig. 3 including the division of the proposed routes into the recommended and alternative variants and the places of hypothetical stops of the high-speed trains.

3.2 The situation at up-grading the railways in the neighbouring countries

3.2.1 Slovakia

The first HSR variants for the territory of the Slovak Republic originate from 1989-1991 when SUDOP Prague and SUDOP Bratislava worked out the HSR Conception Study in the Czechoslovak Federative Republic. The following HSR proposals were the result (Hujsi, Filo, 1997):

- Kúty – Bratislava – Štúrovo;
- Bratislava – Žilina;
- Čadca – Žilina – Košice;

After Slovakia becoming an independent country in 1993, there were other studies which took the fact into account. Of these we can mention some proposals that copied the north-south and east-west axes:

- Austrian border – Bratislava – Žilina – Polish border;
- Bratislava – Košice – Čierna nad Tisou – Ukrainian border.

From the viewpoint of the Czech Republic, it is the first of these proposals that is important because it is in fact a route parallel to the Czech transit Corridor II (Wien) – Břeclav – Ostrava (-Warsaw) which forms a connecting point between the Transeuropean multimodal corridors IV and VI. The Bratislava – Žilina track is also a component of the Transeuropean railway network (see Fig. 1) since it is a part of the multimodal corridor V. Therefore, it can be presumed that the Slovak party will endeavour at building a competitive connection of higher quality. This can be evidenced not only by the present reconstruction of the railway track between Bratislava and Žilina, but mainly by the complex up-grading and electrification of the track Čadca – Skalité – Zwardoň (PKP) that will continue in the Polish territory to Katowice and Kraków.

3.2.2 Austria

In Austria, the railway track between Wien – Linz - Salzburg is being reconstructed at the present time to the speed of 200 $km.h^{-1}$. The Austrian party considers the track in its territory a part of the main European artery Paris – Wien – Budapest – South-East Europe.

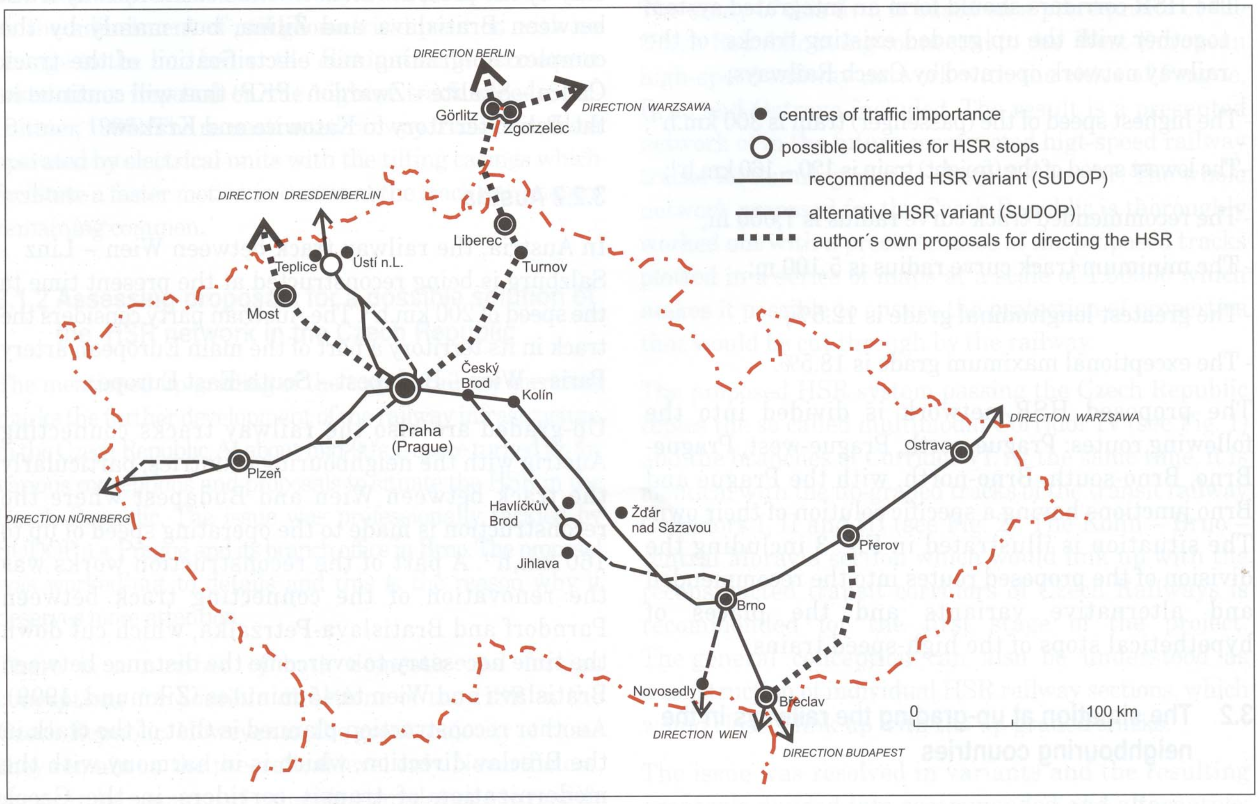
Up-graded are also the railway tracks connecting Austria with the neighbouring countries, particularly the track between Wien and Budapest where the reconstruction is made to the operating speed of up to 160 $km.h^{-1}$. A part of the reconstruction works was the renovation of the connecting track between Parndorf and Bratislava-Petržalka, which cut down the time necessary to overcome the distance between Bratislava and Wien to 45 minutes (Zikmund, 1999). Another reconstruction planned is that of the track in the Břeclav direction, which is in harmony with the modernization of transit corridors in the Czech Republic. In addition, the reconstructed track in the Czech Republic will link up with the transit corridor II which continues to Warsaw.

3.2.3 Germany

Apart from extending the high-speed railway network in the western part of the country, and its further interconnection with France and Benelux countries, a project was worked out for the up-grading of existing tracks and the construction of new ones in the territory of the former German Democratic Republic. The project aims the a removal of barriers developed due to the split of Germany in the past and takes into consideration the intended integration of Europe. It is included in the programme of the „German Union“ which came into force at the beginning of the 90's and covers not only the projects from the field of railway, road and water traffic (Zatloukal, 1992).

In the case of the railway infrastructure, there are altogether nine projects whose resulting effect will be the increased operating speed of up to 160 $km.h^{-1}$, at some places up to 200 $km.h^{-1}$. Regarding the geographical position of the Czech Republic, some of these projects could become a valuable contribution – such as Project 9 in the section Leipzig – Dresden aimed at an improved connection between the Ruhrgebiet and Saxony. Another project includes the reconstruction of the Berlin – Dresden track to the speed of up to 200 $km.h^{-1}$.

Fig. 3: Proposed variants for HSR directions in the Czech Republic



On the other hand, Project 8 for the track from Nürnberg – Erfurt – Halle/Leipzig – Berlin represents certain hazards for the Czech Republic - the main objectives consisting in putting the track section from Nürnberg to Lichtenfels (speed 200 km.h^{-1}) onto a double-rail system, and particularly the new construction in the section between Lichtenfels – Erfurt – Weißenfels – Leipzig (250 km.h^{-1}). It also concerns a reconstruction of the track between Weißenfels and Halle (200 km.h^{-1}) and the maintenance of the section from Bitterfeld to Berlin (speed up to 200 km.h^{-1}). The extent of reconstruction cannot be qualitatively compared with the reconstruction of the transit corridors in the Czech Republic. Also, in the case that the date of the Czech Republic entering the European Union is postponed (and the border formalities slowing down the international traffic will last), a situation seems quite realistic that the important international non-stop trains of some relations (such as Budapest-Wien-Hamburg) can be diversed from the Czech territory and put exclusively onto the tracks in Germany and Austria.

3.2.4 Poland

The major effort is focused on the up-grading and acceleration of the connection with the neighbouring Germany, which is to later become the main axis in the west-east direction to connect Germany with the Baltic countries and Russia. Another axis is that of north-south, which represents the shortest connecting line between the Baltic Sea and Adrian and on which - in addition - are situated the European metropolises of Wien and Budapest. This axis could bring some profit even to the Czech Republic, particularly its eastern section.

The good infrastructure of the Katowice-Warsaw track makes it possible to achieve present speeds of up to 200 km.h^{-1} with the speed of up to 250 km.h^{-1} being considered (Hainitz, 1998).

4. Application of the gravitation model on the issue under study

4.1 The use of gravitation models in geography

In its broadest sense, the gravitation model helps to find a binding between two or more centres – peaks of the graph. The determined intensity of the binding between the graph peaks is directly proportional to their size and indirectly proportional to their distance. The centre size can be defined by the population number, complex functional size etc., and the distance between the centres can be determined for example by means of a simple geometrical distance or accessibility in time, etc. (Hlavička, 1993). The succession of edges between the two studied graph peaks can be marked as a way between the two points. The loading value represents the gravity of the two points which form a relation. The resulting dimensionless value of loading a certain graph edge corresponds with all partial loadings on the definite edge.

The gravitation model edge grid should correspond with the actual situation provided that it is a generalization at which it is important to depict the major traffic trends. One of possible relations used at working out the gravitation models for geographical purposes and applied at this investigation was the following equation:

$$iAB = (O^A . O^B)/d^?,$$

where iAB is the mutual interaction between the A and B graph peaks, O is the magnitude of these peaks, and d is the shortest distance between them across the graphic grid. There are other versions of the gravitation model that can be used in geography (Hlavička, 1993). Calibration of the gravitation model, which is represented by the power of ? distance, is of a special importance. The basic version of the gravitation model makes use of the second power; however, the power of distance can acquire different values (Hlavička, 1993). In this conrete case, the coefficient ? was made 1.2 since the main motivation was to express the transit relations in the Central-European space and to take no account of the regional relations.

4.2 Characteristic of the area under study

The presented gravitation model is based on a set of 22 towns – joints, peaks of the graph, and on 55 connecting lines – edges, forming altogether a grid that became the initial tool to resolve this model problem (see Fig. 4).

The logical abstraction from the problems by means of graphs indicates the importance of the choice of graph peaks for the objectiveness and the nature of results itself (Řehák, 1994). The quality of the gravitation model is highest in the centre of the delineated graphic grid and decreases towards its margin. This logically relates to the fact that the marginal edge loading is lower than could be expected.

The choice of suitable towns took into consideration more attributes from the geographical and traffic point of view. The first factor to either include or discard the given town into(from) the set was its population size. Another criterion was the position of the given urban centre in the present railway network, for example from a viewpoint of the quality and frequency of train connections. The last criterion was of a somewhat abstract nature and concerned the general significance of the given town following out of its geographical localization. This criterion was applied in the first place in towns forming external joints of the network, ie. in those which often do not reach the needed size (Venice, Zurich, Terst) and are not even the important railway crossings (Terst). A great role for their introduction was played exactly by their location and by their general economic and geographical significance (Terst – the habour; Zurich – the economic centre of Switzerland). For the case of two conurbations (the Ruhrgebiet and the Upper Silesian Basin), a representative centre was chosen with the higher population number (Essen/Katowice); the inhabitants of these centres were multiplied by three for the purpose of the analysis by the gravitation model in order to approximately express the general potential of the given conurbation.

Some towns which did not meet the criteria were not included in the graph. Examples can be Krakow or Poznan in Poland. None of these two towns is a representative railway junction that would significantly influence the traffic situation in the Central European space. Also, their possible inclusion would most probably complicate the whole problem which would become more labourious due to the geometrically growing number of calculations. Of other non-included towns let us mention Salzburg and Linz in Austria. While being the railway crossings, the two towns have the population size ranging considerably below the defined standard level. The combination of two mentioned situations also led to the exclusion of Košice.

A disputable case can be the possible inclusion or exclusion of Brno. The population size of this city is closely below the lower limit of 500 000 inhabitants and the city has a realistic chance to be connected to the HSR system. These would be reasons for its inclusion. However, the objective is to resolve the issue primarily in the international context and a possible inclusion of Brno into the graph would have no specific influence on the situation from the international point of view; it would only increase the loading values on the respective edges in the Czech Republic.

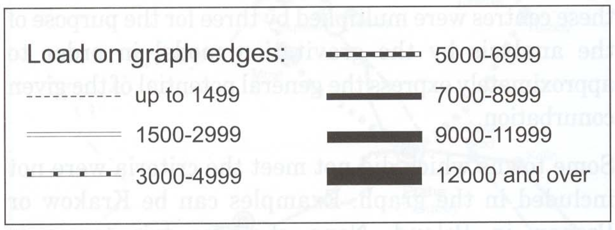
A mutual logical interconnection of the given 22 centres can be the definition of graph grid edges. The initial view of their directioning were the present actual railway connecting lines, mainly on the basis of their influence on the traffic situation in the Czech Republic. The distance in kilometers is based on available railway time-tables in the respective countries, particularly on the DB AG time-table, Volume Ausland.

Efforts were also focused onto the already existing high-speed railway tracks in the German territory such as Würzburg – Fulda – Hannover, Frankfurt – Mannheim – Stuttgart, and Hannover – Berlin. The high-speed trains on these tracks have a usual running speed over 200 $km.h^{-1}$, which enables a pronounced cut of travelling times. The strict criteria for building HSR (track curve of at least 7, 000 m, max. grade 12.5‰)

helped to straighten the track and to shorten the distances. The actual length of these edges was multiplied by the coefficient of 0.75 for the needs of the gravitation model, which put the tracks in advantage in the comparison with the other tracks.

Since the problem is a model one, the edges were not selected according to the actual context in some cases; the intention was to define rather the edges that would represent the actual traffic context. This is the reason why the edge of Prague – München was chosen via Nürnberg, etc. Also missing is the edge of Leipzig – Nürnberg, which could hardly compete under this model situation with the high-speed connection through Hannover.

The edge lengths correspond with the data from the Time-Schedule of Czech Railways 1998/99. Representative variants were chosen in the case of two edges reaching across the Czech border in a certain duplicity: Prague – Wroclaw, and Prague – Nürnberg . In the first case, the variant chosen was Prague – Lichkov – Miedzylesie – Wroclaw, in the second case, it was the track leading through Domažlice.



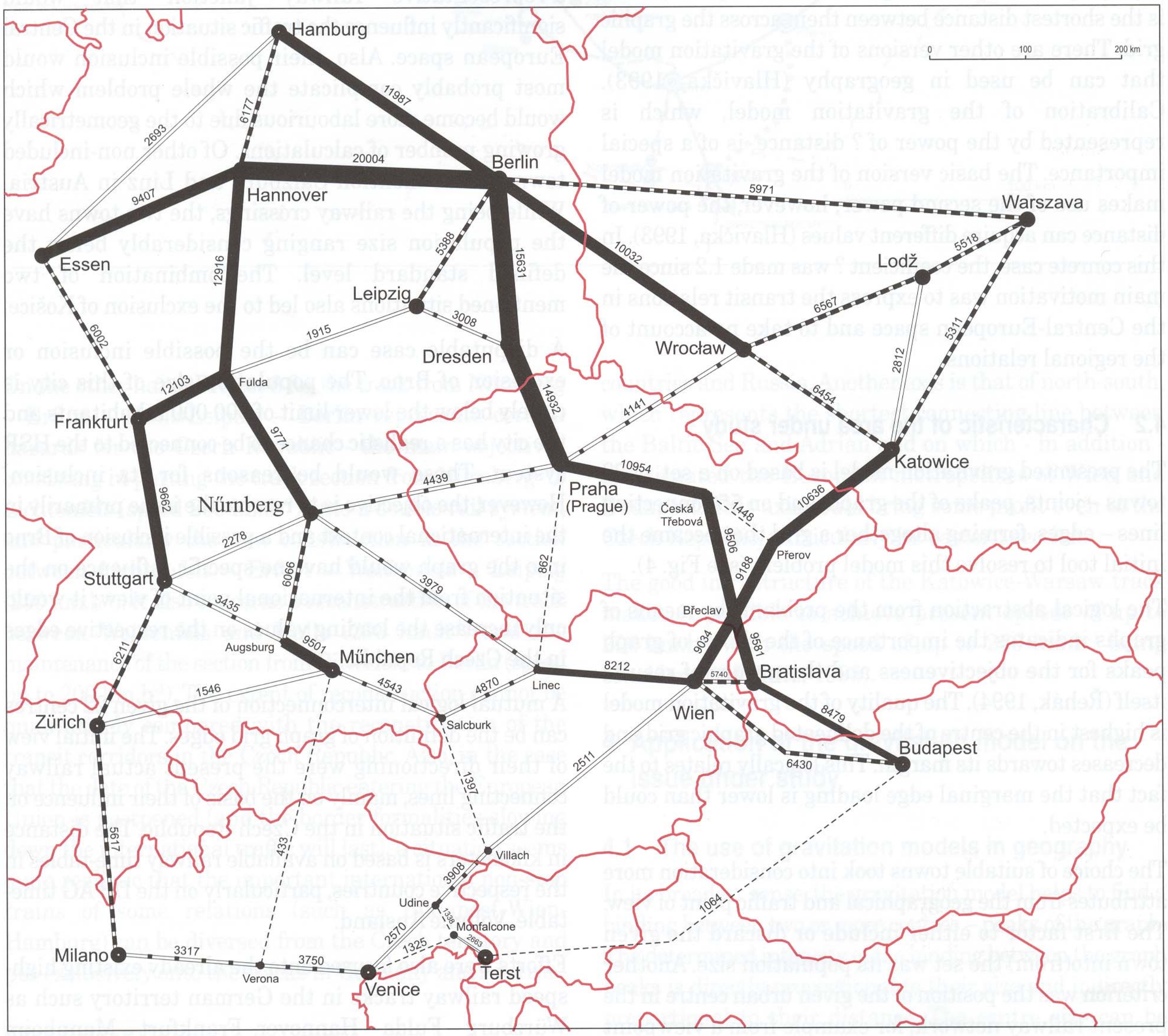


Fig. 4: The loading of gravitation model edges

4.3 Assessing the results of the gravitation model for the territory of the Czech Republic

The conclusions found out by means of the gravitation model well correspond with the basic transport flows in the Central European region. Important for the Czech Republic are edges crossing the country border. By their mutual connection and combination with the domestic sections the following transit directions can be defined:

- Berlin – Dresden – Prague – Česká Třebová – Břeclav – Wien/Budapest;
- Warsaw – Katowice – Přerov – Břeclav – Wien/ Budapest;
- Nürnberg – Prague – Wroclaw – Warsaw.

The major role is played by densely populated cities such as Berlin whose significance is expected to grow in the future. Due to the group of large towns the edges are most loaded in Germany. A surprisingly great importance is attributed also to the edges leading from Berlin to SW and S.

4.3.1 Berlin – Prague – Wien/Budapest

This axis which connects the north-east of Germany including its capital with Prague and the Wien and Budapest conurbations appears most important as viewed from the location of the Czech Republic. The direction is generally given the greatest significance, which can be documented by the fact that its different variants to a certain extent copy Transit corridor I of the Czech Railways, chosen for the priority reconstruction and up-grading at the beginning of the 90's (Jelen, Sellner, 1997).

The model transportation load of this direction is not constant along its entire length; there is a decreasing trend from NW to SE. By considering the so called border effect, the values of load on the respective edges drop by about 20%. The most loaded edges are those of Berlin – Dresden, and Dresden – Prague, which at the same time rank with the edges of the greatest significance within the whole model.

4.3.2 Warsaw – Katowice – Wien/Budapest

This axis connecting the north and south of Europe is of a slightly lower importance than the direction Berlin – Prague – Wien/Budapest, although the resulting load is approximately identical. In this case, too, a reconstruction and up-grading are made of Transit corridor II (Polish border – Přerov – Břeclav – Austrian/Slovak border). Some other facts are identical with the direction Berlin – Wien/Budapest, and the importance is comparable, too. Its future growth can be expected in the integrated Europe.

4.3.3 Nürnberg – Prague - Warsaw

In the comparison with the above two directions, the model load in this direction is considerably lower (by about 50%). The Prague – Nürnberg branch is counted with in the majority of available studies while the Prague – Wroclaw section is usually considered to be of the secondary importance. The potential load is roughly equal, though.

