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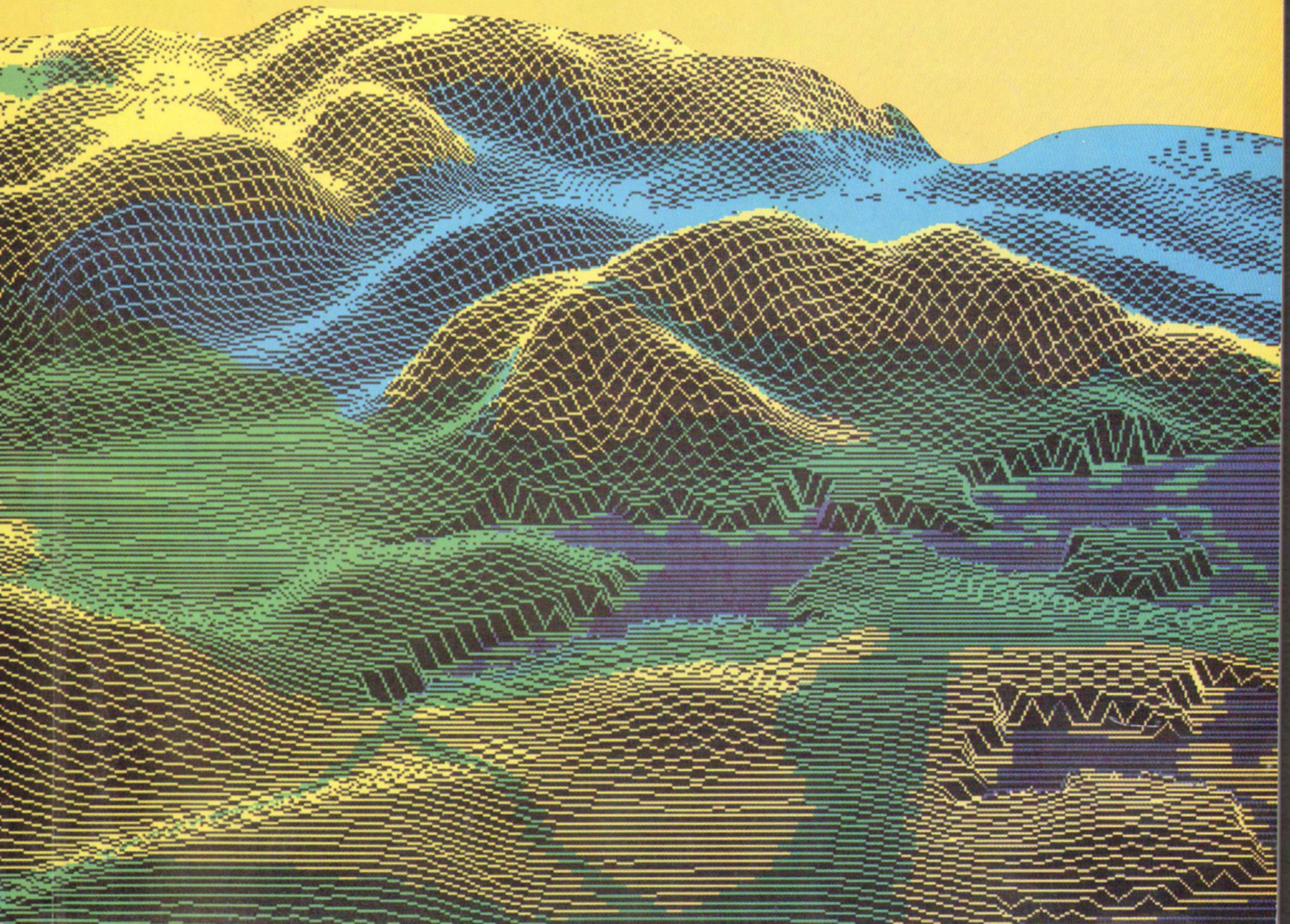