The Nürnberg – Prague – Wroclaw branch can become more important after the integration of Europe – as a connecting line between Poland, southern Germany and other territories in south-western Europe.

4.3.4 Other transit directions

This group includes two directions as follows:

- Prague – Linz;
- Česká Třebová – Přerov.

In the comparison with the other directions the model showed its relatively low loading which can even be considered negligible in the Prague – Linz direction. The reason can be seen both in the low population of Linz (and this is also the reason why the city was not included in the group of 22 centres), and the barrier of the Alps. A certain role is also played by HSR in Germany, which overtake numerous connections of towns in northern Germany and northern Italy. It is to be added at this place that the present quality of the connecting line between Prague and Linz is far from being satisfactory, yet the present railway track reconstruction in the České Budějovice – Summerau section will soon contribute to the faster operation of trains.

In the case of a possible new track crossing located in the Alps between Linz and Udine, or after a possible up-grading of the existing tracks, the section between Prague and Linz can acquire a greater load and it would be possible to start thinking about a reconstruction of the track for HSR; this would, however, come into consideration in the horizon of 20 to 30 years.

Another section with a low load in the network under study is the track from Česká Třebová to Přerov, which is given particularly by the configuration of the graphic grid and a greater emphasis on the connection with West Europe. The connecting line of Česká Třebová – Přerov plays a great role at the present time, namely for the domestic traffic in the direction Prague – Olomouc – Ostrava, and to some extent also Prague – Přerov – Břeclav. The significance is given by the absence of a direct motorway connection between Prague – Olomouc – Ostrava, which means that the railway traffic is in this relation faster and more reliable than the road traffic.

In order to ensure the high-speed traffic between Prague and the Ostrava conurbation, a complete reconstruction of the track from Česká Třebová to Přerov up to the speed of 200 $km.h^{-1}$ (which represents the threshold speed for the transportation by classical train sets of wagons) would be sufficient. The track is a branch of Transit corridor II whose reconstruction is to be finished in 2005, unfortunately only with the aim of achieving the maximum track speed of 160 km.h^{-1} in just a couple of sections (Jelen, Sellner, 1997).

5. Assessing the HSR potential directions in the Czech Republic

5.1 A proposal of HSR variants passing the Czech territory

This chapter includes the author's own proposal for a possible arrangement of the high-speed railway network in the Czech Republic. The results of the applied gravitation model, the so far studies and other available documents concerning the given issue were considered basic premises with the possibilities of the given territory being taken into account.

The proposed arrangement HSR variants for the territory of the Czech Republic were based on tracks delineated by the gravitation model and on the proposals presented by SUDOP Prague.

5.1.1 A proposed network for the territory of Bohemia

The chapter brings an assessment of potential HSR variants in the territory of Bohemia as linked with the HSR network in Moravia. Included are the following parts of tracks:

- (Berlin) German border – Prague – Brno – Austrian/Slovak border (Wien/Budapest);
- (Nürnberg) German border – Prague – eastern Bohemia – Polish border (Warsaw).

Regarding the two considered high-speed railway tracks, it is in the very first place necessary to define the point of their crossing. Since the most important city in the Czech Republic is the capital of Prague, it would be logical and advantageous to install the HSR crossing exactly at this point. There is a possibility of localizing the HSR station right in the territory of the capital (e.g. to establish the HSR station in one of the existing railway stations), or at a point situated in its vicinity (max. distance of 30 – 40 km), whose localization would be beneficial.

The first option appears quite often in various projects, the second one is less frequent. The problem was tackled for example by Řehák (1993) who points out that there are traffic junctions of the „fungus" type across the world, which represent an alternative to the traditional traffic junctions with their localization on the crossing of traffic routes outside the urban centre. The author also discusses a possible construction of a similar junction in the Czech Republic. The possibility is given into the context with a previously discussed project of converting the former military airport at Milovice into a civil airport of international importance. The construction of the first „fungus" type junction in the Czech Republic was not even started since a decision was made to rather invest into the refurbishing of the existing airport in Prague-Ruzyně. The Milovice junction could have had a favourable connection to the HSR connecting Berlin with Wien and Balkan (through Zittau) and to motorways and high-speed communications (R10 Prague – Turnov; D11 Prague – Poděbrady, and in the future – Prague – Hradec Králové – Wroclaw).

HSR Prague – the northern border with Germany/Poland

The Prague – Berlin connection deserves the main attention. Although the new capital of Germany has not won a relevant position yet, the considerable investments flowing into the city must be taken into account. Factors to be included are also the large number of inhabitants and the localization of the German national and supranational institutions and companies. Thanks to all these aspects, the importance of the city can be expected to be increasing.

The SUDOP Prague study of 1995 recommends to lead the high-speed connecting line of Prague with Berlin from Prague along the Elbe into the space of Lovosice, and then via a system of tunnels through the České středohoří (Mts.) and the Krušné hory (Mts.) to Dresden and linking connections to Berlin. The variant is based on the present situation and on the fact that the demanding section between Lovosice and Dresden (bound to the Elbe valley) should bear the HSR in the mentioned way outside the Elbe valley (see Fig. 3). The Prague – Lovosice section has a few variants, too: one of them is the course along D8 and another starts in Prague and leads directly to NW with a possible connection of the Prague-Ruzyně airport.

This variant cannot be deprived of some pros of which one is for example the proposed stop of the „northern Bohemia" that would be located between Teplice and Ústí nad Labem, ie. in the locality which represents a theoretical centre of the heavily urbanized area of northern Bohemia.

Although there are some doubts that the HSR variant is ever going to be implemented, it is also the environmental policy that must be taken into account. A Gordian knot can become the Protected Landscape Area of the České středohoří Mts. which offers unique natural localities and a very important reacreation potential for the basin areas of northern Bohemia. In the case that the continuation of the construction works on D8 through the České středohoří Mts. (and there are unfortunately not too many other options considering the present stage of the construction) goes on, it would be very difficult to force in the building of another traffic vein of

Fig. 5: Two-system engine 363.010 (max. speed 140 km.h^{-1}) been used in the Czech Republic most of all for traction of the express trains, railway station Přerov, August 17th 1999. Photo B. Trávníček.

international importance throught this mountain ridge a couple of years later. The fact is that the track body is less demanding in the sense of the linear land annexation; yet, some negative effects related to the construction cannot be casted doubt upon.

There are several variants offered for the solution. It is possible to consider a track westwards of the České středohoří Mts. via Most, ie. in the corridor that was preferred by environmental organizations and initiatives for the localization of a motorway to Germany. Another continuation would be again via a tunnel under the Krušné hory Mts. and again with the connection to Dresden.

Another example of the problem solution is the track from Prague to the north via the Jizera River area, via a tunnel under the Ještěd-Kozákov mountain ridge into the space of Liberec, and farther on to Berlin via Cottbus. The track would be most probably led in a short „peage" section across the Polish territory with a stop in Görlitz/Zhořelec where a HSR crossing could come into existence that would be comparable in terms of its significance with the crossing in the south of Moravia (chapter 6.2.2). Apart from the mentioned HSR from Prague to Berlin, this crossing point could also include the HSR branch to Warsaw. The construction of the Prague – Görlitz/Zhořelec section would thus be an acceptable solution to the connection of Prague and Warsaw, whose importance is not negligible as indicated by the worked out gravitation model. The full engagement of the track section between Prague and Görlitz/Zhořelec would be ensured by the operation of the two HSR tracks from Prague to Berlin and from Prague to Warsaw. At the same time, the HSR Prague – Hradec Králové – Wroclaw (demanding in terms of construction works) would become redundant. Its directioning would be difficult especially in the border areas of the Czech Republic and Poland where the track would have to get over the Krkonoše Mts. piedmont or the Podorlická pahorkatina (Hilly Land) and the area of the Góry Sowie Mts. on the Polish side of the border.

Another HSR would lead from Görlitz westwards to Dresden and would be bound to the high-speed network in central Germany. This HSR (Warsaw – Görlitz – Erfurt – Nürnberg) would then form a parallel track to the HSR from Essen – Hannover – Berlin – to Warsaw.

Apart from the lower building costs and impacts on the landscape along the section from Prague – Liberec – German border (Polish border) and unlike in the case of the HSR led via Dresden, the solution would improve the traffic access to Liberec and its environs where a stop localization would be suitable for nearly two hundred thousand inhabitants in the conurbation of Liberec, Jablonec nad Nisou, and adjacent towns and villages. The connection of Liberec to the HSR network could be a good stimulation for the further development of the town and would also mean an essential improvement of the railway connection of the town with the capital of Prague.

The section from Prague to Turnov would be relatively modest in terms of the construction expenditure since the HSR would be parallel with the railway line No. 070 (along the Jizera River) and the terrain obstacles between Turnov and Liberec (the Ještěd-Kozákov mountain ridge) would be resolved by a tunnel or by a set of several tunnels.

HSR Prague – the western border with Germany

Another potential direction for HSR is the connection of Prague with south-eastern Germany (Nürnberg, München).

The very first issue to be resolved in this context is whether the capital of Prague should be connected directly with Nürnberg or with München . It would probably be better to prefer the Prague – Nürnberg direction since the city of Nürnberg – although being smaller than München – has a more favourable traffic and geographical location. This means that there could be an HSR crossing at this place, whose importance could be analogical to that of the Hannover crossing. At building a new railway line from Prague (in HSR parameters) to Nürnberg , the SUDOP Prague study of 1995 should become a basis. The railway would cross the Czecho-German border near the motorway border crossing at Rozvadov, which would considerably cut the railway connecting line between Prague and Nürnberg .

Nürnberg would thus become a crossing point of the HSR from Warsaw – Prague – to Nürnberg, and from Berlin – Erfurt – to Nürnberg . Another continuation by the high-speed train would be possible in the following directions (towns in brackets would be reachable by this HSR from the Czech Republic and from south-western Poland):

- Würzburg – Frankfurt – Saarbrücken – Paris/ (-Cologn – Lille – London/Amsterdam/the Ruhrgebiet);
- Stuttgart – Basle – Lyon – Barcelona – Madrid;
- München – Zurich – Milan.

At projecting the direct connection between Prague and München in the future, it would be beneficial to use HSR in the section between Prague and Pilsen. Also, the track between Pilsen and the German border should be refurbished so that the classical trains can reach the common running speed of 80 – 110 $km.h^{-1}$. A possible electrification of the track could be implemented later, in the cooperation with the German party.

HSR Prague – Brno

The most important direction – both from the domestic and international viewpoint - is that of Prague – Brno. It is a link of the international artery Berlin – Prague – Wien/Budapest as it is documented by the gravitation model analysis or by the diagramme of Czech railway tracks loaded by the international railway traffic.

All available studies counted with this relation being directed through Brno; yet, a possibility should be considered to lead the HSR between Prague and Wien outside Brno.

The original track to connect Prague and Wien was that leading through České Velenice. This would make a possible HSR from Prague to Wien (and farther on to Budapest) shorter. However, the problems of building the HSR in southern Bohemia are obvious: the less urbanized territory (and hence the lower potential of passengers) and in addition, the only city with enough potential passengers – České Budějovice - would be situated aside the HSR. Another limitation is the fact that the HSR would be most probably passing a number of protected areas such as the Protected Landscape Area of Třeboň. The area was decreed an international biosphere preserve of the M&B UNESCO Programme (Bedrna, 1998), ie. an area which is in general less impacted by traffic (recalled can be at this place the adverse attitudes of environmental organizations to the construction of the planned motorway D3).

The city of Brno could suddenly appear outside the main centre of European events in the case that its favourable location for HSR or HSR crossings is not utilized. There is a clear conclusion coming at hand that the localization of a high-speed railway track through Brno would be desirable not only from the national point of view but also due to the international reasons.

At assessing the direction of a potential HSR connecting Prague with Brno it is therefore possible to follow out of the conception submitted by SUDOP Prague (1995), in which it is suggested to build the HSR from Prague to Brno directly across the Bohemian-Moravian Upland in two variants: via Kolín, or outside Kolín (see Chapter 3.1.2). The advantage of these two variants is the fact that they can connect Prague with Brno in a straight direction. The variant of leading the HSR via Kolín where the track would pass a territory less demanding in terms of grade and direction can be considered more fitted (Kudrnovská, Kousal, 1975).

5.1.2 A proposed network for the territory of Moravia and Silesia

The presented solutions apply to the Moravian part of the directions Berlin – Wien/Budapest, and Warsaw – Wien/Budapest since the potential high-speed railway in Moravia is given by their combination.

- (Prague) – Brno – Austrian/Slovak border;
- (Wien, Budapest -) Austrian/Hungarian border – (Brno) – Přerov – Ostrava – Polish border (- Warsaw).

The outlined localization is only of an orientation character. In the first place, it is necessary to take into account the Slovak concerns in building the parallel HSR in the direction Budapest – Bratislava – Žilina (-Kraków) – Katowice – Warsaw (see Chapter 3.2.1). If the project of building the HSR connecting the north and south of Europe across the territory of Moravia comes true, it would be necessary to find a solution for the crossing of the Berlin – Wien/Budapest HSR with the Warsaw – Wien/Budapest HSR. There are two basic options: Brno or Břeclav.

In its rough features, the first option could correspond with the delineation of reconstructed transit corridors of Czech Railways (I and II) whose crossing is exactly in Břeclav. However, the already mentioned problem would become a reconstruction of the Břeclav railway station to parameters needed for the HSR operation. It would be possible to consider a displacement of the railway station from its existing position by 1 – 2 km eastwards into the town limits, which would get the HSR crossing closer to motorway D1.

The second option, ie. the localization of the south-Moravian HSR junction in Brno would make the HSR Berlin – Budapest in fact identical with the route mentioned at analyzing the previous option. The only difference would consist in the Berlin – Prague – Brno – Wien/Budapest HSR branching already in Brno with the branch leading to Wien corresponding with the draft project presented by SUDOP Prague (1995) because it would be parallel with the road communication to Pohořelice (R 52) and would be crossing the Austrian border near Novosedly. The section (Brno – Novosedly – Austrian border) would be further used by the branch of the north-south HSR Wien – Warsaw, which could continue from Brno to the opposite side in the NE direction in parallel with D1 to Vyškov (using the Vyškov gateway) and farther on via Přerov into the area of the Ostrava conurbation. This variant would be better suited in the case that the Slovak party succeeds in building the HSR in the north-south direction sooner than the Moravian party. This would impair the importance of the relation Warsaw – Přerov – Brno – Břeclav – Bratislava – Budapest, and for the relation Berlin – Prague – Brno – Břeclav – Bratislava – Budapest in its section from Brno to Bratislava it would be enough for the initial stage to make use of the reconstructed transit corridor I of the Czech Railways together with the up-graded track (Kúty, state border – Bratislava) in the Slovak territory.

The HSR from Přerov farther to the north is less variable. The track course could be identical with the result presented in the project by SUDOP Prague (1995) which suggests to lead the track by several kilometers north-westwards of the existing track No. 270 (Přerov – Bohumín) in the corridor that was partially shared with motorway D 47 being under construction at present. Apart from other factors, the localization is conditioned by an effort to protect the natural values of the Protected Landscape Area of Poodří whose northern boundary in the section Jeseník nad Odrou – Polanka nad Odrou is formed by the mentioned railway track. Thus, the present railway track No. 270 could be used in the first place for the passenger (passenger regional and high-speed regional) traffic as well as for the goods service after the HSR construction.

5.2 Assessing the alternatives of future development

5.2.1 Examples of scenarios for the future development in Central Europe as related to HSR

The choice of a certain proposal or option for the solution of a concrete situation in directing the HSR in the Czech Republic depends on many factors and circumstances which can be of geopolitical, traffic or economic nature and cannot be principally influenced. However, these factors can have an immediate effect on the situation in the Czech Republic and thus become bearers of possible changes and consequences that cannot be estimated at the present time. In the field of traffic, they can be a contribution or can represent some impacts.

One of negative effects for the Czech Republic can be the effort of the Slovak party to win over the Czech Republic at up-grading the connecting line between the north and south. If the Slovaks really succeed in building the track as the high-speed one at the time when there is no such a similar connection in the Czech Republic, it would mean a loss of many advantages for the Czech Republic, brought about by a possibility of the high-speed connection of good quality. Slovakia would become to be perceived as a country of international transit; in contrast, the Czech Republic could then not succeed in building a competitive connection which would –on the top- be entirely unjustified.

A similar jeopardy to the advantageous position of the Czech Republic can become the programme of the „German Union“ whose traffic component aims at building a good quality connection between the former eastern and western countries. The programme does not mean such a load for the developed German economy as it would mean for the Czech economy. The situation might result in the building of a better traffic infrastructure on the German side, which can reflect in changing the direction of some relations such as from Berlin to Wien onto tracks bypassing the Czech territory.

It is also necessary to take into consideration that the potential HSR while being a contribution from the viewpoint of the Czech Republic (but also from the international viewpoints) need not necessarily correspond with the plans of other participating countries. An example can be the connecting line between Prague and Warsaw, whose importance consists mainly in a wider international context. However, Poland considers its priority railway lines being those leading to Germany (Berlin), Russia, the Baltic countries, and the countries of South Europe (Austria, Italy, Hungary, the Balkan countries). On the other hand, there are opposite alternatives with the important role of Berlin, a distinguished metropolis on the interface of Central and West Europe, whose influence on future events in the given area will certainly be growing.

The suggested development can contribute to the fact that the present railway, be it in its high-speed form, will not be able to keep pace with the demand of passengers for the fast and reliable transport of good quality. The prerequisites are fully met by the Transrapid system of magnetic track. The very first track of this super-high-speed system is going to connect Berlin with Hamburg and the term of putting the whole system into operation for public is the year of 2005. Should this way of transport prove well, it is possible to anticipate its further development and implementation in the traffic system. There are also proposals to build other Transrapid system tracks of which one could connect Berlin with Prague and Wien. There is also a realistic possibility that a Transrapid track could be built in this relation with no previous HSR construction.

The building of high-speed railways also depends on different scenarios of our association to the European Union. The entry of the Czech Republic is permanently being postponed although the opinions of prominent politicians often differ from the estimates made by economic experts.

In the case that the Czech Republic is soon affiliated to the European Union (for example in the period between 2005-2007), it could become an interesting partner for the European Union. By extending the today relatively closed Czech labour market (in spite of certain proclamations of the European Union about maintaining a limited possibility of the Czech labour force entering the EU labour market), there would be a pressure on the fast traffic connection with the neighbouring EU member countries. A similar effect would be that of other investments flowing into the Czech Republic or the introduction of a union European currency in the Czech Republic.

The principal up-grading of the existing traffic network would be inevitable, which could be on the other hand facilitated by a financial support from the structural funds of the European Union. A true picture is, however, that a great deal of the existing traffic network does not meet the standard EU requirements.

5.2.2 Assessing the development of the Czech motorway network as related to the HSR network options

The analysis by the gravitation model showed a different loading of the respective relations. The heavily loaded relations such as Prague – Dresden are good for a parallel construction of both the motorway and the HSR in the given corridor. However, some relations with

Fig. 6: Unit ICE 401.554 (in the foreground), railway station Mannhaim - the main station, September 8th 1997. Photo B. Trávníček.

insufficient capacity allow just one type of the traffic system – either the motorway, or the high-speed railway (e.g. Prague – Wroclaw – Warsaw).

A special case are the relations of mainly domestic significance, and here the construction of top-quality international traffic veins (be it just HSR or motorway) would be hardly justified. An example can be the relation of Prague – Linz whose importance is disputable as mentioned by Řehák and Grégr (1997). A reason to these doubts is its low traffic need and the risk that the attractive environment south of Prague could be put into danger of pollution. A solution is seen in a certain up-grading of the existing traffic infrastructure, ie. the construction of bypasses, better permeability of railway tracks, their electrification, etc.

The quality of the network of domestic motorways and high-speed communications is not satisfactory either. A direct motorway connection with the neighbouring countries is entirely absent with the exception of Slovakia. The connecting part to Czech motorway D5 between Nürnberg and Rozvadov on the German/Czech border has not been finished yet on the German side and the earliest date of putting into operation the motorway connection between Prague and Nürnberg is the year of 2005 (Körner, 1999). The bypass of Pilsen has not been finished yet either (and will be finished –according to the adopted variant - in 2004 only, or even as late as in 2012). Another motorway connection with Germany under construction is motorway D8 from Prague to Dresden with the construction works on the German side being at the very beginning, and those on the Czech side stopped at Lovosice due to an unresolved passage of the motorway through the České středohoří Mts. If this passage is approved this year, the construction works can be expected to come to an end in about 2006 (Körner, 1999).

6. Conclusion

The contribution wished to valuate the possibilities of building HSR in the Czech Republic. The study was based on a gravitation model, quoted projects and international treaties and agreements.

The HSR building in the Czech Republic must be seen in the context with the European policy of developing the traffic networks. The HSR building only for the purpose of the domestic connections would not be justifiable. A good and fast connection on the domestic relations should be ensured in the close future by a network of reconstructed transit corridors of Czech Railways. The most important domestic relations such as Prague – Brno should become a part of the HSR European network in the future.

The fact that the considerations concerning the building of high-speed railways to connect important cities of Central Europe, bound to the existing HSR tracks in West Europe, are realistic and justifiable is documented by the gravitation model and its implementation. Both its versions point out a considerable traffic significance of some Central-European tracks passing the Czech Republic (particularly the relations of Wien/Budapest – Prague – Dresden – Berlin, and Wien/Budapest – Katowice – Warsaw) whose traffic load deserves an increased attention on the Czech part. If not so, the situation might happen that the most important European traffic corridors will be passing the territories of the neighbouring countries, which would mean for the Czech Republic a loss of the position of a theoretical bridge connecting the north with the south and the east with the west – the position that is traditionally ascribed to this country.

In addition to the mentioned priority relations passing the Czech territory, attention should also be paid to those whose importance is somewhat disputable (such as Prague – Linz). The results brought from the application of the gravitation model clearly indicated an entirely insufficient loading of this direction. This would be enough to prevent other considerations about the HSR construction, at least at a horizon of two coming decades. Other theses to be pointed out are as follows:

- The HSR building should be viewed in the international context and resolved in the context of domestic traffic networks, motorways in particular. In some relations, one type of a good traffic communication (HSR or motorway) would be sufficient.
- At building the traffic communications (including HSR), it is necessary in some relations to abstract from the traditional and often overloaded traffic corridors and to search new possibilities for the solution of the traffic network. An example to mention is the submitted draft project for the HSR from Prague to Warsaw leading through Wroclaw, ie. leaving aside Ostrava.
- The individual national HSR projects should be well coordinated in order to prevent the construction of duplicate HSRs. An example to mention is the relation from Budapest to Warsaw as there are two countries (Czech Republic and Slovakia) trying to win the course of this HSR via their territories.

It is only the fast and reliable railway traffic that can become an equal competition to the individual use of motorcars and to the short-distance flights. This is the only way how to achieve a relative reduction of motorism and impacts of this kind of traffic on the environment. Future proposals for the solution oftraffic issues should be a result of the consent of all parties concerned – traffic experts, environmentalists, urban specialists and other domestic and foreign experts in all branches concerned.

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Abbreviations used:

HSR	High-speed railway
ČSD	Czechoslovak State Railways
ČD	Czech Railways
ŽSR	Railways of the Slovak Republic
DB	Deutsche Bahn (German Railways)
PKP	Polskie Koleje Panstwowe (Polish Railways)
UIC	Union Internationale des Chemin de fer (International Railway Union)
AGC	Accord européen sur les ligne internationales de chemin de fer (European Treaty on main railway lines)

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NOTES TO THE DEFINITION OF RELIEF TEXTURE FROM TOPOGRAPHIC MAPS (AN EXAMPLE FROM SE MARGIN OF BOHEMIAN MASSIF)

Zdeněk MÁČKA

Abstract

The contribution verifies the validity of a procedure generally used to define drainage density from topographic maps on a scale of 1:25000. The statistic significance of a difference in the drainage length found by measuring from the topographic maps on a scale of 1:25000 was studied by means of the paired t-test and by means of direct field measurements on a sample of twenty watersheds situated in the Sýkořská hornatina (Highlands) and the Deblínská vrchovina (Hilly Land). The testing did not prove any statistically significant difference in the drainage density detected by the two methods; however, the statistically significant difference exists between the two sets if the drainage length includes small gullies and tiny ravines. These minor linear concave formations affect the dynamics of processes occurring within the drainage in a specific way being however distinguished from the streamflown or dry valleys by their size and by the character of active geomorphological processes. These minor forms must be included in the drainage of a given watershed in the case of a more detailed analysis of the relief structure and dynamics of erosional dissection of individual catchment basins; in the case of broader regional comparisons of the relief texture and drainage geometry the forms are not included in the drainage system.

Shrnutí

Poznámky k vymezování textury reliéfu z topografických map (na příkladu JV okraje Českého masívu)

Obsahem předkládaného příspěvku je ověření validity všeobecně používaného postupu vymezování hustoty údolní sítě z topografických map měřítka 1:25 000. Pomocí párového t-testu byla zjišťována statistická významnost rozdílu v délce údolní sítě zjištěné měřením z topografických map měřítka 1:25 000 a přímým měřením v terénu na vzorku dvaceti povodí situovaných v Sýkořské hornatině a Deblínské vrchovině. Testování neprokázalo statisticky významný rozdíl v hustotě údolní sítě zjištěné oběma metodami, statisticky významný rozdíl však mezi oběma soubory existuje pokud se do délky údolní sítě zahrnou rovněž drobné strže a rokle. Tyto drobné lineární konkávní tvary specifickým způsobem ovlivňují dynamiku procesů v rámci údolní sítě, od protékaných či suchých údolí se však odlišují rozměrovým měřítkem a charakterem působících geomorfologických procesů. Zahrnout tyto drobné tvary do údolní sítě daného povodí je nezbytné v případě podrobnější analýzy textury reliéfu a dynamiky erozního rozčleňování jednotlivých povodí, v případě širších regionálních srovnání textury reliéfu a geometrie údolní sítě se tyto tvary do údolní sítě nezahrnují.

Key words: *Relief texture, drainage density, drainage geometry, paired t-test, the Sýkořská hornatina (Highlands), the Deblínská vrchovina (Hilly Land), Czech Republic.*

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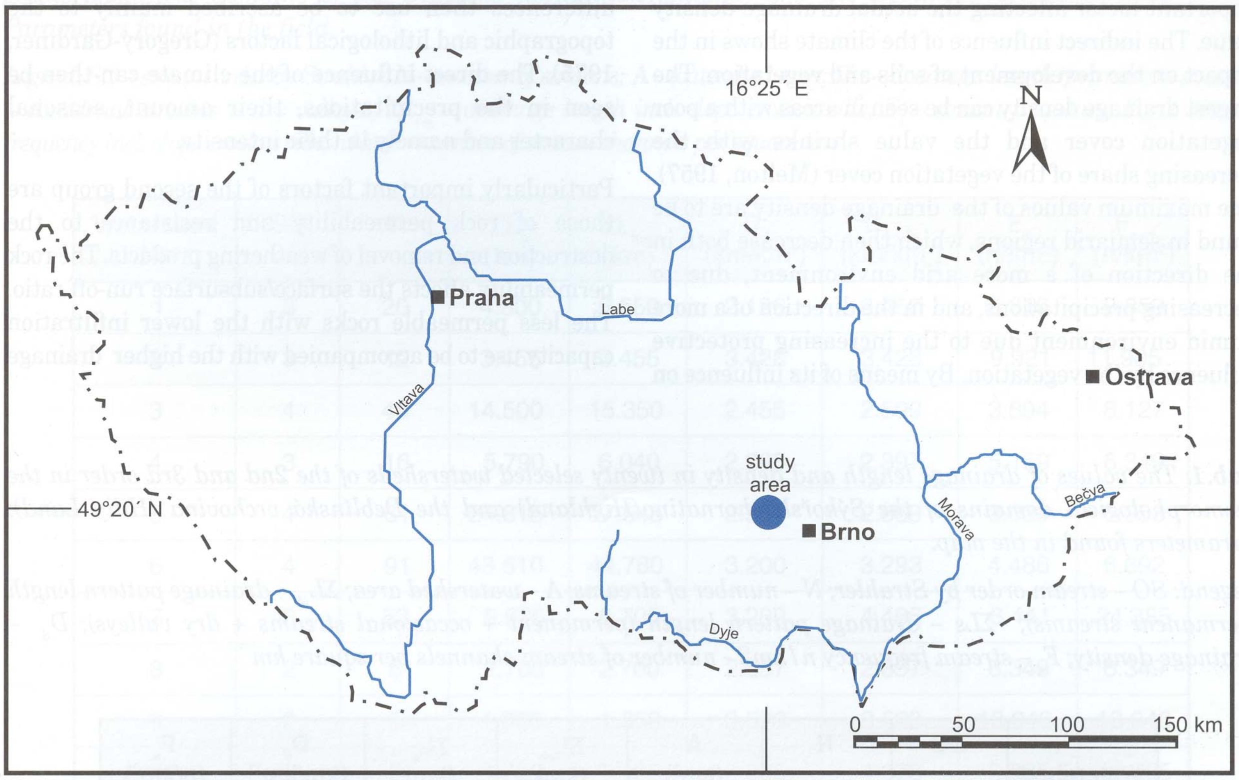
1. Introduction

The relief texture was first defined by Johnson (1933) as a mean size of topographic units of which the relief in the given area is composed of. In other words, the notion expresses the measure of terrain dissection into respective morphological units, allowing – with the regard to its relatively general definition- the use of a relatively broad array of morphometric characteristics for its quantification. In this paper, the meaning of the word has been narrowed to describe the topography modelled by river erosion and is understood as a measure of terrain dissection by the drainage system consisting of valleys either permanently streamflown or dry. It is therefore a synonymum to drainage density or stream frequency (Horton, 1945), possibly a synonymum to the texture coefficient (Smith, 1950).

There is no doubt that the characteristic most frequently used to quantify the relief texture is drainage density. A method often used to determine the drainage density is the interpretation of contour delineation of large scale topographic maps with valleys being plotted in the maps at places with blue lines which indicate the presence of permanent streams and at places where the distorted contours indicate dry valleys. A relatively objective method of the drainage system delineation from the topographic maps was proposed by Bauer (1980).

Fig. 1: The location of the area under study within the territory of the Czech Republic.



Apart from a whole range of natural factors, the value of the detected drainage density also depends on the scale of the map used and on the precision of its delineation. The determination of drainage density values corresponding to reality is directly proportional to the precision of the drainage delineation particular emphasis being put on the number and length of collecting channels of the first order. The paper aims at finding the measure of distortion occurring at measuring the drainage density due to inaccurate map drawing with making use of a sample sample of twenty watersheds of the second and third orders, situated at the eastern edge of the Českomoravská vrchovina (Highland).

The verification of the validity of this procedure is based on a confrontation of the drainage system length determined by measurements from the topographic maps on a scale of 1:25000 and by a field inspection at which the drainage system found from the map was added valleys not recorded in the map. The statistic significance of differences in the length of the drainage system recorded in the map and measured in the field was then tested by the paired t-test. The verification of the sufficient capacity of utterance of the large and medium scale topographic maps on watershed fluvial morphometric characteristics appears necessary where a larger amount of fluvial morphometric data must be processed with no possibility of the fluvial system direct assessment in the field. A similar issue was studied by Morisawa (1957) on an example of small watersheds of less than 1 km^2 in the area of the Appalachian Plateau in northern Pennsylvania.

2. Significance of drainage density for the evaluation of morphology and processes in the watershed

Drainage density (D_d) as defined by the relation D_d=?L/A_d, where ?L is the total length of the watershed drainage system and A_d is the watershed area, is considered to be one of the most important characteristics to describe the morphology and processes occurring in the watershed. The reason is that the drainage density as a measure of watershed surface dissection by streams (permanent or temporary) links the morphographic attributes of the watershed with the occurring processes. On the one hand, the drainage density is a result of interacting factors controlling the surface run-off, on the other hand it is itself determining the effectivity with which water and sediments are being removed from the watershed.

Drainage density is conditioned by two groups of factors the first of them including factors determining the amount and properties of water falling onto the surface, the second group containing factors influencing the subsequent distribution of water across the surface and its availability for the performance of erosion work (Knighton, 1984). The first group therefore relates to the climate while the second one relates to the common influence of topographic, lithological, paedological and vegetative factors.

The effects of the climate on the surface run-off are both direct and indirect the climate itself being the most important factor affecting the actual drainage density value. The indirect influence of the climate shows in the impact on the development of soils and vegetation. The largest drainage density can be seen in areas with a poor vegetation cover and the value shrinks with the increasing share of the vegetation cover (Melton, 1957). The maximum values of the drainage density are to be found in semiarid regions, which then decrease both in the direction of a more arid environment, due to decreasing precipitations, and in the direction of a more humid environment due to the increasing protective influence by the vegetation. By means of its influence on the soil and vegetation, the climate is a dominant factor both on the global and regional scales. The local differences then use to be ascribed mainly to the topographic and lithological factors (Gregory-Gardiner, 1975). The direct influence of the climate can then be seen in the precipitations, their amount, seasonal character and namely in their intensity.

Particularly important factors of the second group are those of rock permeability and resistance to the destruction and removal of weathering products. The rock permeability affects the surface/subsurface run-off ratio. The less permeable rocks with the lower infiltration capacity use to be accompanied with the higher drainage

Tab.1: *The values of drainage length and density in twenty selected watersheds of the 2nd and 3rd order in the geomorphological domains of the Sýkořská hornatina(Highland) and the Deblínská vrchovina (Hilly Land): Parameters found in the map.*

Legend: SO – stream order by Strahler; N – number of streams; A – watershed area; ΣL_{ch} – drainage pattern length (permanent streams), ΣLs – drainage pattern length (permanent + occasional streams + dry valleys); D_d – drainage density; F_s – stream frequency n / km2 - number of stream channels per square km

Watershed No.	SO	N	A (km²)	ΣL_{ch} (km)	ΣL_s (km)	D_d (km/km²)	F_s (n/km²)
1	3	12	2.258	2.125	4.800	2.126	5.3
2	3	9	1.008	1.375	3.325	3.299	8.9
3	3	23	5.906	4.950	12.000	2.032	3.9
4	3	11	2.520	2.600	5.300	2.103	4.4
5	3	29	9.602	11.450	24.475	2.549	3.0
6	3	61	13.598	17.700	43.000	3.162	4.5
7	3	14	2.174	2.500	6.800	3.129	6.4
8	3	10	0.945	1.150	3.775	3.995	10.6
9	3	12	0.383	0	2.550	6.654	31.3
10	3	12	0.782	0.600	3.975	5.081	15.3
11	3	10	3.848	3.700	8.150	2.118	2.6
12	3	7	4.090	2.900	3.150	0.770	1.7
13	3	13	3.444	4.100	8.150	2.366	3.8
14	3	11	2.394	2.650	5.650	2.360	4.6
15	2	6	2.347	4.650	6.800	2.898	2.6
16	3	15	2.357	3.950	8.975	3.807	6.4
17	3	13	1.250	0.900	5.750	4.602	10.4
18	3	29	3.712	7.150	14.400	3.880	7.8
19	3	15	2.877	2.750	8.450	2.937	5.2
20	2	6	0.882	0	4.000	4.535	6.8

Tab. 2: The values of drainage length and density in twenty selected watersheds of the 2nd and 3rd order in the geomorphological domains of the Sýkořská hornatina(Highland) and the Deblínská vrchovina(Hilly Land): Parameters found in the field.

Legend: SO – stream order by Strahler; N – number of streams; A – watershed area; ΣLs – drainage length (permanent streams + occasional streams + dry valleys); ΣL_{s+g} – drainage length incl. slope erosion rills; F_s – stream frequency; F_{s+g} – stream frequency incl. slope erosion rills, n / km² - number of stream channels per square km

Watershed No	SO	N	ΣL_s (km)	ΣL_{s+g} (km)	D_d (km/km²)	$D_{d\text{-}s+g}$ (km/km²)	F_s (n/km²)	F_{s+g} (n/km²)
1	3	20	4.800	5.550	2.126	2.458	5.316	8.859
2	3	12	3.455	3.455	3.428	3.428	9.921	11.905
3	4	48	14.500	15.350	2.455	2.599	3.894	8.127
4	3	16	5.790	6.040	2.298	2.397	5.159	6.349
5	4	61	24.815	27.545	2.584	2.869	3.020	6.353
6	4	91	43.510	44.780	3.200	3.293	4.486	6.692
7	3	53	6.975	9.705	3.209	4.465	6.441	24.385
8	2	6	2.700	2.700	2.857	2.857	6.349	6.349
9	2	5	1.350	1.350	3.523	3.523	13.046	13.046
10	3	9	1.725	3.425	2.205	4.378	3.835	11.505
11	3	12	8.500	8.800	2.209	2.287	2.599	3.118
12	3	11	2.850	3.400	0.697	0.831	2.201	2.690
13	3	19	8.925	9.255	2.591	2.687	4.646	5.517
14	3	18	6.150	6.585	2.569	2.751	4.595	7.519
15	3	16	7.160	7.945	3.051	3.386	2.131	6.818
16	3	15	8.975	9.200	3.807	3.903	5.515	6.363
17	3	11	4.325	4.325	3.461	3.461	8.003	8.804
18	3	44	12.975	15.725	3.469	4.237	7.274	11.854
19	3	14	6.500	6.800	2.259	2.364	3.823	4.866
20	3	11	2.300	4.400	2.608	4.989	3.401	12.472

density. Carlston (1963) mentions that under identical gradients and climatic conditions the drainage density is usually greater on the less resistant rocks.

The precipitations fallen in the watershed induce the surface run-off which –together with the relative superelevation of the area as a source of potential energy- transports the sediments to the watershed mouth. It is not an accidental phenomenon that the territories with the greatest drainage densities, which can be seen in the semiarid climatic zones also show the largest amounts of removed sediments on the watershed outlet (Langbain-Schumm, 1958). The large volumes of sediments on the watershed oulet indicate the dynamic development and effectiveness of the drainage system.

The drainage density holds a central position within the river system the reason being the fact that it can both be considered a response to the set of watershed inputs-characteristics (control variables of the river system) and the characteristic determining the amount and intensity of the outputs (water, sediments) from the watershed. While conditioning the run-off characteristics in a short-term period, the drainage density itself is being affected by environmental factors via the run-off characteristics in the long periods of time (Knighton, 1984). Melton

(1958) claims that the drainage is capable of reaching a balanced condition by accommodating to the prevailing climatic, vegetative, lithological and soil conditions.

3. Methodological procedure of testing drainage density differences found by analyzing topographic maps and by field inspection

The first stage of the verification procedure included the measuring of drainage length and watershed area of twenty selected streams of the second and third order (sensu Strahler, 1952), situated in the Sýkořská hornatina (Highlands) and the Deblínská vrchovina (Hilly Land) from 1:25000 topographic maps. The resulting drainage length included both the streams plotted in the map with blue lines (blue line method), and the waterless valleys indicated in the map with distorted contour lines (contour crenulation method). The definition of length of dry valleys by analyzing the contour delineation was made to the recommendations by Bauer (1980). The erosional incision was plotted in the map in the case that the contour lines contained an angle of less than 120° and the incision was indicated by at least two of the contour lines distorted in this way. The erosional incisions meeting the criteria but not continuing in the lower portion of the slope were also included in the drainage system and linked with the nearest erosional incision of the higher order.

The second stage included a field inspection of the studied watersheds and the complementation of the missing parts of the drainage system, which were not defined from the topographic maps. In the majority of cases, the forms in question were slope erosional rills-tiny gullies and ravines-erosional incisions of the first- and less of the second order. There were only a few cases of shorter dry valleys situated in a peripheral position on the drainage circumference (the first order in the drainage system hierarchy).