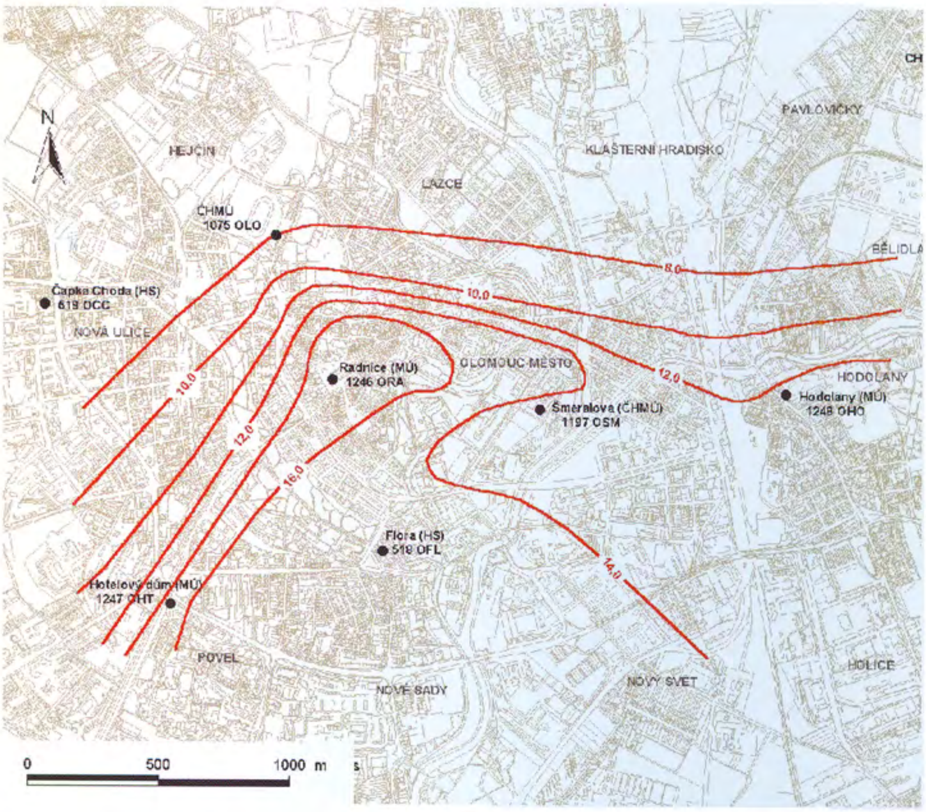

Fig. 3: Spatial distribution of SO_2 in Olomouc 1991 – 2000

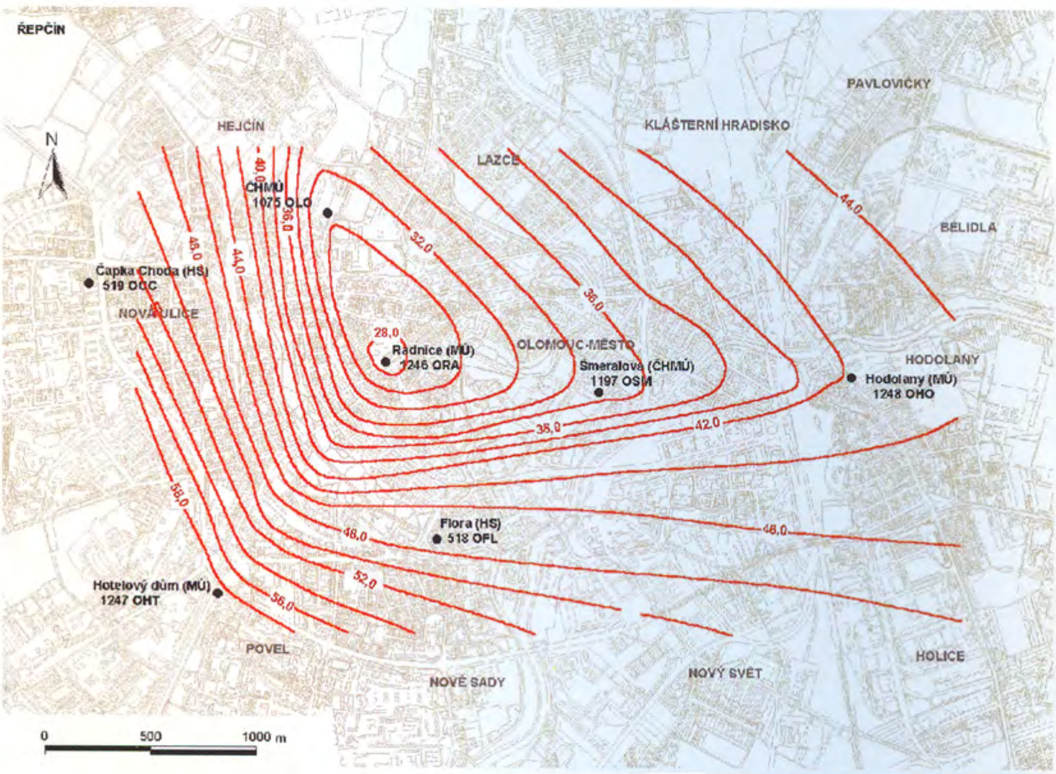

Fig. 5: Spatial distribution of NO_x in Olomouc 1991 – 2000.

Illustrations to the paper of M. Vysoudil, M. Jurek

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TOWARDS A GEOGRAPHY OF SUSTAINABLE DEVELOPMENT AND/OR SUSTAINABILITY?[1]

Bryn GREER-WOOTTEN

Abstract

Conceptual analysis reveals strong differences in the meanings of 'sustainable development' and 'sustainability'. The inter-relationships between economic, environmental and socio-political dimensions of sustainability are intricate and complex, revealing some new methodological challenges. The role of Geography, as a discipline, in exploring these relationships appears to be quite sound for the case of sustainable development. In comparison, the demands posed for research on sustainability, with the prominence afforded to governance issues, call into question many of the traditional approaches in Geography. An outline of potential responses to these questions is presented, together with some examples taken from research carried out in Canada.

Shrnutí

Ke geografii udržitelného rozvoje či udržitelnosti?

Pojmová analýza odkrývá velké rozdíly mezi významovým pojetím trvale udržitelného rozvoje a udržitelností. Vzájemné vztahy mezi ekonomickými, environmentálními a sociálně politickými dimenzemi udržitelnosti jsou komplikované a komplexní a odhalují některé nové metodologické otázky. Úloha geografie jako vědní disciplíny se zdá být v případě trvale udržitelného rozvoje pro zkoumání těchto vztahů velmi podstatná. Na druhé straně, požadavky kladené na výzkum udržitelnosti, s důrazem věnovaným problematice řízení společnosti, zpochybňují mnoho tradičních geografických přístupů. K těmto otázkám nabízí článek nástin možných odpovědí spolu s některými příklady převzatými z kanadských výzkumů.

***Key words**: sustainable development, sustainability, governance, Canada.*

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1. Conceptual distinctions between sustainable development and sustainability.

An examination of the different meanings given to the concepts of 'sustainable development' and 'sustainability' is enhanced by recounting their origins. Some commentators open their history books in 1972, with the publication of The Limits to Growth (Meadows et al., 1972). Still more would point to the World Conservation Strategy (IUCN, 1980), an effort to demonstrate that continuing levels of economic development were not sustainable. In fact, the first use of the word 'sustainable' occurs in this document (with some minor quibbles: see MacNeill, Winsemius and Yakushiji, 1991). Adding the word 'development' to 'sustainable', however, is indelibly linked for virtually everyone, to the report of the World Commission on Environment and Development (1987): Our Common Future, a report and commission popularly named after its chair, Gro Harlem Brundtland. It is from the Brundtland Commission that the oft-repeated definition of sustainable development became common-speak: "...(development) that...meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8).

Inevitably, 'sustainable development' was and remains a highly contested notion: the Brundtland report generated a verbal industry, with contributions ranging far beyond the academy, to include world leaders and politicians of all stripes, prominent executives from the private sector ('The Greening of Business'), and members of Non-Governmental Organizations (NGOs), including those from the environmental movement. The proposition that economy and environment could somehow be reconciled, to meet the notion of 'balance' at the core of sustainable development, had the comforting ring of 'Mother's apple pie': who could be against it? Of course, there were critics, largely from the academy (Redclift, 1987) but also from the environmental movement (Jacobs, 1991), who pointed out, inter alia, that the concept had been hi-jacked by the corporate sector and that it did little for the fundamental problems of poverty in the Third

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[1] This paper has been developed from a seminar presented at the Institute of Geonics, Brno Branch, on February 20, 2003. I would like to acknowledge, in particular, the comments and questions posed by RNDrs. Antonín Vaishar, Jana Zapletalová, Mojmír Hrádek and Karel Kirchner, which were extremely valuable in reformulating several propositions from the seminar.