The paired t-test was used to verify the significance of the differences in drainage density values, found by these two methods in order to define the difference in averages of the two selections. Elements of dependent choices were the values of drainage length for each watershed, measured from the map and in the field (see Tabs. 1 and 2). The testing was made for two variant cases as follows: a) cross-testing of drainage lengths measured from the map and in the field, complemented with the length of dry valleys of the first order and with the length of slope erosional rills; b) cross-testing of drainage lengths measured from the map and in the field (the drainage length in the map complemented with the dry valleys), the latter of the values not including the length of the slope erosional rills. The reason for not including the slope erosional rills in the overall drainage length found in the field inspection at the second testing variant was the different character of morphology and prevailing processes of these small linear forms. The slope erosional rills differ from the permanently streamflown or dry valleys mainly by their size, i.e. by the volume of the material removed from the surface. Another reason was the different nature of the preponderant modelling processes. While the morphology of the smaller slope erosional rills is formed mainly by the impacts of the linear run-off, occasionally running through these forms under precipitation or melting events of sufficient magnitude, the morphology of the valley forms results from a joint action of processes working within the stream bed and slope processes. Thus, the valley forms consist of at least two mutually linked sub-systems: the stream bed sub-system and the sub-system of slopes. In contrast, the slope erosional rills are rather the forms with a simpler functioning, their dominating task consisting in the linear run-off as a major modelling agent. However, in spite of their considerably lesser area the slope erosional rills play an important role in the dynamics of the contemporary landscape being indicators signalling that the threshold conditions were overstepped and a new stage of the drainage extension has started (see Schumm-Hadley, 1957; Patton-Schumm, 1975). Also, the active gorges and ravines included in the drainage subsidize the stream beds with the eroded material, this being a reason to make the separate testing for two sets with the length of slope erosional rills included and not included, resp.

The mean drainage density deviation for the twenty watersheds under study, found by comparing the map and field measurements with the slope erosional rills included and not included was 0.607 km/km^2 and 0.596 km/km^2, respectively. Testing at the selected significance level of 5% brought an evidence of the deviations in the values of both tested sets in the first case not being of the accidental character, which means that the difference in the drainage densities found from the map and in the field was statistically significant. In the second case, when the slope erosional rills found in the field were not included in the drainage density calculation, it was proven that the difference between the values of the two tested sets was statistically insignificant and a possible deviation is to be explained by incidental causes. The test results indicate a necessity of using different methods to define the drainage system according to the purpose for which the analysis of its geometry is to be made. The analysis of topographic maps on a scale of 1:25000, which facilitates the fast collection of a great number of fluvial-morphometric data proves optimum for the comparison of the regional variability in the drainage density values. Any more detailed analyses of the relief texture that would include the smaller linear erosional forms characteristic of the lesser size and different nature and dynamics of the prevailing modelling processes would then call for a time-consuming field survey made on a scale of at least 1:10000.

4. Erosional dissection of watersheds under study

The field reconnaissance of the studied watersheds showed some interesting facts about the development of erosional dissection of the Sýkořská hornatina (Highland) and the Deblínská vrchovina (Hilly Land). The following comments concern in the first place the network of minor slope erosion rills-gullies and ravines:

- In some of the watersheds under study the development of slope erosional rills reached a higher stage of progress; the rills do not just form individual plain incisions along the slope line perpendicular to contour but rather develop simpler branching networks. If the forms are included in the watershed drainage system, they can significantly change its geometric and topological characteristics (see Tab. 2, Fig. 2).
- The slope erosion rills are usually not distributed evenly across the watershed but rather concentrated at certain places. Therefore, the density of the network of erosional incisions is considerably variable in terms of space and the local values of drainage density can many times exceed the value for the whole watershed. Extensive systems of the slope erosion rills are usually developed in the closures of valley forms a possible cause to this phenomenon being the concentration of the surface run-off by the „funnel" effect in some types of the valley closures (see Knighton, 1984; Karásek, 1990). The higher concentration of the slope erosion rills can similarly occur in cut banks of superinduced stream meanders.
- A frequent phenomenon occurring particularly in the streamflown valleys of the Deblínská vrchovina (Hilly Land), is the occurrence of the opened broad valleys with milder slopes in the upper spring portions of the watershed, and that of the narrow and deeply incised valleys with steep slopes in the lower portions of the watershed before the opening into the controlling stream (branches of the Svratka River, Bílý Potok/ Brook/, Blahoňůvka). The slope erosion rills occur mainly in the upper parts of the watershed along the drainage circumference on milder slopes with a deeper cover of deluvia with their occurrence diminishing towards the steeper slopes of internal parts of the watershed where they are replaced with rock outcrops. The concave slope erosion rills in the circumferential parts of the watershed and the convex rock outcrops in its inner parts play an important role in the balance of material flows through the drainage of the Deblínská vrchovina (Highland) watershed. The two types of the

Fig. 2: Diagrammes illustrating the differences in the drainage topology of five selected watersheds when using two different methods of the drainage delineation: cartometric from the topographic maps scale 1:25000, and by reconnaissance in the field.

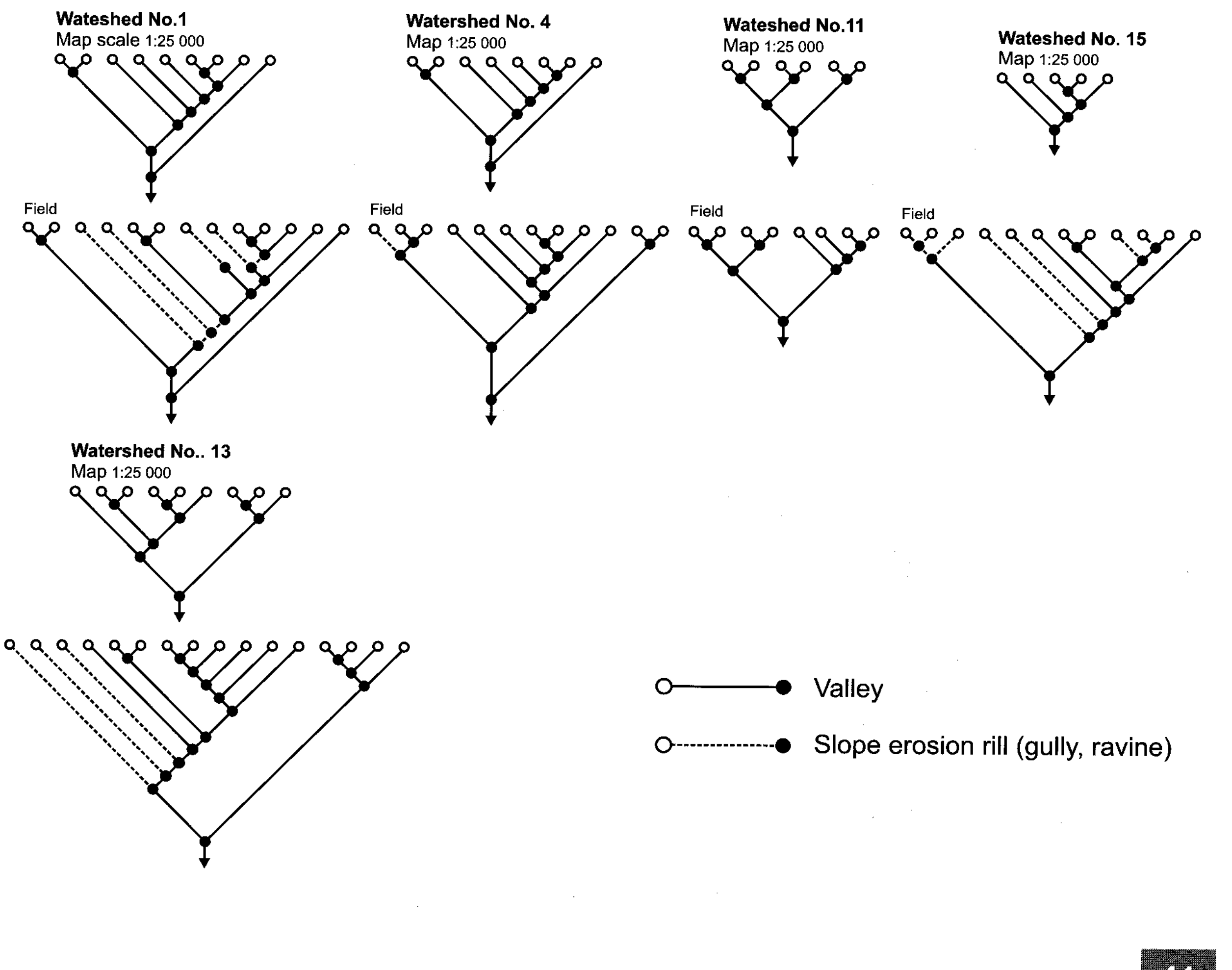
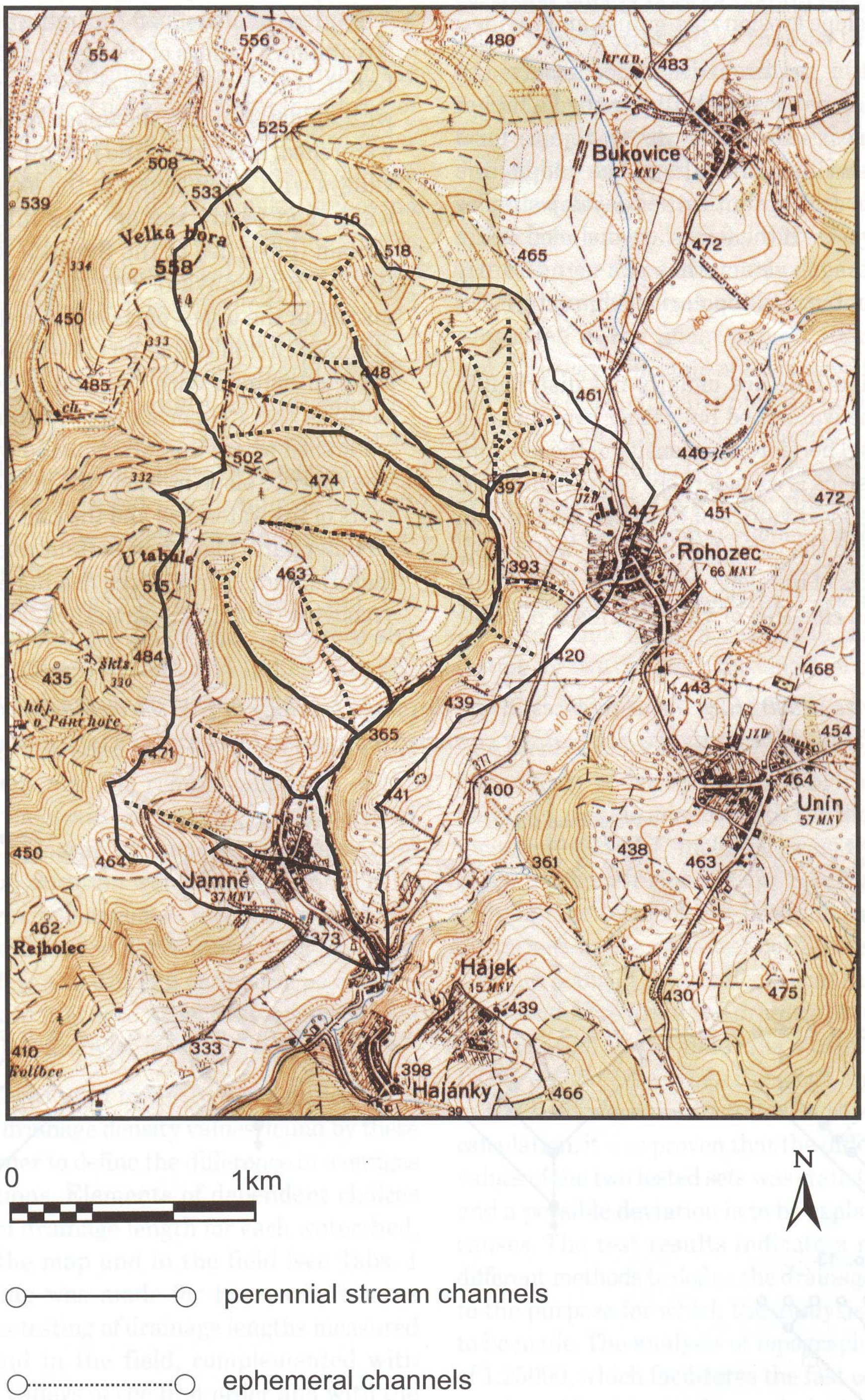


Fig. 3: *A specimen of the drainage delineation from the topographic map 1:25000 (Basic Map of the Czech Republic, Sheet 24-321). The Figure illustrates a watershed of the 3rd order in the Sýkořská hornatina(Highland), marked off with the watershed divide. Permanently streamflown valleys and dry valleys are marked with the full line, and with the dashed and dotted line, resp. During the field survey, the basic drainage skeleton defined in this way is then added the missing dry valleys and the slope erosion rills.*



slope elements, disturbing the continuity of the smooth slope surface, subsidize the stream beds with a considerable amount of material. Thanks to their gradient and when full of running water, the gullies and ravines become streams of high energy potential with a considerable erosional and transport power and subsidize the stream beds with the mixed material which, however, includes mainly finer sediment fractions (compare Casalí-López-Giráldez, 1999). The slopes of the stream valleys in the studied watersheds are usually lithologically uniform, formed by one type of the rock; in the situation like this, the forms of the rock outcrops are not in the condition of equilibrium since the material is being removed more rapidly from them than from the surrounding parts of the slope due to the greater inclination of their surface. These places of the slope system disturbed equilibrium then significantly subsidize the stream beds with the coarse clastic material.

- Some of the slope erosion rills exhibit a certain measure of sinuosity.
- Valleys of some permanent streams bear signs of the polycyclic development (shorter brooks, especially the branches of the Bílý Potok/Brook/ and the Svratka R. in the Deblínská vrchovina/Hilly Land). The beds and cross-profiles of several streams in the Deblínská vrchovina (Hilly Land) bear preserved traces of two-to-three erosional cycles (waves of stream back erosion) which show as stairs in the streams and gradient fractures in the valley slopes resulting in the valley-in-valley effect. The present erosional activity in the small watersheds of the studied geomorphological units seems to be induced by internal causes issuing from the watersheds themselves such as a change in the surface utilization (deforestation), possibly also as a consequence of local fluctuations of the main stream bottom level connected with the episodic transport of the bottom material and due to the development of the stream bed bottom morphology. The above mentioned waves of back erosion in these small watersheds can apparently not be related to the phases of main stream incision.
- At the present time, the floors of some dry valleys are being activated by the developing new generation of incisions which at many a place show as a consequence of the wave of the back erosion from the lower parts of the valley which are flown through by the permanent streams. Frequently occurring are water outflows in these incisions on the floor of the dry valleys in the upper parts of the watershed with water gradually diminishing from the incision in the downstream direction and its repeated appearance as far as a permanent stream comes to existence in the valley.

5. Conclusion

The length of the drainage pattern of the twenty selected watersheds in the Sýkořská hornatina (Highland) and the Deblínská vrchovina (Hilly Land) was studied in order to test the validity of the generally used procedure of the drainage density definition from contour maps on a scale of 1:25000 for the system of streams draining the eastern portion of the Bohemian Massif. The analysis was made by two methods as follows: a) examination of blue lines (permanent streams) and contour delineation (occasionally streamflown valleys) in the topographic maps on a scale of 1:25000 (the so called blue line method, contour crenulation method); b) mapping of valley and slope linear erosion forms in the field on a working scale of 1:10000 with additional measurements of the slope erosion rills by the survey tape.

The testing was made both between the set of data obtained from the maps and the set of data obtained from the field without the inclusion of the smaller slope erosion rills, and then between the set of the data obtained from the maps and the set of the data obtained from the field with the slope erosion rills being included. The results of testing by the paired t-test proved a good agreement between the sets obtained from the maps and from the field, including only valleys with the level of significance being 5% and any statistically significant difference between the sets not existing. However, on the significance level of 5% the comparison of the sets obtained from the maps and from the field with the valleys and small slope erosion rills included proved statistically significant differences in the values of the two sets of data. The testing proved that the drainage density values detected cartographically from the maps on a scale of 1:25000 provide a sufficiently precise reflexion of the actual situation in the field. It seems more convenient not to include the smaller slope erosion rills-gorges and ravines into the regional comparison analysis of drainage geometry due to the different morphology and preponderant modelling processes of these forms. Should a detailed local analysis of the erosional dissection (texture) of the terrain be required e.g. in order to investigate the balance of the moving sediments, it is necessary to conduct the field research on a more detailed scale than that of 1:25000.

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GEOMORPHOLOGY OF THE MT. SMRK AREA IN THE MORAVSKOSLEZSKÉ BESKYDY MTS. (CZECH REPUBLIC)

Jan HRADECKÝ - Tomáš PÁNEK

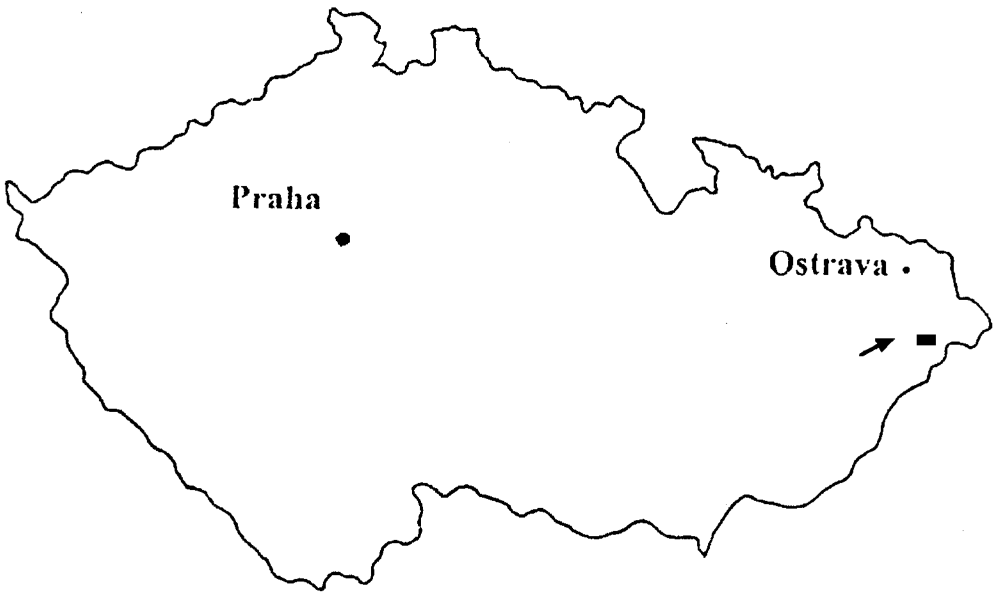


Fig.1: *The situation of the Mt. Smrk group in the Czech Republic*

Abstract

The authors present results of the detailed geomorphological mapping at a scale of 1: 10 000 of the Mt. Smrk vicinity (49° 31´ N 18° 23´ E) which is the second highest mountain group of the Moravskoslezské Beskydy Mts. The studied area is situated about 35 km to the south-east of Ostrava town. It is the high intensity of geomorphological processes which are influenced by lithological and structural features of the flysch constitution of the investigated locality that is typical for the relief of the Mt. Smrk (1276 m). The morphogenesis of the Mt. Smrk group was studied in connection with mountain glaciation during the Pleistocene. J. Pelíšek (1952) published a study about the presence of two generations of cirques and moraine accumulations on the northern slopes of the Mt. Smrk. The authors did not identify any geomorphological forms typical of the glacial relief; the head parts of the Bučící potok Brook are with high probability nivation cirques.

Shrnutí

Geomorfologie oblasti Smrku v Moravskoslezských Beskydech (Česká republika)

Autoři v příspěvku prezentují výsledky podrobného geomorfologického mapování v měřítku 1:10 000 v nejbližším okolí hory Smrk (1276 m n. m.), která je druhou nejvyšší kulminační oblastí Moravskoslezských Beskyd. Studované území leží přibližně 35 km jv. od Ostravy (49° 23´ s. z. š., 18° 23´ v. z. d.). Reliéf horské skupiny Smrku se vyznačuje vysokou intenzitou geomorfologických procesů, které jsou výrazně podmíněné litologickými a strukturními vlastnostmi území budovaného flyšem. Geneze reliéfu byla studována v souvislosti s předpokládaným horským zaledněním v pleistocénu. J. Pelíšek publikoval v roce 1952 studii, ve které popisuje v dané lokalitě existenci dvou generací karů a morénových akumulací. Autoři však nenalezli žádné formy reliéfu, které by horské zalednění potvrzovaly. Pramenné oblasti Bučícího potoka byly identifikovány jako nivační kotle.

Key words: *Czech Republic, Moravskoslezské Beskydy Mts., Mt. Smrk, geomorphological mapping, geomorphological processes in the flysch rocks, glaciation.*

1. Introduction

The mapped sheet 25-24-01 of the Basic Map of Czech Republic (scale 1:10 000) includes the northern slopes and foreland of the second highest mountain of the Moravskoslezské Beskydy Mts. - Mt. Smrk (1276 m). The studied area is situated at the border between the Czech Republic and Slovakia, about 35 km to the south-east from Ostrava town (Fig. 1). The Mt. Smrk mountain group represents the most eastern part of the geomorphological unit of the Radhošťský hřbet Ridge which includes the Radhošťská hornatina Mts. subunit, the zone of culmination (see the geomorphological map, Fig. 2). The northern part of the map sheet belongs already in the Frenštátská brázda Furrow, a part of the vast geomorphological unit of the Podbeskydská pahorkatina Hills. The massif of Mt. Smrk itself stands for the great relief energy (high differences above valleys of the Čeladenka River and the Ostravice River exceeds 600 m) and extreme slope inclination proportions with values up to 40° on the northern slopes (Fig. 3). The northern part of the sheet surrounding the high-point Mt. Horka (593 m) represents the foot of hilly land with lower values of slope inclination and high difference above the floodplain of the Ostravice River up to 150 m. The terrain intermediate stage between the northern slopes of the Mt. Smrk and the foot of the hilly land constitutes conspicuously protrusive ridges of Mt. Malý Smrček (712 m), Mt. Smrček (859 m) and Mt. Skalka (613 m).

The area of interest also consists of the parts of valley bottoms of the Čeladenka River on the west and the Ostravice River on the eastern margin of the sheet which forms morphologically obvious border with the group of the Mt. Lysá hora (1234 m), the highest point of the Moravskoslezské Beskydy Mts. the northwestern slopes of the Mt. Smrk are drained by the Psí doliny Brook and the Matulákův potok Brook into the Čeladenka River; the Bučící potok Brook which acts as a main hydrographic axis of the northern slopes leads into the Ostravice River. A characteristic feature of the steep slopes of the Mt. Smrk is the considerable deforestation which was caused by the serious damage to spruce monocultures little resistant to the air pollutant impact of the industrial Ostrava region.

2. Geological characteristics

From the geological point of view the area was investigated by Menčík et al. (1983) and Menčík, Tyráček

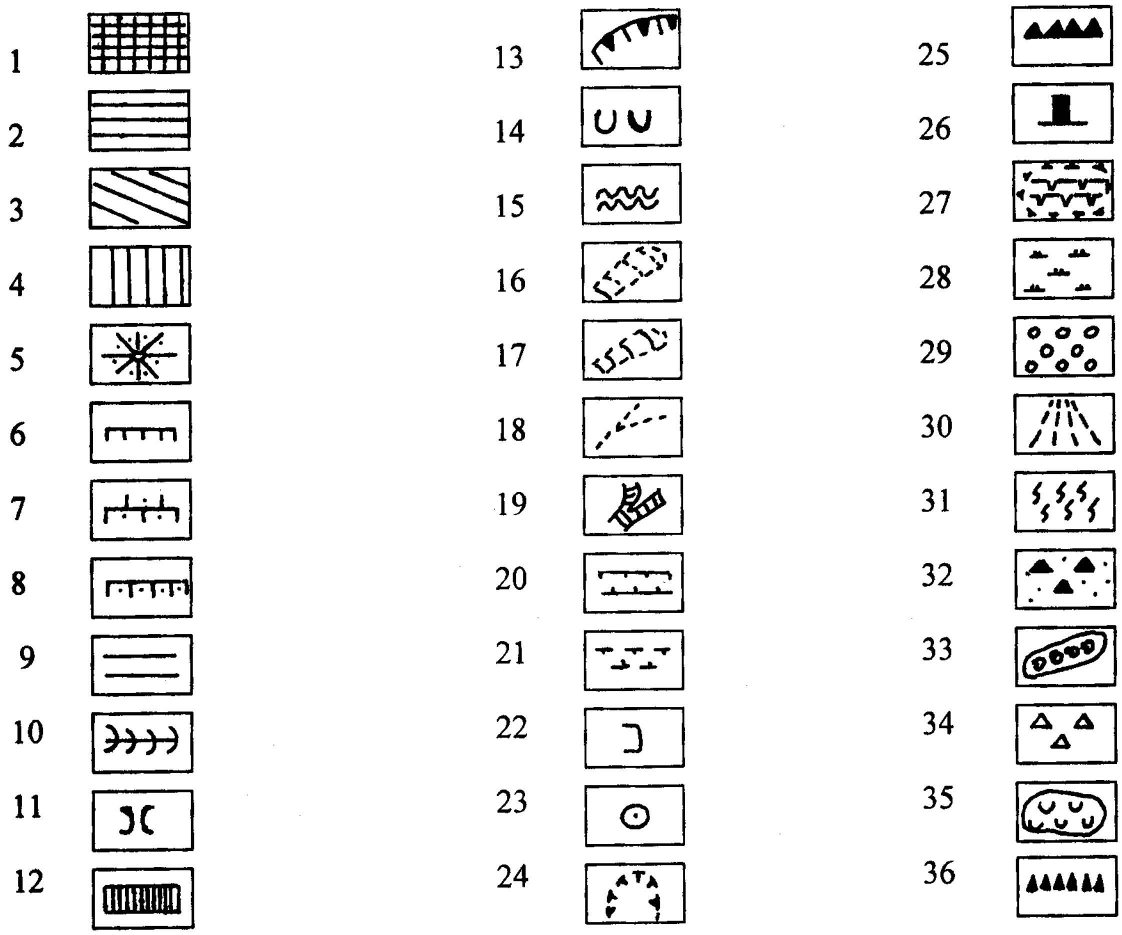
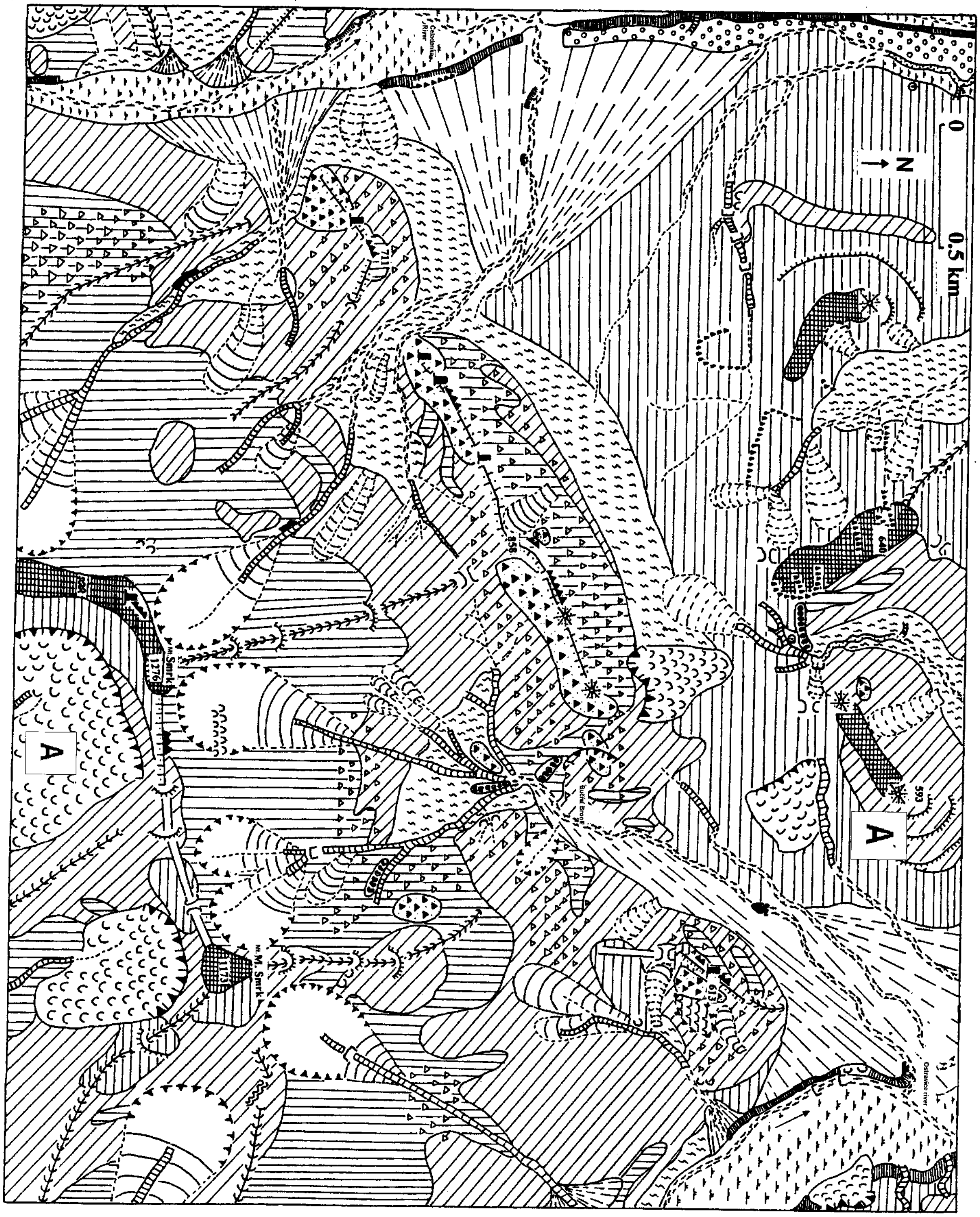


Fig. 2: *Detailed geomorphological map of the vicinity of Mt. Smrk. Legend: 1.Remnant of planation surface inclined at 0-5°; 2. Slopes inclined at 5.1-15°; 3. Slopes inclined 15.1-25°; 4. Slopes inclined at 25°and more; 5. Monadnock originated by periglacial processes in the Pleistocene; 6. Structural break on slopes and ridges; 7. Structural ridge formed by more resistant strata; 8. Monoclinal ridge; 9. Denudation ridge originated by the intersection of valley sides; 10. Significant slope ridges; 11. Saddle; 12. Slope affected by lateral erosion (erosion slope); 13. Root area of fossil landslide; 14. Small landslide; 15. Tension gashe; 16. Dell inclined 0-15°; 17. Dell inclined more than 15°; 18. Gully; 19. V-shaped valley; 20. Bed of streams incised in rock; 21. Bed of streams incised in Quaternary deposit; 22. Rapid and waterfall; 23. Suffosion pit; 24. Nivation cirque; 25. Frost-riven cliff; 26. Tor; 27. Cryoplanation terrace; 28. Floodplain; 29. Fluvial terrace of probably Riss age; 30. Alluvial cone; 31. Solifluction foothill deposits; 32. Blockfield; 33. Solifluction stream; 34. Angular debris on slopes; 35. Accumulation part of landslide; 36. Agriculture heap; 37. Small water reservoir.*



(1985). The basic geological characteristic is the central location within the Silesian Unit of the outer flysch nappes. The area is predominated by cretaceous sedimentary rocks of the Aptian stage. Igneous and pyroclastic rocks of the teschenite association protrude at some locations in the northern part of the studied area.

The geomorphological group of the Mt. Smrk is built of a several-kilometer thick Godula Formation (Turonian - Senonian) with a slight inclination (approx. 25°) towards the south and southeast. Strata values of only about 10 - 15° have been found in teh highest parts. The largest representation is symbolized by the Middle Godula Member which is formed by the coarse rhytmic flysch with the thick-bedded glauconitic sandstones. The fine to medium rhytmic flysch of the Lower Godula Member is not spread continuously. There is a geomorphologically important horizon of the Ostravice sandstone constituted by massive coarse-grained qartzose sandstones and conglomerates on the base of the Godula development has been formed.

The northern foothill part of the mapped area is built of an especially less resistant formation in the bedrock of the Godula complex. This part consists of Těšín – Hradiště Formation and Lhoty Formation. The morphological display is recognized mainly in connection with the position of quartzose sandstones of the Hradiště type (Aptian-Valagian).

Geologically proven fault lines are characterized by SW-NE and NNW-SSE directions. The fault of the SW-NE direction separating the lower part of the Godula Formation from the Ostravice sandstone bedrock is marked best from the geological point of view. The tectonic line of NNW-SSE direction is also supported by a deep incised valley of the Ostravice River between the Mt. Smrk and the Mt. Lysá hora.

3. Morphostructure

Basic morphostructural features are conditioned by the lithological characteristics of flysch rocks and their intensive tectonic deformation. The massif of the Mt. Smrk is situated in the central area of culmination where neotectonic uplifts of the Západní Beskydy Mts. bow take place. The directions of individual ridges and slope inclination proportions are limited by the position of layers and geomorphological quality of rocks. Prevailing are the ridges of SW-NE direction; their origin was marked by the course of individual rock complexes and by the typical direction of the fault and fissure systems. The Mt. Malý Smrček, Mt. Smrček and Mt. Skalka are characterized by structurally conditioned crests formed in resistant Ostravice sandstones. In correspondence with the horizontal position of beds some of the ridges manifest monoclinal character (the summit of Mt. Smrk). Striking morphological differences can be traced mainly between the Mt. Smrk massif composed of quasihomogenic layers of the Godula Formation and the northern dissectional foreland built by lithological variegated complexes. Saddles and valley sections are typical for less resistant positions.

Fig. 3: *Nivation cirque on the northern steep slopes of Mt. Smrk. Photo T. Pánek.*

A remarkable role in the contemporary relief of the investigated area is played by fault systems. The fault of SW-NE direction which follows the line of the saddles to the south of the Mt. Malý Smrček, Mt. Smrček and Mt. Skalka played most probably a dominant role in the development of the marginal northern slope. From the geomorphological point of view there is a supposed fault line of SW-NE direction also at the northern foot of the ridges of Mt. Malý Smrček, Mt. Smrček and Mt. Skalka. This statement is supported by the discovery of the tectonic contact of rocks of different lithological characteristics in deep incised valley of the Bílý potok Brook (1500 m NE from the high-point a Mt. Smrček). The dominance of the tectonic lines of SW-NE direction is connected with the deformation of the marginal part of the Silesian nappe in the vicinity of the main nappe line. The N-S and NNW-SSE transversal faults are geologically located in the Ostravice River valley and they marked the eastern marginal slopes of this mountain group. In the Čeladenka River valley there is no fault geologically proven but from the point of the geomorphological characteristics of this deep incised valley its existence can be presumed.

4. Morphosculpture

Tectonic forms of the relief were heavily modified by erosional and denudational processes at the end of the Tertiary and in the course of the Quaternary. Most of the authors (Buzek, 1976; Stehlík, 1964) suppose that in the relief of the Moravskoslezské Beskydy Mts. there are morphosculptures preserved, which came into existence after the nappe tectonics between the Lower and the Upper Badenian (Styrian orogenetic phase) was over. However, a possible influence of erosional and denudational processes and the preservation of relief forms aroused simultaneously with the orogenesis (see Ivan, 1981) have not been resolved yet. The contemporary relief of the studied area is a product of particularly the Quaternary morphogenesis.

4.1 Problems of planation surfaces

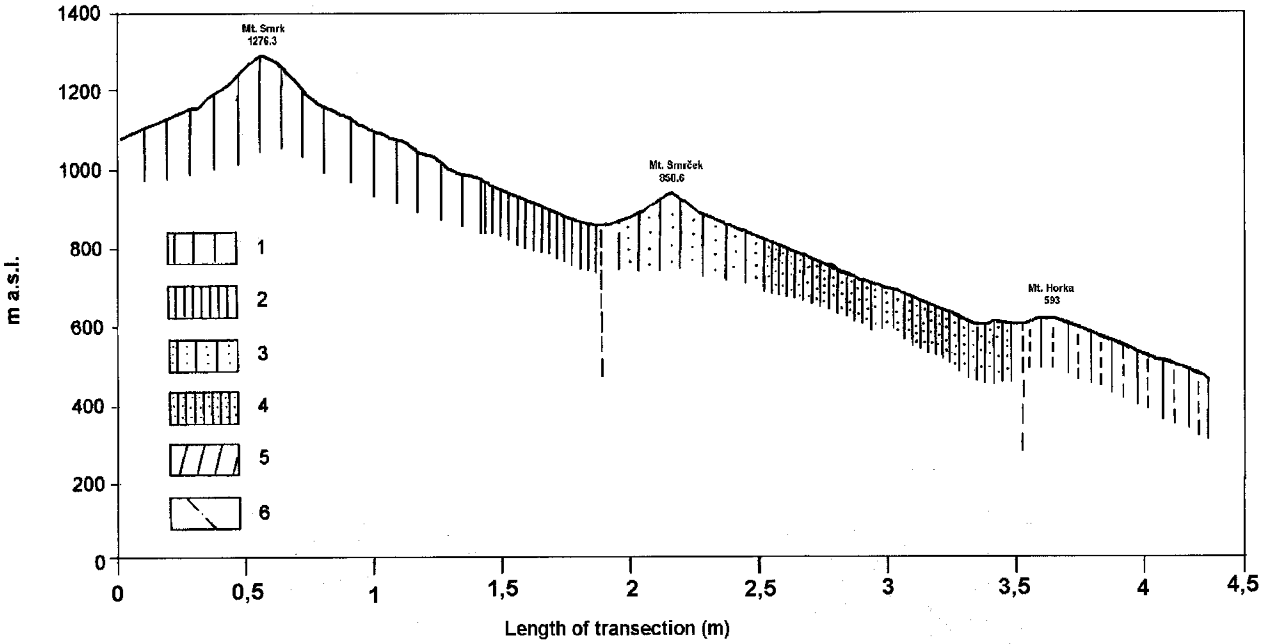
The genesis of the flat relief forms in the flysch Carpathians, as it has been presented up to this day, is debatable from the point of the present knowledge of the denudational chronology of the Carpathians (Bizubová, Minár, 1992; Bizubová, 1993). In the area of interest the parts of the relief with the slope inclination lower than 5°, in some places with even higher slope inclination depending on the morphographical and morphometrical location, represent the subject of discussion. Two groups of these forms can be determined:

- erosional and denudational remnants of planation surfaces,
- surfaces with a considerable structural predisposition.

The following facts were found out during the geomorphological mapping:

- The existence of the planation surface remnants can be supposed in the Mt. Smrk part of culmination at the altitude of about 1260 m and on the broad ridges of the foot hilly land (e.g. Mt. Horka 593 m, see Fig. 4). In the summit part of the Mt. Smrk there is an after Badenian or synorogenic planation that spreads also in the summit parts of the Západní Beskydy Mts. system. Based on the connections with the Slovak part of the flysch Carpathians (the Slovenské Beskydy Mts.) this planation surface can be correlated with the middlemountain level of the Panonian stage (e.g. Lacika, Urbánek, 1998). The planation surface is preserved on the broad ridges of the Mt. Horka group in the foreland of the highland (Fig. 4) at the elevation of 590 - 640 m, which is about 150 m above the valleys of the Ostravice River and the Čeladenka River. The authors assume that these are fragments of the so-called river level of the Upper Pliocene to the Lower Quaternary stage. The original connection with the summit part of the Mt. Smrk (the difference of elevation is about 600 m) cannot be excluded because the northern slopes of Mt. Smrk and Mt. Smrček group are originally based on the tectonic failure of the NE direction. It can be stated that in the period before the Upper Pliocene there was a downfall along the failure and the subsequent incorporation of the part of the summit surface into the younger planation.
- The structurally conditioned surfaces are less extensive and their character is mostly that of structural brakes. They follow the contact of the rocks of various resistance towards weathering and removal. These forms are more typical of the northern slope ridges of the Mt. Smrk where they arouse on thin claystone intralayers in the massive layers of the Middle Godula Member. In the Mt. Horka group they were mapped at the places of the contact of the Hradiště sandstones with dilapidating shales. The debris of sandstones gives an evidence of a considerable formation of the surfaces structurally conditioned by periglacial processes in the Pleistocene. A certain structural predisposition can be recognized also in the connection with the summit surface surrounding the high-point Mt. Smrk which is based only on the slightly or sub-horizonally inclined layers of the Middle Godula Member (slope inclinations at up to 10° were documented). The periglacial processes in the Pleistocene period also took part in pointing up of the structural predisposition of the summit part.
- The planation forms of relief were considerably modified by the periglacial and gravitational (potentionally cryogravitational) processes of the Pleistocene. The evidence is given from the side of the blockfields and the rock of the type of "tors" in the summit part of the Mt. Smrk. The tension gashes caused deformations at some places of the summit part of the ridge of culmination.