World, which had been, after all, the primary focus of the Brundtland Commission's mandate (Lélé, 1991).

It is not my purpose here to present a detailed review of these debates: for some such recent work, see the conceptual overview by Bell, Halucha and Hopkins (2000, available from the York Centre for Applied Sustainability web-site: see Appendix); a recent statement on industry's perspectives on 'eco-industrial strategies' (Cohen-Rosenthall and Musnikov, 2003), one aspect of the on-going debate about ecological modernization (Tibbs, 1993); the continuing political debates (see Baker et al., 1997, with special reference to the European Union); and David Harvey's (1996) magisterial contextualization of the issues. Similarly, space forbids inclusion of important arguments concerning the development of sustainability indicators (Moldan and Hák, 2000), as well as extended discussion of the role of civil society (Fagin, 1999).

Rather, I wish to examine the most cogent criticism that has been levelled at the earlier euphoria over the Brundtland report: the distinctions that exist between 'sustainable development' and 'sustainability', inferring some implications of these distinctions for geographic research. My experiential base is located in Canadian responses to the Brundtland Report, but I attempt to generalize the findings beyond this particular case.

First, however, I must complete this incomplete historical account: 1992 witnessed the UNCED (United Nations Conference on Environment and Development) Rio de Janeiro 'Eco-Summit' (promised five years after Brundtland: see Thomas, 1994, for an informative review), and for our purposes here, the important (Local) Agenda 21. Most recently, we have seen the next global leap of faith to the WSSD (World Summit on Sustainable Development) held in Johannesburg in 2002. Ironically, perhaps, these pre-programmed events reflect the criticisms made in more academic literature, in that the rhetoric of sustainable development from well-publicized speeches from leading politicians hardly touches the reality of continuing poverty for most Third World nations: there is no balancing of environment and development, to judge from deepening levels of disparities. 'Balance' may be necessary, but does not appear to be sufficient.

It now seems clear that the original 'core' notion of balance for sustainable development was too simplistic: the concept of 'balance' requires some prior assumptions concerning what it is that has to be balanced – in Brundtland's case, economy and environment. A balancing act also implies strongly that economy and environment are competing in some manner, perhaps in the pursuit of 'development'. Placed into a discourse that is grounded in competition, one has the realization that 'sustainable' development was conceived as development that somehow allowed environmental impacts to enter into its equation – hence the balancing. Some 'invisible hands' would be required for this to happen, of course; at least some guidance, implicitly from 'above' (i.e., corporate interests).

Absent the 'competition', however, and the discourse changes in a subtle but profound way: rather than balance, one is necessarily steered towards 'integration' – economy and environment are parts of the same set of societal processes. This is even more marked when one defines environment not simply as the bio-physical milieu but also as the socio-political context in which decisions about development are made. Clearly, it is not only the discourse arena that changes, but all actors in the development play would have re-written roles to perform. Rather than 'from above', a multiplicity of voices is now engaged: this is sustainability. It has a different edginess to it: like an evolutionary pathway, there can be set-backs, side-steps – the linearity of 'development' (as in sustainable development) has vanished.

The distinctions drawn here are strongly phrased, in part because I believe that they are so distinct, in part because in this way the subsequent impacts on geographic research can be more clearly delineated. Such distinctions, in fact, are captured so well by the subtleties of the Czech language, between *'vývoj'* and *'rozvoj'*[2]: between 'sustainability' and 'sustainable development', between 'integration' and 'balance'. Integration demands that one considers the inter-relationships of concepts in terms of both analysis and implied action.

In the final analysis, 'sustainability' must be regarded as a necessary and sufficient framing of 'sustainable development', as defined in such a succinct manner by David Bell and associates (Molnar, Morgan and Bell, 2001):

"***Sustainability*** is an approach to decision making that considers the interconnections and impacts of economic, social and environmental factors on today's and future generation's quality of life. It is a dynamic and evolving notion, and as a process, it strives to be participatory, transparent, equitable, informed, and accountable."

Furthermore, there is a direct corollary: "***Sustainable development*** is development (economic or otherwise) that incorporates the notion of sustainability (see above definition) into the decision-making process." (Molnar, Morgan and Bell, 2001, p. 34).

[2] These distinctions, as well as many other subtleties of the Czech language, have been illuminated to me in many conversations with RNDr. Svatava Ondráčková and Mgr. Josef Šťáva, in the course of intellectually stimulating sojourns in Jackov, seven minutes drive West from Moravské Budějovice.

These distinctions in definition are more than semantic: they imply distinctly different ways of both representing the problem at hand and of then deciding how to participate in the resolution of such problems. As we shall see, such a paradox has direct implications for the research that geographers might engage in, with respect to sustainable development or sustainability.

2. The inter-relationships of economic, environmental and social dimensions

Many discussions of sustainable development implicitly neglect the social dimensions of sustainability, privileging then, the relations between economy and environment (Bell, 2000). Such an approach regards 'environment' as equivalent to the natural resource base on which economic development is built, particularly in terms of the energy inputs into productive processes. At the same time, numerous 'free' goods (such as air and water, minimally) from the bio-physical environment are ignored (or, at least, not subject to monetary evaluation), as well as inputs from the social environment (labour, minimally). That these three components of economic and social well-being are highly inter-related is quite evident to all but the most reductive of scientific attempts to understand them.

If one was to take only the economic dimension into account, then clearly we are talking about the effects of previous 'unsustainable' development. The non-sustainable nature of economic development is shown when one incorporates the environmental effects, revealing bio-physical limits and the huge impacts shown by ecological footprints (Wackernagel and Rees, 1996). But the social dimensions cannot be ignored: one witnesses socio-economic disparities resulting from 'normal' economic development, in almost all nations at virtually all times in the past (intra-generational equity issues), as much as in the present, let alone the future (inter-generational inequities). All three dimensions must be brought into a single analysis.