***Fig. 4:** Profile in the direction of Mt. Smrk - Mt. Smrček - Mt. Horka. Explanations: 1. Middle Godula Member (coarse – rhytmic flysch), 2. Lower Godula Member (fine - to medium - rhytmic flysch), 3. Ostravice sandstone (quartzose sandstones), 4. Lhoty Formation (sandy flysch with claystones), 5. Sandstones of the Hradiště type (quartzose sandstones), 6. Faults.*



4.2 Slopes

The studied area is predominated by erosional-denudational or structural-denudational slopes. Some parts of the slope sections are faceted and their character is that of remodified fault scarps (e.g. northwestern slopes of the Mt. Smrk). The lithogical features of the rocks reflect e.g. in the structurally predisposed slopes of the Mt. Smrček on the resistant Ostravice sandstone or in the northern steep slopes of the Mt. Smrk group based on the escarpments of the layers of the Godula Formation. The massif of Mt. Smrk is predominated by slopes with the inclination above 15°; the values of the northern slopes of Mt. Smrk themselves are represented by categories at above 25°. The slope inclination values for the major part do not exceed 15° in the foot hilly land. The slopes are covered with debris, the layer thickness of which grows towards the foot of the slope where it merges into the solifluction deposits. Outcrops are typical of the frost riven cliffs or the head scarps of block landslides.

Slope failures of various genesis stand for a significant geomorphological element. Block landslides prevail in the mountain parts; the most extensive areas affected by landslides are on the southern slopes of the Mt. Smrk and the Mt. Malý Smrk at the head of the Kyčerov Brook valley where the slope has been deformed along the bedding plane of the Middle Godula beds. The slope deformations resulted in the development of tension gashes, block gullies, steep head scarps and typical undulation of slopes parts in the landslide accumulation. The landslides affecting foot solifluction deposits, block fields or steps of river terraces in the valleys of bigger streams are areally less extensive. The contemporary movements of debris accelerated by the slope deformations which were induced by roads construction on the northern slopes of the Mt. Smrk were studied by Adamčík (1986) and Trčka (1988). Active development of the landslides occurs also on the 12 m high terrace step which is under cut of the lateral erosion of the Čeladenka River.

Rockfalls are less common, their occurence was mapped only on the western slopes of the Mt. Smrk ouside the mapped area.

4.3 Pleistocene periglacial forms

Individual but numerous groups consist of relief forms which came into the existence by intensive frost weathering and removal in the cold period of the Pleistocene. The following groups of forms represent this type of weathering:

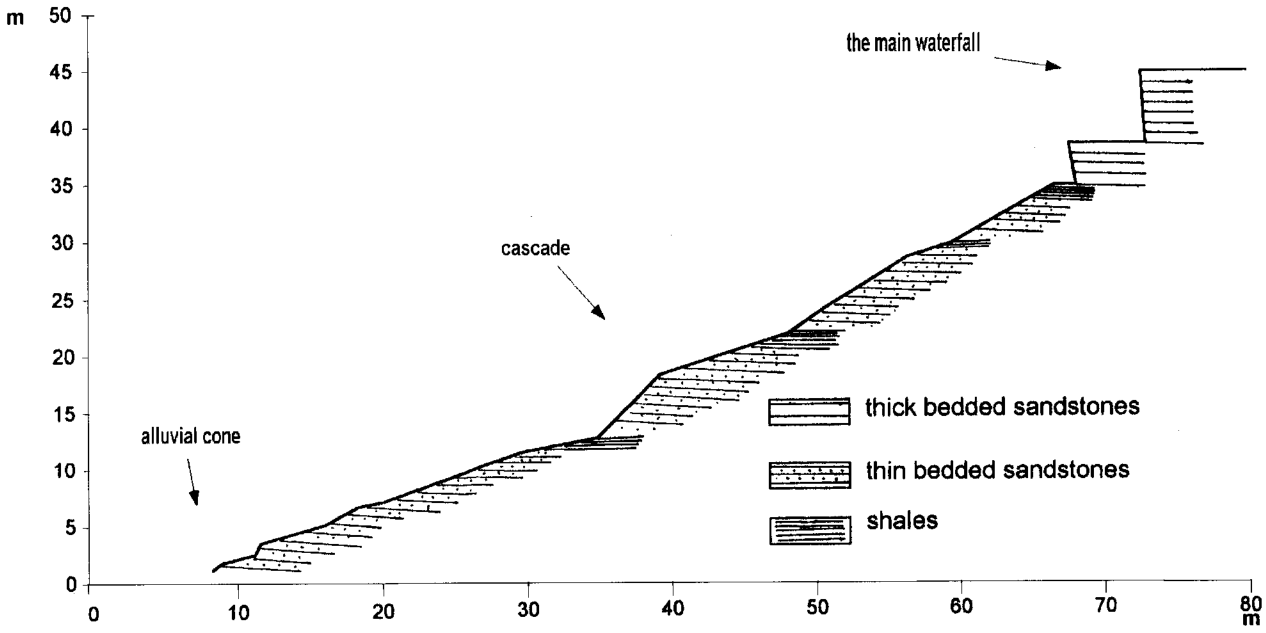
- Frost riven cliffs are conspicuous rock forms which occur in the upper parts of slopes in the investigated area. The rock forms were isolated during the intensive periglacial destruction of ridges and predominate today over the level of the ridges and planation surfaces as the "tor" type rocks (Fig. 5). Summit rocks in the area of culmination of the Mt. Smrk (the maximum height is 4 m) and significant ridges of the Mt. Malý Smrček, Mt. Smrček and Mt.

Skalka with tors not higher than 3 m serve as a good example here. The frost riven cliffs are more common for outcrops of Ostravice quartzose sandstone on the crest of Mt. Smrček. Typical features of the Ostravice sandstone are as follows: high resistance, tectonic disintegration and asher dilapidation; they stand for the features of rocks helping to frost weathering but at the same time in conditions of humid morphogenesis they keep the rocks in the "fresh" state. Frost riven scarps accompany the frost riven cliffs but their inclination is more gentle and the bedrocks do not protrude on their surface. There are interesting microforms on the rockwalls which developed by selective weathering of variously weakened parts of rocks. The authors point out the discovery a "tafoni" type of hollow on an isolated rock nearby the southwestern end part of the Mt. Smrček ridge. The hollow conspicuously extends about 0.5 m towards the rock massif and is prolonged along the fissure at a length of about 1 m.

- Cryoplanation terraces evolved after the retreat of the frost riven cliffs. They can be found especially on the layers of the Middle Godula Member and Ostravice sandstone. The best developed cryoplanation terrace is situated on the eastern slope of the Mt. Skalka, which developed as a result of the retreat of the frost riven scarp covered with a well developed block field. The proportions of cryoplanation terraces are 100x200 m. A number of breaks on the slopes were marked by periglacial processes.

Fig. 5: Tor in the area of culmination of Mt. Smrček. Photo T. Pánek.

***Fig. 6:** Longitudinal profile of the Bučící potok Brook cascade on the northern slopes of Mt. Smrk in altitude of 780 – 825 m (see Fig. 2)*



- Some of valley heads in the massif of the Mt Smrk are characterized by amphitheatral depressions which are open in the valley direction. These depressions are interpreted as nivation hollows and nivation cirques (Fig. 3) which are in the best development on the northern slopes of the Mt. Smrk at the head of the Bučící potok Brook. The inclination of the cirque heads reaches up to 40°. The bottom parts of the nivation cirques and the sections closely below them are filled with debris which indicates intensive nivation processes. Steps in the longitudinal profiles of streams which are very often of the waterfall character are representative for the accompanying forms.
- The frost riven cliffs and tors are often surrounded by great block accumulations. These block fields are the phenomenon of the ridges of Mt. Malý Smrček, Mt. Smrček and Mt. Skalka. From these locations they are transported to the slope positions where they concentrate in dells and form block streams. They are noticeable on the eastern, quite deforested slopes of the Mt. Smrček. The solifluction deposits can be traced at the foot of the northern slopes of the Mt. Smrk and Mt. Smrček. Typical localities of their occurence can be found in the lowest part of the slope dells (e.g. the valley of the Bučící potok Brook). The solifluction processes are morphologically expressed by common solifluction streams.

4.4 Fluvial forms

The fluvial processes are represented by erosional and accumulational landforms which are connected with the work of streams. Intensive erosional dissection of the Mt. Smrk group is conditioned by the great relief energy of the area and the geological features of the flysch rocks. Steep structural - denudational slopes are divided by V-shaped valleys with considerable steps in the longitudinal profile. Waterfalls have been documented in several slope valleys. The highest of them is located on the Bučící potok Brook at the altitude of 780-825 m. It consists of a cascade of waterfalls and rapids with the height of main steps being 6.4 m and 3.6 m, which are connected with the outcrops of thick beds of sandstone of the Middle Godula Member (Fig. 6). A well developed cascade was described in the bed of the Bílý potok Brook at the altitude of 530 m on the thick beds of the Hradiště sandstones. The total height of two highest steps is 6 m. The V-shaped valleys on the slopes of the Mt. Smrk are filled with a several-meter thicklayer of slightly water-worn rock material which is stabilized by the vegetation cover. These accumulations are products of the morphoclimatic conditions in the Pleistocene period. Into the bed positions the material was transported in the historical period in connection with the antropogenic changes of vegetation.

Lateral erosion represents a very important process in the foreland of the Mt. Smrk ridge of culmination. Active development of undercut banks with the length of several tens of meters and the height up to 10 m takes place in the valleys of the Matulákův potok Brook, the Psí doliny Brook and the Bílý potok Brook etc. Most of the streams flowing from the northern slopes of the Mt. Smrk are marked by intensively acting erosion in unconsolidated proluvial deposits in the foot hilly land. A nice example of these processes can be shown within the lower part of the Bílý potok Brook which follows the course of the fault line of the NE-SW direction. The valley is incised 20 m below the level of the gently inclined slopes of the alluvial cone as a result of the Těšín - Hradiště Formation lithological features and passive impact of fault failure.

Accumulation fluvial forms are represented by floodplains and terrace levels. The level of the main terrace of Ostrava region (Riss) is preserved on the right bank of the Čeladenka River at the elevation of 13 m above the surface of the water. There are vast terraced alluvial cones, too. The alluvial cone of the Matulákův potok Brook which is constituted of the stone material of sorts (Godula and Ostravice sandstones) dispersed in yellowish-brown loamy-sandy deposits merges together with the Riss main terrace of the Čeladenka River. In the direction towards the foot of the Mt. Smrček the alluvial cone gradually unifies with the solifluction deposition. A similar character can be recognized within the alluvial cone of the Bučící potok Brook by the confluence into the Ostravice River. A recently formed alluvial cone is in the lower part of the Psí doliny Brook valley. On the surface of this cone there are marks of the latest accumulation and resedimentation of the stone material.

The forms of suffosion were documented in the studied area, too. There are shallow depressions on the arable land in the north – western part of the mapped sheet. The processes of suffosion have been accelerated by artificial drainage of the fields. Another locality with suffosion but without anthropogenical impact is situated in the slope sediments to the south - west of the Mt. Horka.

4.5 Anthropogenic transformation of relief

In the studied area, the present and historical activities of the mankind resulted in the acceleration of some geomorphological processes and in the development of various forms which came into existence due to the direct anthropogenic impact. The whole area of the northern slopes of the Mt. Smrk is patterned with a dense network of forest roads which create good conditions for rill erosion and which in some places caused the development of landslides (e.g. the vicinity of the Barabská cesta Road and the Knížecí chodník Pavement). Total deforestation of the northwestern and northern slopes of the Mt. Smrk accelerated the slope processes such as creep, landslides, occasional occurence of avalanches in winter time. In the vicinity of the Mt. Horka agricultural dumps are more common. Their length reaches several hundreds meters and their occurence in the forested parts of the mapped area provides an evidence of different land use in the past.

5. Problems of mountain glaciation

The northern slopes of the Mt. Smrk were often classified as a potential locality of mountain glaciation within the flysch range of the Carpathians (Vitásek, 1956; Czudek, 1997). In 1952, J. Pelíšek published a study about the presence of two generations of cirques and moraine accumulations in the valley of the Bučící potok Brook. He indicated the area of the whole northern slopes of the Mt. Smrk as a large glacial cirque. Within this cirque he supposed the occurence of two younger and smaller cirques. Pelíšek dated the origin of the cirques to two periods of the Würm. Although this fact is not disproved by the topographical position and the presence of a nearby continental glaciation during the geomorphological mapping, the fact is that no forms typical of mountain glaciation were found. The question of a possible occurence of the mountain glacier in the investigated area was studied in the connection with new data on a possible existence of the cold-base glacier on the slopes of the Mt. Králický Sněžník (Demek, 1998; Demek, Kopecký, 1998).

During the field research in the Mt. Smrk area the authors found out the following facts:

- The head parts of the source sections of the Bučící potok Brook do not indicate any morphological signs typical of cirques (unlike Pelíšek, 1952). The outcrops do not protrude on the surface and the cirque step is missing too. In the lower sections of the valley there are accumulations of stone material, which document the intensive cryonival destruction of the bedrock in the period of the Pleistocene. The two spring areas show the typical morphology of well developed nivation cirques; we assume that the accumulations in the lower parts of the valley bottoms are the resedimented products of nivation processes.
- The moraines supposed by Pelíšek in the Bučící potok Brook valley at the altitude of 550 - 620 m are, according to all their morphological features, solifluction streams, partially also the resedimented material of nivation deposits. The accumulations of the same morphology and area extent were mapped in localities where the slope valleys lead into the lower parts of relief (e.g. the Psí doliny Brook valley at the elevation of 650 m).
- Similar features can be found on the northern marginal slopes of the whole area of the Moravskoslezské Beskydy Mts. The valleys have amphitheatral heads and in the lowest sections of them, thick proluvial and solifluction deposits were sedimented which can be mistakenly considered as morain accumulations, e.g. the basins of the Mazák Brook and the Satina Brook in the Mt. Lysá hora locality (1323 m).

6. Conclusion

The geomorphological research in the locality of Mt. Smrk confirmed both the morphographical and the morphogenetic complex character of the relief on the flysch rocks. From the point of a long-term investigation of the geomorphological development there is a need to carry out the geomorphological mapping in the whole range of the Západní Beskydy Mts. The main problem to be solved is the interpretation of the tectonic forms of the relief in connection with the specific lithological features of the flysch rocks. The preservation of forms which correspond to the potential mountain glaciation is less probable. A detailed investigation in other localities of the possible glaciation (Mt. Lysá hora) will be a contribution to the issue.

Acknowledgment

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TO THE GEOMORPHOLOGY AND GEOLOGY OF THE NORTHERN APENNINES

Karel KIRCHNER, Oldřich KREJČÍ, Antonín IVAN

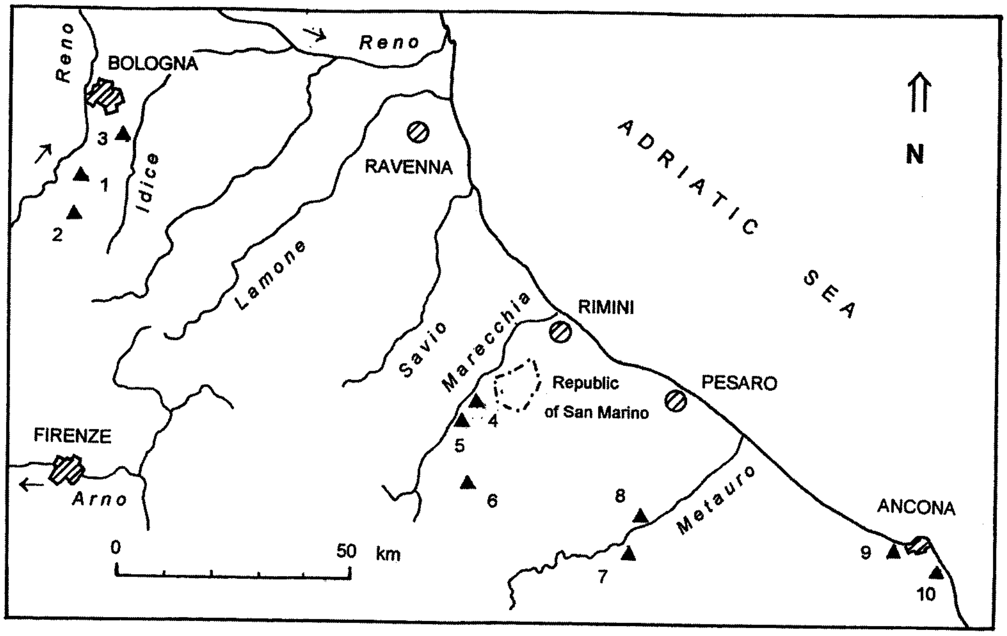

Fig. 1: Localities visited in the Northern Apennines: 1-Surroundings of Monte Sabbiuno and Monte Adone, 2-The village of Monzuno, 3-The region of Buca di Ronsana, 4-The castle of San Leo, 5-The summit of Rocca di Maioletto, 6-The Monte Carpegna, 7-The coombe of Furlo, 8-The village of San Lazaro, 9-The Borghetto slide, 10-The Conero Natural Park.

A Czech-Italian geomorphological and geological workshop was held in Brno in 1998. One of its conclusions was to organize a scientific excursion to Italy for Czech colleagues (details see Kirchner, 1998). This was the reason for workers from the Institute of Geonics, Branch Brno to visit Italy in May 1999 together with experts from the Czech Geological Survey, Branch Brno after having agreed all details of the journey with the Italian colleagues. We visited the Department of Earth Sciences and Environment Geology at the University of Bologna and the Institute of Geology at the University of Urbino. A field excursion was made into the area of the Northern Apennines – regions Emilia Romagna and Marche.

The journey was focused on learning the basic geological and geomorphological features of the Northern Apennines, which are comparable with the geological and geomorphological characteristics of the Outer Carpathians in the territory of Moravia. However, the Italian territory is younger and geologically more active. It is in particular the slope processes that are highly dynamic and reflect conspicuously in the socio-economic sphere of the contemporary landscape. The experience will be applied in the Grant Project No. A 3086903, funded by the Grant Agency, Academy of Sciences of Czech Republik. The attention was also paid to the creation of geomorphological maps on the visited workplaces and the documentation is going to contribute to the solution of the Grant Project No. 205/99/0329 funded by the Grant Agency of Czech Republik. The paper presents a basic informations on geomorphology and geology of the Northern Apennines with some more details on some important visited localities.

The main mountain ranges of the Apennines have the form of a great arc that opens onto the Tyrrhenian Sea. Here the Apennines fall down in a so called internal slope. In contrast, their so called external slope bends into the Po Plain and to the Adriatic and Ionian Seas. In their basic features, the geomorphological characteristics of the Apennines are controlled both tectonically and structurally. Typical are longitudinal mountain belts. In terms of the relief development, a great importance is played by the high lithological diversity of the bedrock (sandstones, limestones, marls, flysh complexes) and their different resistance to weathering and slope movements, neotectonic activity in the Pliocene and Pleistocene (for example, the Pliocene sediments were uplifted by as much as 1000 m in the Pleistocene), and the Pleistocene to contemporary volcanism (Sestini, 1984).