Some of these inter-connections are shown in Tab. 1 – 3, which are meant to be illustrative (i.e., not definitive) of some of the elements of the relationships. Any one of the rows of the tables can be read for its direct and indirect associations with other rows. For example, from Tab. 1 the 'bio-physical' problems of air quality, common to most urban areas and thus germane to further arguments below, are clearly registered in costs for health-care services, as well as the physical remediation of buildings. Further, the effects are more frequently recorded for the more vulnerable segments of society, seniors and the young, and are thus socially discriminatory. From Tab. 2, one notes the costs of pollution prevention in terms of a possible proactive set of services for remedial action, yet the overall effects can be a loss of work capacity.

In terms of human health (Tab. 3), there are again the direct (reactive) and indirect (proactive) costs to consider, as well as social inequities. In many ways, it should not be surprising that the inter-relationships between economic, environmental and social aspects of sustainability demonstrate, in many instances, the health effects of unsustainable development.

It is also not surprising that the direct effects of bio-physical environmental problems are dissipated across the other components of interest: it is an unfortunate reflection of the current state of knowledge of linkages, as much as it is a reflection of the inward-looking concerns of bio-physical environmental scientists (Lemons, 1994). Alternately, one might look to the development of 'civic science' as an antidote to the blindness concerning such linkages (Wynne, 1995). There are some important lesson for geographers that result from such an inference.

There are many generalizations that can be gleaned from an analysis of these tables. Firstly, it is clear that the inter-relationships demonstrate the inherent complexity of the issues faced in analyzing sustainability.

Furthermore, this complexity cuts across the typical sectors one might associate with elements such as 'health care', which clearly has all three dimensions implicit in its character as an issue: environmental, economic and social aspects. Take this one step further: "How, then, does one manage health care?". Clearly, sustainability requires some rather radical rethinking of how one imagines the delivery of services, such as health care.

It is also clear that in pursuing sustainability objectives, one is forced into thinking about the quality of life, rather than its quantity or some objective measure of livelihood. Bringing in the three elements requires a redefinition of standard of living or general socio-economic welfare. Furthermore, the orientation is definitely towards the future: no longer is it sufficient to analyze past or even current situations; rather, a necessary planning perspective is also required – as a practical outcome of the 'future generations' argument.

The various linkages between aspects of the three dimensions for various issue areas also have different weights or salience for interest groups in society (Greer-Wootten, 1994). As a first-level simplification, for example, it is clear that the private sector (corporate interests) will place greater emphasis on economic aspects of these relationships, regardless of post-Brundtland 'greening' pronouncements to the contrary. Equally, the civil sector (NGOs and similar public interest groups) would place a greater stress on the social – and hence political – aspects. There is, accordingly, a dilemma facing the public sector (government) in this complex situation. Is it able to perform the difficult integrating role required

Environmental Issues	*Some Economic Aspects*	*Some Social Aspects*
Natural ecosystems / land uses / biodiversity	Land prices	Availability of wilderness for recreational purposes
Quantity and quality of water	Price and availability of water	Water-borne diseases
Area, thickness and quality of soils	Cost of soil amendmentsand rehabilitation	Out-migration from farming communities
Air quality	Cost of repair to physical structures; health care costs (respiratory illnesses)	Hospitalization of vulnerable people (especially youth and seniors)
Ozone layer	Health care costs from increased incidence of cancers	Differential exposures (based on social class) and residence
Climate change	Insurance costs from storm damage (ice; floods)	Disruption of coastal and low-lying communities
Ecosystem research /Traditional knowledge /Indicators	Measurement of progress	Understanding of our surroundings

Tab. 1: The Inter-relatedness of Environmental, Economic and Social Dimensions

Source: Adapted from David V. J. Bell (2000), Social Dimensions of Sustainable Development (SD2), Discussion Document, Toronto: York University:York Centre for Applied Sustainability.

Economic Issues	*Some Economic Aspects*	*Some Social Aspects*
Quantity and quality of food	Price and availability of food	Hunger
Poverty, (un) employment, underemployment	Maintaining a decent Standard of living	Self – respect, dignity
Housing	Costs for social housing	Availability of decent living conditions
Conservation / depletion of natural resources	Price and availability of goods	Out-migration from mining and forestry communities
Efficient use of resources / throwing away resources as waste / recycling	Economic efficiency and waste disposal costs	Self – reliance
Pollution prevention /dangerous substances	Avoidance of costs forremedial action	Loss of work capacity
Development of green products	Eco-efficiency (competitively – priced products + few impacts)	Improved quality of life

Tab. 2: The Inter-relatedness of Environmental, Economic and Social Dimensions

Source: Adapted from David V.J. Bell (2000), Social Dimensions of Sustainable Development (SD2), Discussion Document, Toronto: York University: York Centre for Applied Sustainability.

Social Issues	*Some Economic Aspects*	*Some Social Aspects*
Human health	Health care costs from chemical and radiation exposures	Differential rates of disease by social group
Justice, human rights, autonomy, inter – generational equit	Ability of the next eneration(s) to maintain a decent standard of living	Freedom and equal opportunity
Internal safety and security	Costs for policing, border patrols, and correctional services	Fear of crime
Breakup of communities / stable society / heritage / culture	Continuing economic production capacity	Loss of unwritten history and understanding of traditional ways of life
Use of green products	Avoidance of remedial, rehabilitative, and health care costs	Satisfaction of basic needs
Management processes	Efficiency, relationships with trading partners	Consensus – building
Leadership, advice and consulting	Continuous improvements in efficiency and productivity	Sharing of knowledge

Tab. 3: The Inter-relatedness of Environmental, Economic and Social Dimensions

Source: Adapted from David V.J. Bell (2000), Social Dimensions of Sustainable Development (SD2), Discussion Document, Toronto: York University:York Centre for Applied Sustainability.

by these relationships? Is it structured in a way to respond effectively?