Within the field excursion we visited the Northern Apennines and their NE part – Marche Apennines (Appennino Marchigiano). The excursion localities were situated to the south of Bologna in the catchment of the Reno and Savena Rivers, in the Marche Apennines in the catchment of the Marecchia and Metauro Rivers. The territory of the so called external slope of the Apennines is characteristic with transversal ridges that become crests at some places, perpendicularly to the axes of summit ridges and main divides. Thanks to the recent tectonic movements the relief is young, structurally-erosional with visible effects of both transverse and nappe tectonics. Extensive areas are subjected to slope movements (Elmi – Nesci, 1996; Bisci – Dramis, 1991) and water erosion. The north-eastern slope of the Apennines, formed by Pliocene clays and by the Argille Scagliose Formation (Upper Cretaceous-Eocene), is typical with its intensive development of linear erosion. The Argille Scagliose Formation represents a large and not further divided lithostratigraphical unit which mainly includes flysh sediments. The sporadically occurring areas of the „badland" type are called calanchi. Divide ridges built in the less resistant flysh sediments are flat with the remnants of planation surfaces. The surfaces often occur above the highest river terraces (Mid-Pleistocene) such as in the Metauro River. catchment basin and are influenced by the tectonic uplift of the territory (Veneri - Nesci - Colantoni, 1991). Longitudinal cuestas are bound to the outcrops of Miocene gypsums and there are also occasional karst forms (gypsum karst).

From the geological point of view the area belongs to the Ligurian Apennines and is distinguished in its varied geological structure. It is a nappe system of flysh and foredeep units. The flysh units originate from the Upper Cretaceous, Paleocene up to Oligocene. The flysh development can also be traced in a number of units from the Apennine Foredeep, even within the Upper Miocene. There are for example deep-water flysh sediments which are equivalent in terms of origination time to the evaporites from the period of Mediterranean crisis of Messine salinity (Pannonian). The nappe movements diminished as late as in the Pliocene and Lower Pleistocene, and are still diminishing to these days above the Calabrian subduction zone in southern Italy. It is a typical accretion wedge which developed in the upper layers of the contact of the subducting Adriatic premontory of the African plate with the back arc basin of the Tyrrhenian Sea.

Similarly as the Alps, the Apennines did not come into existence as a result of the collision between two plates – African and European. They developed through the mechanism of a simple eastward roll-back of the westward-dipping subduction hinge (drawn back from the edge of the Adriatic premontory of the African plate) (Moores, Fairbridge et al., 1997). The Apenninic-Tyrrhenian System is very young and was formed during the last 10 to 15 million years. Basic magmatism in the back arc basin of the Tyrrhenian Sea accompanied with the expansion of its crust, is the main mechanism to these extensive mountain-forming processes. The Apennines are further typical with the extension disintegration of the entire megastructure of the mountain ranges along the listric (normal) faults of a very deep reach. Thus, the orogeny front is characteristic of the compression, nappe tectonics afflicting a considerable part of the foredeep while the summit part of the mountain range with an older nappe construction is dissected by longitudinal graben structures.

The Miocene sediments on the surface are integrated into the nappe system of the Apennines and are to be found in their deep basement in the autochthonous position. The nappe units of flysh and foredeep were transgressed with the sediments of the intra-Apenninic Pliocene which forms morphologically conspicuous monoclinal cuests in the psammitic-psephitic development. Today, we can rather speak of the outliers of a larger cover, thick several hundred meters. The nappe units are sinking in the northern direction under the continuous Pliocene cover in the area of the Po Plain, whose maximum thickness amounts up to 7500 m. The Po Plain depression margins are marked with fault systems. In the basement of the Pliocene sediments there is a tectonic contact of the Apennines and the southern Alps. The boundary between the Western Alps and the Apennines is referred to as the Sestri-Voltaggio Line.

Excursion localities

The presented characteristics were worked out on the basis of accounts provided by Prof.Dr. Carlo Elmi (University of Bologna), Prof.Dr. Olivia Nesci, Prof.Dr. Danielle Savelli, Dr. Elvio Moretti (University of Urbino) while visiting the excursion localities, and using the available literature combined with personal field experience.

The surroundings of Monte Sabbiuno and Monte Adone

(south of Bologna, the lower part of the Savena and Reno Rivers catchment basin)

The dissected relief of the hilly land to upland character with flat ridges and broad valleys is built by clays and claystones of the Upper Cretaceous to Eocene age, which are parts of the tectonites and olistostromes. These lutaceous rocks contain numerous slide bodies of Jurassic and Lower Cretaceous limestones, Jurassic radiolarites, Aptian-Albian sediments with reddish-brown claystones and other deposits. The major rock of the olistolite mass are grey clays. In the underlying

***Fig. 1:** The San-Marino type limestones (Lower to Middle Miocene) form a conspicuous ridge with the summit of San Leo (639 m). The rock walls are impacted by rock collapse and block deformations. The foot of rock walls exhibits the impact of landsliding and earth flows. Photo O. Krejčí*

layers of these intensively tectonized units is a transgressive contact with the Mid-Eocene and Oligocene sediments. The summit positions of ranges such as Monte Adone (655 m) are formed by the sediments of the transgressive, nearly unfaulted Pliocene. The definitive regression of the sea occurred some 600 000 years ago. The monoclinal attitude of the sediments conditions the development of asymmetric ridges (cuestas). The slopes with a lower gradient are usually used for agriculture while the steep slopes, built mainly on faults, are erosion-affected and dissected by smaller and larger gullies (development of calanchi). The calanchi-type relief occurs in extensive areas (formed by clays and claystones) that can be used neither for agricultural purposes nor for house building. The steep slopes of the cuests are often formed by pronounced sandstone rock walls (e.g. the wall of Monte Adone reaches as high as to about 200 m). In addition, the relief exhibits mudflows and structurally conditioned slides (e.g. in the surroundings of Pieve del Pino).

Monzuno

(the Monzuno small town surroundings, 8 km to the south of Monte Adone)

The flat divide ridges between the Savena and Setta Rivers are mainly built by the flysh Monghidoro Formation of the Upper Cretaceous to Paleocene age. It is a medium- to coarse rhythmite carbonate flysh with the predominance of calcareous, grey, silty claystones which are at some places strongly coherent and thick several meters. The sandstone benches are of a much lesser thickness and are formed by fine-grained calciarenites with turbidite textures. On the underlying layer of these sediments, there are very numerous and extensive slides of the earth flow character with rotational surface of ruptures.

Buca di Ronsana

(15 km to SSE of Bologna)

The relief of the marginal slope of the Apennines is formed by a belt of coarse grained, recrystallized gypsums (selenite) of the Messine evaporite sediments. Today, these gypsums are being classified in the system of the alochthonous groups of nappes. In the area of Buca di Ronsana, the gypsums developed in a conspicuous range which is transversally crossed by the Zena and Idice Rivers streams. The region is characteristic of extensive dolines whose diameter ranges between 200 – 300 m and the depth reaches to about 100 m. The doline walls bear entrances into minor caves.

The Marecchia River valley

(SW of Rimini – the Marche Apennines)

In the broad floodplain of the Marecchia River, there is a frequent branching and shifting of the river bed with river gravel sands being very young and often resedimented. The river channel is not reconstructed and the seats are founded on the low river terraces (of the Upper Pleistocene age). The structural-erosional relief markedly shows the effects of tectonics. At a relative height of 60-70 m above the valley floor near the seat of Novafeltria, there are remainders of the valley planation surfaces of the glacis type (the Riss age). The area is characteristic with its typical extensive slides. For example, an intensive slide of the earth flow type was activated on the Tausano ridge twenty years ago, which was long over 1000 m and wide up to 400 m. The root section is on a pronounced lithological boundary plane between the claystone system of layers of a chaotic complex with the predominance of grey claystones up to marlstones of the Upper Cretaceous to Eocene and overlying limestones of the San Marino Formation. The San Marino-type limestones (Lower to Middle Miocene) are sandy shallow-water limestones which today form morphological klippes on the basement built mainly of claystones. Since the slide destroyed the road, it was fixed with gabion walls and drainage systems. There are several more important localities in the area (San Leo, Rocca di Maioletto, Monte Carpegna).

San Leo

(639 m)

On the right valley slope of the Marecchia River, there is a number of structural and tectonic ranges and crests built of the San Marino-type limestones, whose average thickness is about 800 m. On one of the ridges, which is confined by steep to overhanging walls high up to 200 m, there is a castle of San Leo originating from the Middle Ages. The limestone outlier dwells on an unstable claystone basement of the Upper Cretaceous to Eocene age (Argille Scagliose Formation) which outcrops at the foot-hills. The territory exhibits a high dynamics of slope movements. Due to the heavy erosion along the slope pediment, the development can be seen of limestone overhangs and the collapsing of bulky rock blocks along the fissures. There are also block deformations. The collapsing rocks endanger the marginal part of the castle and this was the reason to start monitoring and rehabilitation works (cementing drills, anchoring). The rocks of the argille scagliose complex at the pediment of the limestone rock walls show an intensive development of slope movements of the type of earth flows, which are to a certain extent secured with moles.

Rocca di Maioletto

(624 m, an isolated summit with the Maioletto castle near the village of Novafeltria)

The summit is formed by claystones and sandstones of the Lower Pliocene with its escarpments being exceptionally unstable and developing a whole array of slope movements. As early as in 1620-1630, there was a mighty slope deformation that completely destroyed the village in the foot-hills. The upper part of the summit experienced a vast rock collapse and block movements, the lower part had a heavy earth flow. The accumulation reached the bed of the Marecchia River, which was blocked. The total length of the slide is over 1000 m. Later on, there was a certain revival of the movements, and the last movement in the 50's of our century was several meters long. A part of the territory situated on the Pliocene claystones suffers from intensive erosion and forms an extensive relief of the calanchi type (several kilometers in length). The contact between the sandstone summit and claystone pediment is markedly tectonic, having the character of a mildly tilted overthrust fault.

The summit of Monte Carpegna and its surroundings

(1415 m)

The mountain massif of Monte Carpegna (1415 m) forms a SE boundary of the Marecchia River. divide. The rock basement is built of flysh Pietraforte-Alberese Formation which is a typical flysh with siliceous and calcareous sandstones, claystones and siltites of the Upper Cretaceous up to Eocene. Predominant are sandstones and calcareous claystones. The flysh sediments form olistolites or outliers of higher overthrusts on the bedrock of the chaotic argille scagliose complex. Locally occurring are blocks of serpentinites, gabbro and reddish-brown claystones (Centamore - Pambianchi - Deiana - Calamita et al., 1991). The slopes of Monte Carpegna exhibit intensive slope movements of which particularly extensive are structurally conditioned block deformations. The favourable attitude of layers results in the movement of entire slopes and in the development of deep tensile fissures. The whole area is being tectonically uplifted (4 to 5 cm per year) and there is also a further development of the slope movements. The situation reflects in a low population density in the region. The local roads are not rescued with expensive piles and anchoring; when local slide movements appear, the embankments are given additional tips and the surface is being repeatedly repaired.

The Furlo coombe

(canyon of the Candigliano River, 13 km to the SE of Urbino, the Marche Apennines)

The Candigliano River (right-hand tributary of the Metauro River) formed an expressive canyon-like valley with walls high 200 up to 300 m, at some places up to 600 m. The canyon was gouged out in the anticlinal structure of a carbonate group of nappes in the Pliocene. In the lower part of the canyon, near the settlement of Furlo, the Candigliano River formed a typical coombe with steep rock walls. Not far from Furlo, there is an inactive quarry with the basic lithostratigraphical succession of the Jurassic up to Lower Cretaceous sediments. There were roads with tunnels (the so called Via Flaminia from Rome to the Adriatic Sea) running through the coombe as early as in the periods of Etruscan and Roman civilizations. A tunnel constructed at the turn of the Gregorian epoch (Roman period) is still used for the local traffic. At the present time, the main traffic vein leads through the motorway tunnel. The valley floor is flooded with a dam lake which is nearly silting up, however.

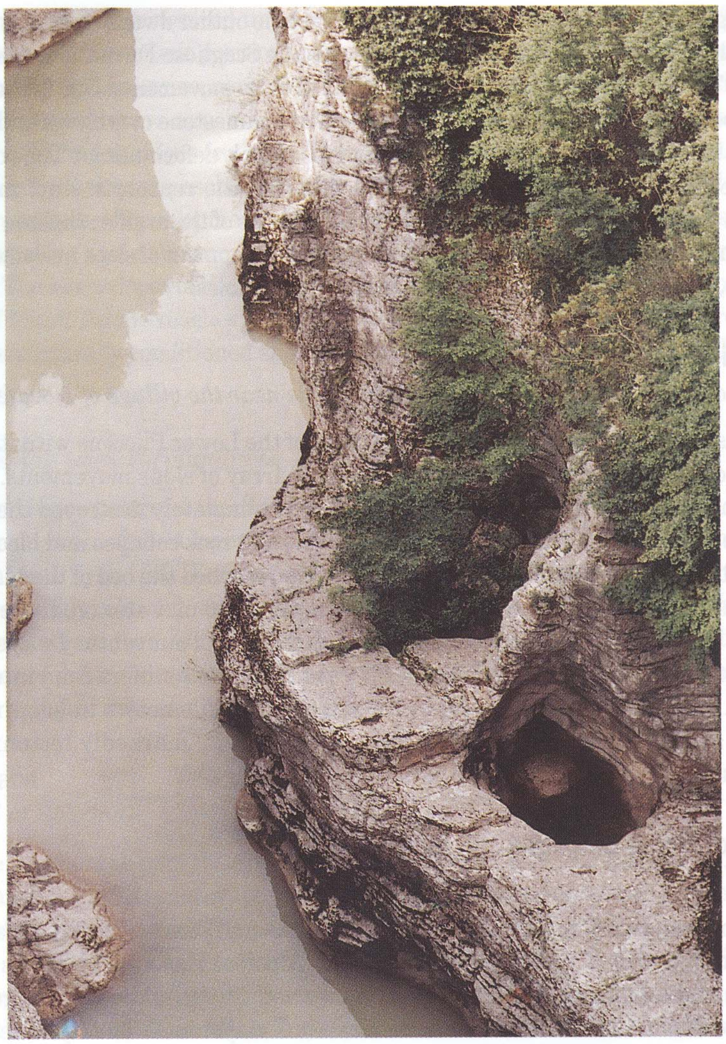

***Fig. 2:** Large rock pot holes are developed in the Maiolica Formation limestones (Lower Cretaceous) in the Metauro River coombe in the village of San Lazzaro. Photo O. Krejčí*

San Lazzaro
(valley of the Metauro River, 12 km to the SE of Urbino, the Marche Apennines)

In the settlement of San Lazzaro, the Metauro River formed a deep coombe in the rock bottom of which (Maiolica Formation limestones) there are large pot holes gouged out to diameters of 3 to 4 m and deep several meters. The presumed age of the coombe is Würm. The geomorphological research discovered a palaeocurrent (aged 20 to 30 thous. years) together with the coombe, filled with gravel sediments (Nesci - Savelli - Veneri, 1992). The valley slopes on the left bank of the Metauro R. are covered with thick Quaternary sediments (debris assorted by frost). The parent rock built of plate limestones and marlstones (Scaglia Bianca and Rossa Formation) is deeply disturbed by fissures. Also, there are extensive slides here whose length is about 2 km. The main slide originates from 1932-1933. The historical photographs show that its character was that of enormous blocks with the debris cover. Today, the slide bears abundant vegetation. At that time, the material losses were great. The slope movements are repeatedly activated, both due to the precipitation and the tectonic activity in the region.

The Borghetto slide
(Ancona)

One of the largest slide areas in the region is situated to the NW of Ancona (the Borghetto slide). The area exhibited some movements already in the past. In 1919, the Borghetto slide was mapped, the protection of the area improved and the slide monitored. Yet, construction works went on in the area since the building sites had a favourable position in the close vicinity of the port. Strong movements occurred on 12 and 13 December 1982 when the local Faculty of Medicine, hospital, coastal highway, railway were destroyed together with a number of luxurious villas. The slide area is 1000 m long and 2000 m wide and is composed of a great number of blocks with rotational slip planes. The building of the old post office from the 17th century still bears marks on which the respective movement stages can be seen with the most pronounced movement starting from 1860. The rock basement is formed by clays of the Middle Pliocene to Middle Pleistocene age with incoherent sand inserts. The movements are predisposed by the internal structure - a shallow brachysyncline and fault fractures. The syncline axis runs parallel to the coast and the interlayer slips support the slope movements (Manciavelli - Pambianchi, 1986). The slide is still active although the rehabilitation works are costly and extensive. The geophysical documents indicate that some slide planes reach as deep as below the sea bottom and can put into danger the planned extension of the port. A by-pass communication is being built in the adjacent part of the port. The construction works will call for further research and more massive sanitation elements since the original ones such as drilled drainage wells with horizontal drills are no longer functional.

The Conero Natural Park

(the Portonovo area some 10 km to the SE of Ancona)

The natural park is established to conserve and protect important geological and geomorphological phenomena and the character of natural environment in this coastal region. The area of Portonovo is one of the most attractive parts, with steep rock cliffs falling into the Adriatic Sea. The cliffs are formed of Mesozoic Maiolica Fm. limestones (Coccioni-Moretti-Nesci-Savelli et al., 1997) and of various Miocene lithostratigraphical units of the faulted Apennine Foredeep. The rock escarpments of mainly Mesozoic carbonates exhibit massive slides which have the character of rock collapse. At the very foot of the cliffs, there are great accumulations of debris and collapsed rock blocks. The gradient of the escarpments indicates three stages of the developing abrasion cliff. There is an evidenced withdrawal of the abrasion cliff by 2-3 km over the last 10 000 years. The very fast process represents hundreds of meters in the historical time.

MAPS

In Italy, there are frequent disastrous landslides and floods occurring nearly every year. This is why the country has a very good methodology of assessing the geodynamic phenomena and of setting up maps of hazards taking into account the occurrence of floods and slides. The land slide phenomena are particularly damaging in areas built of incoherent volcanoclastics, flysh rocks and on coasts with the severe effects of marine abrasion. The slope deformations can also be initiated by strong earthquakes. Since the mentioned natural processes are a serious problem, the Italian experts run the AVI Project (Aree Vulnerate Italiane per alluvioni e frane) under the patronage of Department of Civil Protection existing at the Ministerial Board of Italy and the National Group for the Prevention of Hydrological Hazards. The Project included an inventory of slides and floods in the period between 1918-1990. Bibliographies were worked out by 17 teams of researchers from 350 000 newspaper records, 1400 published or unpublished research reports and 150 interviews with specialists in the given problem. One of major results of the Project is the development of a database containing over 30 000 articles published in 22 periodicals and digital archives with the information about as many as 11 455 landslides and 5 385 floods, available on Internet. There is also a set of regional records with the list of areas affected by floods and landslides that was supplied to the territorial administrative bodies. The results were cartographically worked out into a „Map of areas affected by landslides and floods – AVI Project“ (Scale 1:1200000) (Guzzetti-Cardinalli-Reinbach, 1996). All landslides and floods are plotted by regions, provinces and catchment basins. The map sheet has an enclosure of three complementary maps with a number of diagrammes and a table capturing the landslides and floods in the respective provinces in the period from 1991-1995. The additional maps express the type of damage after the slides and floods, the frequency of floods, and the number of floods and slides in the catchment basin of the Tiber River. The Tiber River basin map at a more detailed scale contains a larger amount of information about the distribution of landslides (1504) and floods (950) in the comparison with the Tiber River. catchment basin on the less detailed main map (674 slides, 208 floods). Interesting data are also included in the diagrammes accompanying the complementary maps. For example, the diagrammes accompanying the Map of Flood Frequency describe the number of inundated localities in the individual regions expressing at the same time how many times the given localities were flood-afflicted. The greatest number of inundated localities (392) was found in the Veneto region. In the given period of 1918-1990, the localities were flooded three times. A certain shortcoming of the map work is the absence of mentioning the scale of the complementary maps.