One argument that negates such a possibility is difficult to counter: the structure of government, from its elected representatives through to the usually powerful bureaucracy, is organized in such a way as to resist change. Ministries, Departments and the like are all organized along sectoral lines (Ministry of Agriculture, Ministry of Energy, Ministry of Health, etc.), vertical in more senses than one. In many ways these structures are not questioned as to correctness: at times, one wonders if this is not the unquestioned way in which 'we' accept that a 'liberal democratic society' is organized (implicit and explicit hierarchies)?

Inevitably, then, one asks if sustainability implies a 'sea-change' in societal organization and decision-making processes, compared to sustainable development which can be viewed as the more comforting 'business-as-usual'?

Implicitly, as well, there is a strong inference for the spatial aspects of all of these arguments: sustainability seems to imply forcibly that a 'correct' orientation by geographers to these questions would inevitably involve community or locality studies, since the role of civil society is at stake. In comparison, sustainable development qua 'business-as-usual', appears to substantiate traditional perspectives of 'the view from afar'.

3. The three dimensions and geographic scale: global, national, regional, local?

Given that 'sustainable development' is better defined as a subset of 'sustainability', the pertinent issues for a scalar translation can be characterized in a similar way to that of the Brundtland Report (WCED, 1987, p. 5), as follows: "Ecology and economy are becoming ever more interwoven – locally, regionally, nationally, and globally – into a seamless net of causes and effects".

The problem one is faced with, then, is defining partitions of the "seamless net": such definitional issues have plagued Geography since time immemorial. And these problems remain unresolved, as geographic space is continuous, as are the multi-dimensional spaces of decision making for both public and private sector actors. Further, the political 'reality' of national boundaries is today subject to debate, as the forces of globalization appear to reduce the legitimacy of the nation state. Does the alternate view invoking sustainability offer more promise, especially at the geographic levels of region and locality?

As a contextual container, 'region' is imprecisely defined, but it is a container of localities and is, itself, contextualized by the nation state: what have been the effects of recent changes in the global reach of economic development on such sub-national geographic spaces? For most commentators, these changes are seen in the context of various interpretations of globalization forces, which have had an interesting dual effect on research paradigms: as noted by Clark, Feldman and Gertler (2000, p. viii):

"For some analysts, difference and the heterogeneity of the economic landscape demand close, detailed analyses of the particular attributes of certain firms, regions, and industries. For others, particularity has to be balanced against larger economic forces operating at higher spatial scales: there is a tension between the local and the global and between fine-grained case studies and stylized facts."

The problem of scale, then, as an analytical problem, does not appear to be easily resolvable using traditional geographic approaches: it is almost as if 'anything goes?' Whilst I am not arguing for a uniform approach to this question on any sort of disciplinary grounds, I am intrigued by the possibility that 'sustainability' demands a new perspective on the issues and that it is, in fact, the 'integration' aspects [e.g., in not separating (or 'balancing') ecology/environment from economy and society] that propels such new approaches.

4. Deconstructing the conceptual framework: process and categorical barriers?

There are some interesting distinctions that can be developed from the responses to the Brundtland Report in Canada. In fact, following the visit by the WCED in 1986, the Canadian Council of Resource Ministers established a National Task Force to examine the implications of Brundtland for Canada, resulting in a highly influential report (Lecuyer and Aitken, 1987). Some of the recommendations were implemented almost immediately in most jurisdictions (i.e., federally and provincially), particularly evident in the establishment of multi-sectoral Round Tables on Economy and Environment. At the national level, the federal government introduced an optimistic 'Green Plan' in 1988 (much of which was forgotten as the government changed hands shortly thereafter), but there were some institutional changes of a longer-lasting structural importance: the House of Commons Standing Committee on the Environment and Sustainable Development (1990); a Federal Guide to Green Government (1995); and the office of the Commissioner of the Environment and Sustainable Development (1996).

It is important to note that the tenor of the discourse that surrounded these events primarily concerned sustainable development. Further it was largely governmental in nature, notwithstanding the importance of the multi-stakeholder decision-making structures and processes that were initiated. The actors in these debates originated largely from the elites in Canadian society, and not only from the private and public sectors, but also from the representatives of the NGOs involved.

In comparison, Canadian responses at the regional and local jurisdictional levels to Chapter 28 of Agenda 21 from the Rio Summit (popularly labelled as 'Local Agenda 21', as it called upon cities to develop appropriate responses to the demands of sustainable development), signalled new directions in the debates. Localities, and cities in particular, play an important role in sustainable development as engines both of economic change and environmental degradation (conversion of arable land to urban purposes, pollution from industrial establishments and automobile traffic, etc.). These new initiatives include the British Columbia Community Charter (2001), Nova Scotia's Sustainable Communities Initiative (1999), the Toronto Environment Task Force of 1998, which has evolved into a Sustainability Round Table (2000), and many others (see Bell and Grinstein, 2001, for a full account of these developments).

At these sub-national levels, importantly, the changes are not only structural but more broadly-based in terms of the stakeholders involved in redefining the roles of localities. In effect, there has been a redefinition of the ways in which sustainable development might be achieved. These changes concern governance. In many ways a radical notion, governance encompasses stronger roles for concerned publics. The 'ordinary' people have become members of decision-making bodies (primarily at local levels). Civil society is legitimized in this way. A new public language has emerged, replacing the stereotypical modernist discourse of traditional government.

The epistemological implications of these recent developments, for the discipline of Geography, are extremely important. To represent governmental responses to the problems posed by sustainable development in a traditional manner, is to continue modernist ways of thought, by accepting categorical ways of thinking. Breaking through these barriers demands a realization of the powers of thinking dialectically, with a focus on the processes of decision making – as well as an activist orientation to engagement in the process itself.

5. Governance / decision-making processes: key to sustainability?

Quoting again the definition of sustainability by David Bell et al. (2001): "...as a process, it strives to be participatory, transparent, equitable, informed, and accountable."

A clearly-defined, community-based governance strategy would focus on the integrated delivery of policies, programs and services. But, importantly, such a strategy would result from broad public, private and civic sector participation in the necessary decision-making processes. These processes must address the issues of the horizontal challenges associated with sustainability. The terminology "horizontal challenges" emanates from a political scientific view of the problems: clearly, there are some ironic implications of these ideas for geographical research!

Since local authorities are "...the level of governance closest to the people, (and they) play a vital role in educating, mobilizing and responding to the public to promote sustainable development" (Chapter 28, Agenda 21), the scale at which a proactive stance with respect to sustainability is established, is quite apparent. Hence, the designation "Local Agenda 21", locally-organised public consultation activities, which are co-ordinated by ICLEI (International Council for Local Environmental Initiatives) in Toronto. At local levels, the process itself is very complex, yet there are possibilities of social learning across cultures. Most of these efforts, like much recent academic research (see, for example: Portney, 2003) concern larger urban areas and cities, as for example in the 'Global Cities' research projects. The settlement system as a whole is rarely treated.

6. Conclusions: some implications for geographical research

In general terms, the implications of this argument for geographic research appear to be quite strong: following the rubric of 'sustainable development' does not appear to be that difficult – basically, requiring an up-dated version of an economic geography which includes, wherever possible, the costs and benefits of environmental impacts into the analysis of economic development. At national and global levels, there appear to be strong imperatives for including the more abstract arguments related to globalization. Environmental impact assessment procedures appear to meet these demands at local levels of analysis (Greer-Wootten, 1997, 1999), albeit with a greater attention to both context and political processes. At the same time, there are conflicting perspectives on geographic research at local levels.

Do the more traditional, modernist approaches for geographic research at local levels of analysis match the demands of sustainability? One interesting case for readers of this journal concerns the 'Small Towns in Moravia' study. From the viewpoint of sustainable development, one aspect of the work should incorporate the interactions of economy and environment in the context of the so-called 'new regionalism' (Brenner, 1999). This potential approach calls into question political economies of scale: in many ways, it is a set of theoretical questions. Yet, the joint consideration of urban and rural issues so common in small town discussions, the commonalities that join (small) town and country, call upon a different set of expectations. As a researcher, how does one access these important issues at the local level? How does the 'horizontal challenge' of sustainability affect small towns?

It seems quite evident that a different approach is needed to answer such questions, but one can be equally clear in stating that the approach must be one based on sustainability objectives, rather than the more simplistic aims emanating from a sustainable development perspective on the issues.

Acknowledgements:

This paper owes much to the inspiration of my colleague, David V. J. Bell, founder and past Director of the York Centre for Applied Sustainability (now transformed into the Institute for Research on Innovation and Sustainability), for his many writings and generous support of this research. I wish also to thank Charles Caccia, MP for Davenport (a federal riding in Toronto, Ontario), previously a Minister of the Environment and currently the Commissioner on the Environment and Sustainable Development, Government of Canada. Mr. Caccia delivered a provocative and informative series of seminars at York University, Faculty of Environmental Studies, in early 2001. All disclaimers apply, of course.

Appendix: some relevant web-sites.

(i) The York University Web-site for the Faculty of Environmental Studies is: <yorku.ca/fes>; a key link is to the York Centre for Applied Sustainability (YCAS): go to the search engine on that page, ask for David V. J. Bell and his publications [e.g., 'Community Indicators Network (RP-Cinet)'; a report on 'Sustainable Urban Communities: From Rio to Johannesburg' {produced for the Canadian government and its report to the WSSD}; 'Social Dimensions of Sustainable Development (SD2)' {produced for the Canadian Commissioner of the Environment and Sustainable Development for the Ottawa workshop, July 4 – 5, 2000}, etc.].

(ii) For the question of indicators, one of the best sites is: <sustainablemeasures.com> which takes one to the work of Maureen Hart.

(iii) An interesting project is 'Sustainable Toronto' – the so-called CURA project [Community University Research Alliance]: accessible from the YCAS site. The linkages between university and community groups give one a broader view of sustainability.

(iv) Another project linked to YCAS is the excellent on-going sustainability report produced by Michael Keating: <sustreport.org>.

(v) The site for the International Council for Local Environmental Initiatives: <iclei.org>.

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HYDROLOGICAL REGIME OF SOME SPRINGS IN THE UPPER ODER RIVER BASIN

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Abstract

The research area was the Upper Oder River Basin: from its springs to the Koźle gauge-station. The total area of the territory studied was 9,173.6 km². Field observations were carried out in the hydrological years: 1996, 1998, 1999 and 2000. In the course of field research in the Polish part of the river basin, 18 springs were chosen for periodical observations which were made at monthly intervals. In the Czech part, the study comprised nine springs, which are part of the Czech Hydrometeorological Institute (CHMI) observation network. Yields of the researched springs vary. From the time series measurement of spring yields, for most of the objects the yield is predominantly influenced by thaw water alimentation, and to a lesser degree by rainwater. Most of the researched springs have the thaw-rain regime. The Upper Oder River Basin is predominated by springs with yields of up to 1 dm³.s⁻¹.

Shrnutí

Hydrologická charakteristika vybraných pramenů v povodí horní Odry

Výzkum probíhal v povodí horní Odry po profil Koźle. Plocha takto vymezeného území je 9173.6 km². Terénní výzkum byl prováděn v hydrologických letech 1996, 1998, 1999, 2000. V průběhu terénních výzkumů bylo vybráno 18 pramenů na území polské části povodí, kde byl výzkum v daném období prováděn v měsíčních odstupech. V české části bylo zkoumáno 9 pramenů, které patří do pozorovací sítě CHMÚ. Vydatnost zkoumaných pramenů je různorodá. Z provedených analýz časových řad měřených vydatností pramenů je možné tvrdit, že ve většině případů vydatnost ovlivňují vody z tání sněhu a v menší míře vody dešťové. Zkoumané prameny jsou charakteristické režimem, který je typický pro prameny, jejichž zásoby jsou doplňované sněhovými a dešťovými srážkami. V oblasti horního povodí řeky Odry převažují prameny o vydatnosti 1 dm³.s⁻¹.

***Key words**: hydrology, spring, groundwater, hydrological regime, Upper Oder basin, Poland, Czech Republic.*

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1. Introduction

Springs represent one of the forms of natural groundwater outflow to the ground surface. They are one of the most spectacular manifestations and evidence of water circulation in the nature. Specific location of the spring in the water cycle makes it a kind of link between the underground and the surface circulation. Knowledge about the distribution, characteristics and chemical composition of springs is one of the most important premises helping us to learn about hydrological and hydrogeological conditions in the territory. Springs are also extremely interesting components of landscape – both as natural niches and with their accompanying architectonic structures (Absalon, Jankowski, Matysik, 1999; Jokiel, 1997).