During our stay in Italy, we were given a chance to get acquainted with some detailed geomorphological maps whose setting up was contributed to by the experts from the visited institutions. A feature common to all maps is the detailed areal description of geological conditions (type and age of rocks). Tectonic and structural characteristics of the parent rock are expressed by marks. Relief forms (both destructive and accumulative) are also expressed by marks. Two geomorphological maps depict in details territories that are very small in terms of their acreage: the sea coast between the towns of Pesaro and Gabicce at the scale of 1:20 000 (Elmi - Nesci, 1988), and the summit of Monte Titano with the surroundings at the scale of 1:10 000 (Guerra - Nesci - Savelli - Tramontana, 1995). The relief forms are distinguished genetically with the marks also illustrating the impact of present-day geomorphological processes (water erosion, sliding, solifluction). In the Map of the Physical Environment in the Marche Region that was set up at the scale of 1:100 000 (Centamore - Pambianchi - Deiana - Calamita et al., 1991), geomorphology is only one of the parts. This complex map also includes geology and hydrogeology. The geological part, in particular, is very detailed and mentions the classification of rocks by their permeability in addition to their type and age, and the tectonic elements. The geomorphological part illustrates the relief forms by their genesis with anthropogenic forms being plotted in details. The Geomorphological Map of the Po Plain at the scale of 1:250 000 (Castiglioni et al., 1997) is a unique map piece of work. It consists of three sheets which are supplemented with geological cross-cuts and a structural-geological map of the Po Plain and its surroundings at the scale of 1:2 000 000. It contains the areal plotting of accumulation forms with colours and hatching used to distinguish their genesis (glacial, fluvial, glaciofluvial, fluviolacustrine, slope, marine, eolian, anthropogenic forms). The fluvial forms are for example further distinguished by grain size and surface gradient with the relative height of river terraces being expressed, too. It is possible to make a statement that the map gives a true picture of the high diversity of the relief genetics and forms in the given area and its cartographical workmanship is highly cultivated. The same applies to the previously mentioned maps. Legends of the geomorphological maps react to the character of the mapped territory with typical categories of forms being worked out into detail. Schematization is not used at setting up the legends. The discussed geomorphological maps are not only of a very high scientific value but they also have a practical significance having been worked out with taking into account the needs of the territorial administrative institutions.

CONCLUSION

The official journey to Italy brought some new knowledge about the geology and geomorphology of the Northern Apennines, particularly about contemporary modelling processes. The information will be used at the solution of grant projects assumed by our workplaces. Also, the methodological experience from the creation of geomorphological maps will be employed at the geomorphological mapping in our country. Discussions with our Italian colleagues resulted in a decision to continue in the mutual cooperation on themes that can be jointly worked upon within related tasks and grant projects. Interesting themes for the cooperation appear to be the dynamics of slope processes, the biostratigraphical correlations of Tertiary and Mesozoic flysh sediments, the correlations of foredeep Tertiary sediments, the study of Quaternary sediments, and the development of drainage patterns. Considered is also an exchange of experts studying for the doctor's degree.

We would like to thank our Italian colleagues: Prof.Dr. Carlo Elmi, Prof.Dr. Olivia Nesci, Prof.Dr. Danielle Savelli and Dr. Elvio Moretti for making the short attachment possible for us, for all valuable information provided during the excursions and discussions, which contributed to the successful fulfilment of the purpose of our trip.

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THE 4TH CZECHO-SLOVAK ACADEMIC SEMINAR IN GEOGRAPHY

Oldřich MIKULÍK, Peter MARIOT

The already 4th Academic Czecho-Slovak seminar in geography was held at the Institute of Geonics, Academy of Sciences of the Czech Republic in Brno from 8 - 9 December December 1999 its theme being the „Topical aspects of the territorial structure of the Czech and Slovak Republics".

In four years the organizers succeeded in linking with the former forms of cooperation and extending the contacts among the young scientific workers of the Institute of Geography, Slovak Academy of Sciences and the Brno branch of the Institute of Geonics, Academy of Sciences of the Czech Republic. there were 17 papers presented on the first day of the 2-day Seminar; the second day was devoted to the issue of karst regions and included an excursion to the area of the Moravian Karst.

The first block of papers presented in the morning was traditionally composed of contributions of the guests from the Institute of Geography, Slovak Academy of Sciences in Bratislava. In his opening presentation Vladimir Ira assessed some aspects of the territorial structure of living standard in Slovakia.

Daniel Kollár discussed the territorial aspects of innovation activities performed by industrial enterprises of the Bratislava conurbation from the viewpoint of spatial aspects. The industrial facilities are not isolated within the space but rather tied by the commitments of supplier-customer relations with a huge amount of other entities. In this context, the speaker presented a comparison of an actual territorial structure of the turnover scored by the industrial facilities with the territorial structure of their innovative activities since the existing network of business partners significantly affects also the spatial structure of the innovative activities performed by the industrial facilities.

Peter Mariot introduced in his contribution „Topical aspects of the position of the largest towns in the Slovak Republic" the results of the typification of Slovak towns with the population over 10 thousand inhabitants that is based on three criteria (religious structure of the population, structure of political preferences, intensity of criminality). Results of these typifications represent a new and original knowledge of the set of the largest towns in the Slovak Republic and of the relations between the studied characteristics.

Anton Michálek discussed poverty as a topical problem of the contemporary Slovak society. On the basis of obtained values for some characteristics he analyzed its spatial differentiation a identified the present regions of poverty in Slovakia. One of particularly interesting informations is a finding that there is a relatively large macroregion of poverty developing in Slovakia, which consists of 19 districts at the present time.

František Podhorský ficused his paper on the valuation of processes that induced the changed location of administrative units in Slovakia after 1989 and on the assessment of their consequences. It is above all the changed political situation after 1989, the split of Czechoslovakia and the constitution of the independent Slovak Republic, and the introduction of the new administrative arrangement of the state. These are reasons why the traffic on the main routes between Slovakia and the Czech Republic was heavily reduced and the originally intranational districts of the Slovak-Czech borderland became the frontier regions many of them suddenly appearing at a very disadvantageous position in the relation to the western economic structures.

The contribution of Peter Podolák concerned the issue of classifying the geographical structures. A set of basic characteristics of the structure and development of the population, mean life length and population density was used to illustrate the specific features of spatial aspects of Slovakia on the level of districts. The speaker pointed out the specific spatial aspects of demographic structure of the state territory in the evolution series of several last decades and paid attention also to the specific features of Slovak population development and structure as related to the theory of the so called second demographic transition.

Vladimír Székely dealt with the influence of the territorial and administrative division of Slovakia on the regional differentiation of unemployment. The new law treating the territorial and administrative division of the Slovak Republic resulted in a considerable spatial disaggregation of the country. There are 8 counties and 79 districts in Slovakia now. In 16 of the former districts, the original territory was split into 2 – 5 new districts in dependence to spatial links and political interests. In terms of the area, this territory is fully identical with 42 existing districts. The districts were used for an example analysis of changes occurring in the regional variability of unemployment in dependence on the changes of the territorial and administrative division. The results were compared with the generalized empirical knowledge, theoretical constructions and explanations of the influence of the spatial disaggregation on the increasing spatial differentiation of unemployment.

The block of papers presented in the afternoon was devoted to the contributions from the host working place. Eva Kallabová discussed the position of school leavers on the Czech labour market. From the viewpoint of the labour market the school leavers are one of risk groups. Their share in total unemployment is about 1/5 and the figure has been increasing being, however, markedly differentiated by regions. The great dynamics of the process results from the ever worsening standard and development of the Czech economy. From the viewpoint of the new territorial administrative units (since 1 January 2000), the worst availability of jobs for the school leavers is recorded in the counties of Ústí nad Labem and Ostrava with problematic counties being also those of Olomouc and Brno. The „National plan of employment“, issued by the Czech government, puts a particular emphasis on young people entering the labour market, which is in harmony with one of the directives of the European Union. A communication has been started on the lowest levels between the educational institutions and the state administration.

Hana Kellnerová presented in her contribution a comparison of commutation to Brno at the very beginning of the transformation period and today.

Viktor Jaroš presented an assessment of the situation on the labour market in Brno on the turn of 1998-99 with a special emphasis on vacant jobs. The increasing unemployment is markedly affected by the decreasing demand for labour power, which reflects in the shrinking offer of available jobs registered by the Labour Exchange offices. On the other hand, there is a lot of available jobs that are not registered by the Labour Office. The speaker discussed the extent and structure of this unregistered demand for labour power.

Barbora Kolibová informed in her paper of the topical aspects of the style of living experienced by the unemployed in the Ostrava-Karviná conurbation. The measure of unemployment in the region of Ostrava-Karviná is increasing due to the restricted coal mining, restructuring and modernization of technologies in industrial facilities. A selected group of unemployed people registered at the Labour Exchange offices in Ostrava and Karviná provided the material expressing by the means of a standardized questionnaire the opinions and approaches of people who suddenly found themselves outside the process of work.

Bohumír Trávníček informed the Seminar participants about the possibilities of connecting the Czech and Slovak Republics to the European network of speed railways. It is the different technical standards, directives and regularities of individual countries that lead to differences and have been complicating the global development of the railway systems within the integrating Europe. The process is expected to result in a unified complex of European railways, which would facilitate a fast and comfortable connection between towns and agglomerations, being also linked to the regional public transport.

Jana Zapletalová tried to compare the accessibility of the new regional centres on the example of South Moravia.

Alžběta Strachová presented a contribution concerning the issue of the perception of social transformation of the Czech society by workers in Brno. She informed that the period of transformation has not practically brought any particular change in working men's attitudes to the society due to its chaotic character, changes in employment, new social phenomena such as unemployment, homeless people and non-existence of a sole ideology. During the Communist period and in harmony with the Communist ideology the working men acquired a privileged position in the society and were encouraged to keep the awareness until 1990, being also stimulated by various incentives and benefits. It is these people who still expect the state to find a solution to the described phenomena by redistributing the funds similarly as in the past.

Oldřich Mikulík briefly evaluated the topical aspects of regional changes in the Ostrava region which exhibits high industrialization with all consequences resulting from the negative influence of economic activities of the man on the environment. The nearly unlimited preference of main industries (coal mining, metallurgy, chemistry) had an enormous impact not only on the landscaping and environment quality, but also on the condition and development of the whole socio-economic system in the region. The period of transformation raised a lot of problems that will call for a supraregional conception of restructuring the impacted territory.

The contribution of Antonín Vaishar dealt with the relation between the character of settlement and the floods on the example of the events from July 1997. The localization of human seats in the past, in the period of industrialization and extensive urbanization was documented on the example of three model areas of Hanušovice, Olomouc and Otrokovice. The paper presents three possible conceptions of flood protection of seats. It is a geographical conception which advocates a return to the construction of seats in protected locations, a technical conception consisting primarily in the improvement of dams, and a conception of accepting the flood danger, which is based on a presumption that an occasional flooding of some settled areas can be tolerated provided that measures will be made to minimize flood losses. It seems that at the present time all these conceptions should be adopted and accommodated to actual regional conditions.

Pavlína Hlavinková and Jitka Škrabalová presented a direct follow-up to the above topic. They tried to evaluate the regional aspects of the 1997 flood in the catchment of the Morava River where 538 towns and villages were flooded, estimated losses amounted to 60 billion CZK and 50 persons lost their lives. The losses than could not be expressed in figures included increased unemployment in the surroundings of industrial facilities which suffered an incurable damage and whose re-putting into operation would have been not economical, and the losses resulting from psychological problems of the afflicted persons.A great problem that complicated the rescue works was the collaps of communication systems and the poor discipline of people who did not respond to the announced evacuation. It was found out that the population is not prepared to respond to uncommon situations. The paper presented characteristics of some model regions and a summary of knowledge from the course of the flood in the areas of Hanušovice-Jindřichov, Bystřička-Mikulůvka-Růžďka, Bochoř-Troubky-Vlkoš and Otrokovice.

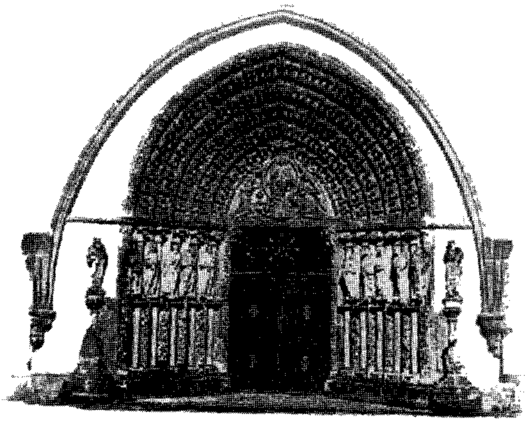
The mutual long-term exchange of information and experience from the research programmes of both workplaces appeared very beneficial. The 5th Academic Seminar is to be held in Bratislava towards the end of 2000. It will conclude the first period of the mutual communication and it is believed that it will lead to joint proposals of the new forms of international cooperation in the future. The Seminar proceedings will be issued in the first half of the year 2000.

4th Moravian Geographical Conference CONGEO ´01

NATURE AND SOCIETY IN REGIONAL CONTEXT

September 10-14, 2001

Tišnov, Czech Republic



Dear colleagues,

We have the honour of inviting you to the CONGEO ´01 conference on NATURE AND SOCIETY IN REGIONAL CONTEXT. It is the 4th of the Moravian geographical conferences, which continues in the tradition of biennial international meetings of geographers and other scientists dealing with regional problems. The conference is aimed at accelerating the international collaboration in regional research and at improving the acquaintance of the scientific public with the research achievements of prominent geographical workplaces. The tradition of the CONGEO conferences binds the organizers to create a familiar milieu for 30 - 40 scientists not only to present their papers but also to discuss informally and to conclude personal contacts. The atmosphere of a pleasant hotel in a small Moravian town helps to achieve the goal. Program of the CONGEO '01 conference will consist of a block of paper (poster) presentations, bilateral discussions, an excursion and social activities. We ask you kindly to send preliminary registrations including themes of papers by the October 31, 2000 at the latest. Working language of the conference is English.

CONFERENCE TOPIC

The topic of CONGEO '01 conference includes wide issues of regional geography:

- **Central and Eastern Europe: nature and society in the period of transition**
- **Changing urban environment: problems of sustainability**
- **Old industrial centres: structural changes, revitalization, environmental remedies**
- **New role of small and medium towns in regional development**
- **Disasters and their natural and social consequences**
- **Landscape protection and its social aspects**

For more informations please see *http://www.geonika.cz/congeo_01.html*

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EDITORIAL

Since 1 January 2000, there have been some changes made in the Moravian Geographical Reports Editorial Board. Dr. Antonín Ivan from the Institute of Geonics, Academy of Sciences of the Czech Republic, Branch Brno resigned due to health reasons, and Dr. Alois Matoušek from the Faculty of Paedagogics, Masaryk University in Brno, resigned the reason being his leaving the Department of Geography at the University. The Editorial Board thanks the two colleagues for their long-term contribution to the profile of the periodical and believes that they remain helpful at its future publication.

The Editorial Board addressed two experts from countries of the European Union, specialized in the issue of the transforming central European countries: Dr. Francis W. Carter (School of Slavonic and East European Studies, University of London), and Prof. Fritz Hönsch (Leipzig), who were nominated new members of the Board upon their approval. Invited to cooperation was also Dr. Jana Zapletalová from the Institute of Geonics Brno.

The Editorial Board wishes the new members much success at their function and would like to encourage them to contribute both as authors and in the form of consultations or reviews to achieve an even better standard of the Moravian Geographical Reports.

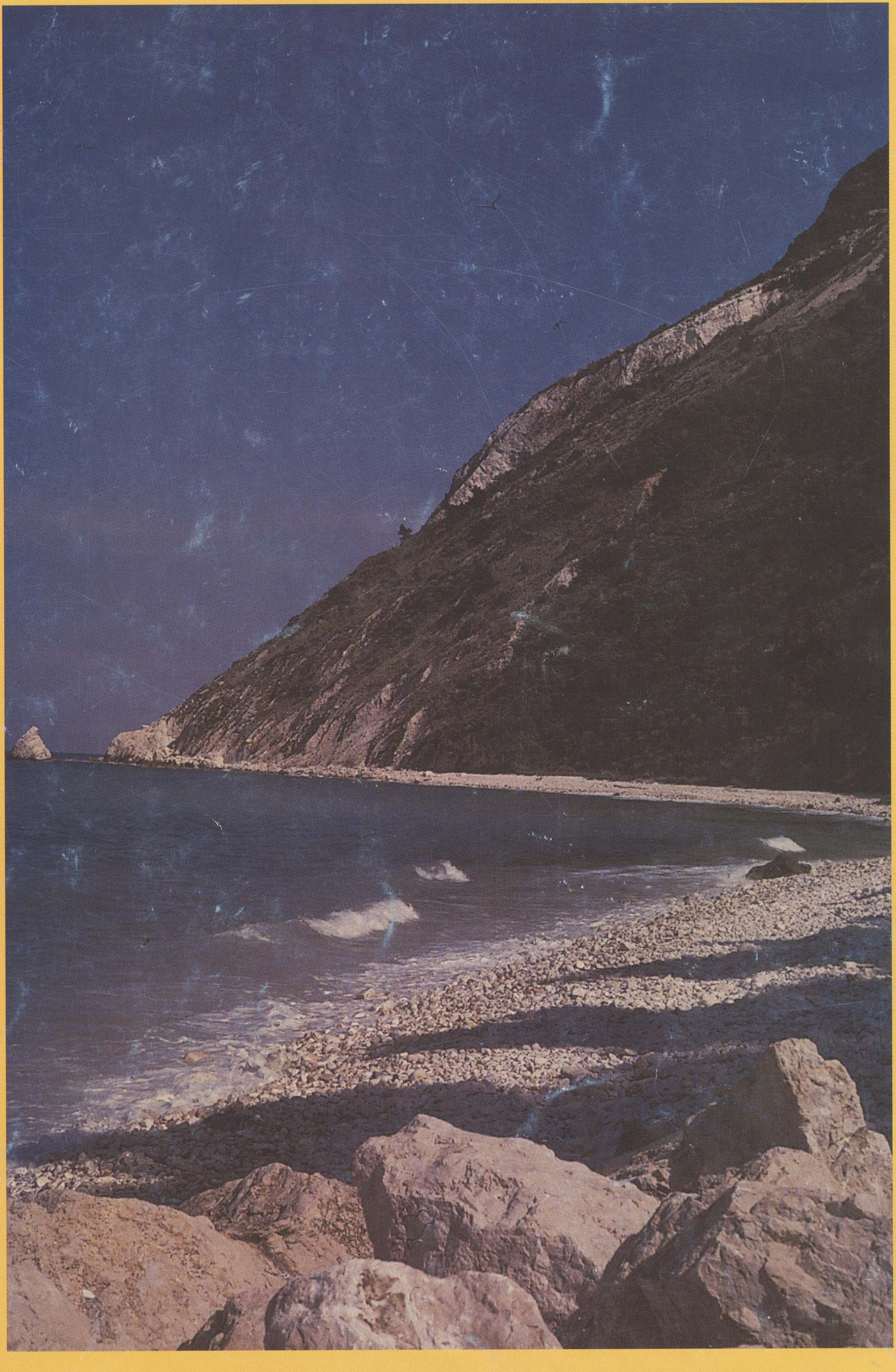
The isolated summit of Rocca di Maioletto (624 m), built of claystones and sandstones (Lower Pliocene), is intensively modelled by rock fall, block movements and earth flows. The calanchi-type of relief is typically developing at the foot.

Photo: O. Krejčí

The surroundings of Monte Sabbiuno: The hilly land and upland relief built of clays and claystones (Upper Cretaceous-Eocene) is heavily dissected by linear erosion in order to give rise to a badland-type area, locally called calanchi.

Photo: O. Krejčí

Illustrations to K. Kirchner´s, O. Krejčí´s and A. Ivan´s paper



The Conero Natural Park, the Portonovo area SE of Ancona. The limestone cliffs (Maiolica Formation – Lower Cretaceous) have a typical abrasion cliff with a narrow gravel beach in the lower part.

Photo: K. Kirchner

Illustration to K. Kirchner´s, O. Krejčí´s and A. Ivan´s paper