2. Researched area

The researched area was the Upper Oder River Basin: from its springs to Koźle gauge-station. Total area of the investigated territory was 9,173.6 km².

As regards morphology, the Upper Oder River Basin is a very diversified area comprising the following physico-geographical units: the north-eastern edge of the Czech Massif – Jeseníky Massif, West Carpathians represented by the Silesian Foothills, Silesian Beskids, Jablunkovská brázda (Furrow), Moravian-Silesian Beskids Mts., Moravská brána (Gateway), Ostrava Basin, Silesian Upland – through the Rybnik Plateau and Katowice Upland, Silesian Lowland, including the Racibórz Basin and the Głubczyce Plateau (Fig. 1). Next to the slightly transformed areas (Jeseníky Massif, Silesian Beskids Mts, Opava Mts), there are also some degraded areas or areas which are under a severe impact of anthropogenic pressure (Upper Silesia Industrial District, Ostrava-Karviná Industrial Agglomeration, Rybnik Coal Mining District).

Reference works (Dynowska, 1986; Pawlik, Dobrowolski, 1965) point to an apparent shortage of springs in most of the Polish part of the Upper Oder River Basin (excluding the Beskids Mts and the south-western Sudeten). In

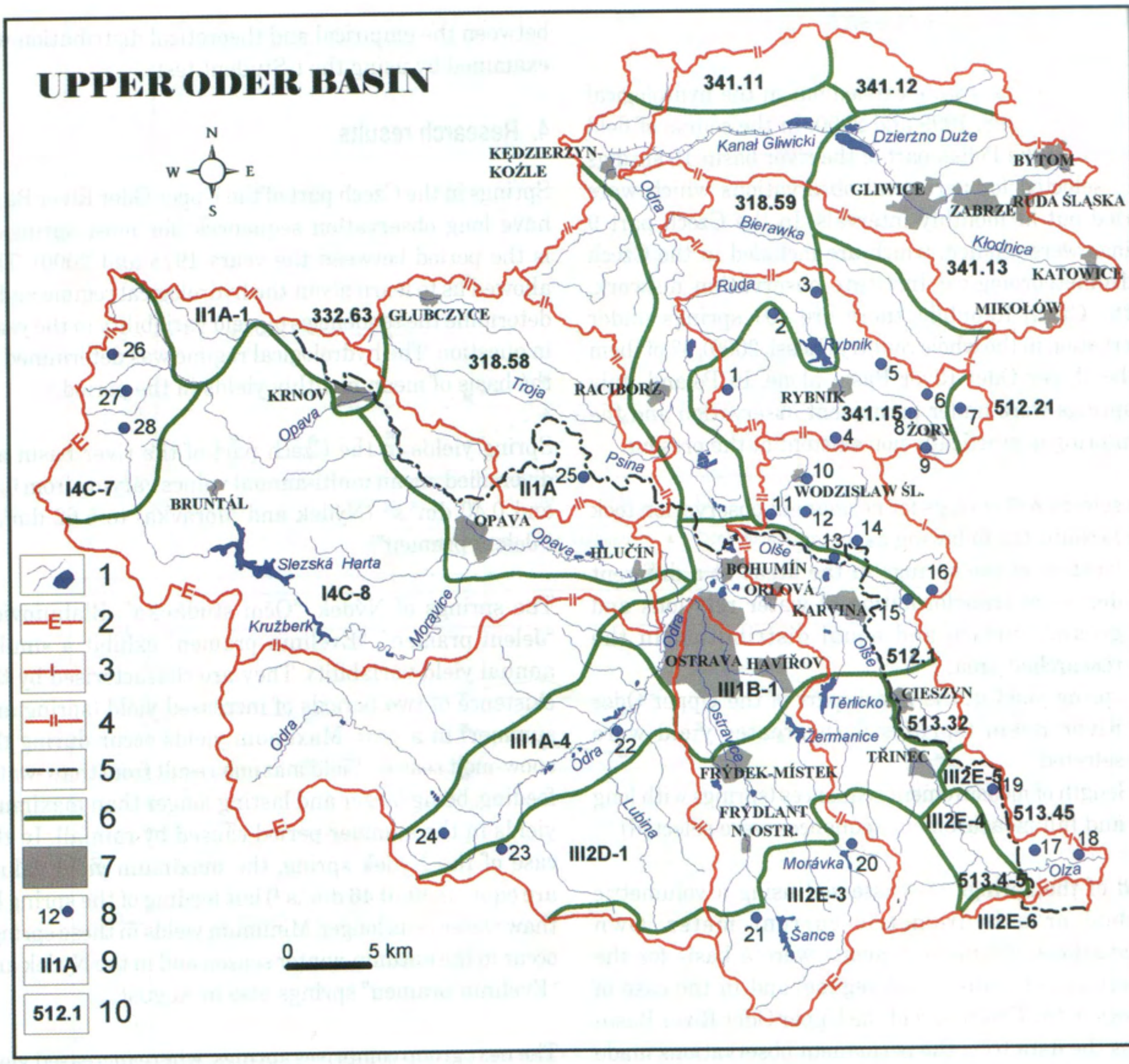


Fig. 1: Distribution of the researched springs within the physico-geographical and geomorphological units: 1 – river patterns and water reservoirs, 2 – European watershed, 3 – 1st order watershed, 4 – 2nd order watershed, 5 – state border, 6 – borders of the physico-geographical and geomorphological units, 7 – towns, 8 – researched springs, 9 – numbers of geomorphological units in Czech Republic, 10 – numbers of physico-geographical units in Poland and Czech Republic.

Researched springs: 1 – Nowa Wieś, 2 – „Szybki", 3 – Biały Dwór, 4 – "Jankowice-kapliczka", 5 – Przegędza, 6 – „Dobra Woda", 7 – Lipowiec, 8 – Rogoźna, 9 – Źródło Rudy, 10 – Wodzisław Śl., 11 – „Żabie źródła", 12 – „Gajowe źródło", 13 – „Zimne doły", 14 – Jastrzębie, 15 – Kończyce, 16 – Podlesie, 17 – Istebna I, 18 – Istebna II, 19 – Nýdek, 20 – Morávka, 21 – Ostravice, 22 – Albrechtičky, 23 – Oční studánka, 24 – Blahutovice, 25 – Evelinin pramen, 26 – Jelení pramen, 27 – Ludvíkov, 28 – Milanův pramen.

Names of physico-geographical units in Poland and Czech Republic: 332.63 – Góry Opawskie (Opawa Mountains), 332.64 – Niski Jesionik (Low Jesionik Highland), 332.65 – Wysoki Jesionik (High Jesionik Mountains), 318.5 – Nizina Śląska (Silesian Lowland), 318.58 – Płaskowyż Głubczycki (Głubczyce Plateau), 318.59 – Kotlina Raciborska (Racibórz Basin), 341.11 – Chełm (Chełm), 341.12 Garb Tarnogórski (Tarnogórski Hummock), 341.13 – Wyżyna Katowicka (Katowice Upland), 341.15 – Płaskowyż Rybnicki (Rybnik Plateau), 511.4 – Brama Morawska (Moravian Gate), 512.1 – Kotlina Ostrawska (Ostrava Basin), 512.21 – Równina Pszczyńska (Pszczyna Plain), 513.3 – Pogórze Zachodniobeskidzkie (Western Beskidy Hilly land), 513.32 – Pogórze Śląskie (Silesian Hilly land), 513.4-5 – Beskidy Zachodnie (Western Beskids Mountains), 513.45 – Beskid Śląski (Silesian Beskid Mountains).

Names of geomorphological units in Czech Republic: I4C-7 – Hrubý Jeseník (Mountains), I4C-8 – Nízký Jeseník (Highland), II1A – Slezská nížina (Silesian Lowland), II1A-1 – Opavská pahorkatina (Hilly land), III1A-4 – Moravská brána (Moravian Gate), III1B-1 – Ostravská pánev (Basin), III2D-1 – Podbeskydská pahorkatina (Hilly land), III2E-3 – Moravskoslezské Beskydy (Moravian-Silesian Beskids), III2E-4 – Jablunkovská brázda (Furrow), III2E-5 – Slezské Beskydy (Silesian Beskids), III2E-6 – Jablunkovské mezihoří (Intermountains).

the light of the carried out research it turns out that this scarcity is only seeming, and resulting from an inadequate insight into the area in terms of spring hydrology.

3. Methodology of the research

Field observations were carried out in the hydrological years: 1996, 1998, 1999 and 2000. In the course of field research in the Polish part of the river basin 18 springs were selected for periodical observations which were carried out at monthly intervals. In the Czech part 9 springs were studied, which are included in the Czech Hydrometeorological Institute observation network. In the Czech Republic, there are 401 springs under observation in the whole country (Kessl, 2000), 47 of them in the Upper Oder River Basin alone. In Poland, only 10 springs were under permanent observation and the monitoring is practically non existent at the present.

The selection of springs for permanent observation took into account the following aspects:

- location of the springs in the areas at a different degree of transformation of water relations and ground surface and equal distribution in the researched area;
- spring yield in the Polish part of the Upper Oder River Basin (springs with greater yield were selected);
- length of measurement sequences (springs with long and full measurement sequences were selected).

Yield of the springs was assessed using a volumetric method or a hydrometric current meter. Own observations and measurements were a basis for the elaboration of hydrological regime, and in the case of springs in the Czech part of the Upper Oder River Basin it was the data from the permanent observations made by the Czech Hydrometeorological Institute (CHMI). Hydrological regime of Czech springs was constructed on the basis of mean monthly yields calculated from monthly yields in the years 1978 – 2000. In order to characterise the variability of springs in the Upper Oder River Basin, categorisation according to E. Maillet (1905) was adopted along with O. Meinzer's classification (1923, 1932), where springs are classified according to their yield. Additionally, in order to characterise the spring regime of the Czech part of the Upper Oder River Basin, a calculation was made of the recession coefficients α.

Variability tendencies were also determined on the basis of spring yields in the Czech part of the Upper Oder River Basin, because only these had the sufficiently long measurement sequences. In order to define the yield variability of these springs within the period in question, a following calculation was made of the parameters of linear regression equation:

$$y = ax + b \qquad (1)$$

Regression lines were presented against the background of mean monthly yields. Significance of the correlation between the empirical and theoretical distribution was examined by using the t-Student test.

4. Research results

Springs in the Czech part of the Upper Oder River Basin have long observation sequences (for most springs it is the period between the years 1978 and 2000). This allowed us to learn about the hydrological regime and to determine the tendencies of yield variability in the years in question. The hydrological regime was determined on the basis of mean monthly yields in the period.

Spring yields in the Czech part of the river basin are diversified, mean multi-annual values varying from 0.41 and 0.40 $dm^3.s^{-1}$ (Nýdek and Morávka) to 5.62 $dm^3.s^{-1}$ ("Jelení pramen").

The springs of Nýdek, "Oční studánka", Blahutovice, "Jelení pramen", "Evelinin pramen" exhibit a similar annual yield variability. They are characterised by the existence of two periods of increased yield (spring and summer) in a year. Maximum yields occur during the snow-melt season. Yield maxima result from thaw-water feeding, being larger and lasting longer than maximum yields in the summer period caused by rainfall. In the case of the Nýdek spring, the maximum yield values are equivalent (0.46 $dm^3.s^{-1}$) but feeding of the spring by thaw water lasts longer. Minimum yields in these springs occur in the autumn-winter season and in the Nýdek and "Evelinin pramen" springs also in August.

The next group comprises springs, where increased yield due to the snow-melting is lower than the maximum caused by rainfall. In the springs of Ostravice and Morávka the maximum yield occurs in the summer, it is bigger and lasts longer than the spring-season maximum caused by thaws. Minimum yields in these springs also occur in the autumn-winter season (Fig. 2).

In the Ludvíkov spring, there is only one maximum occurring in a year – in the spring season (Fig. 2). The yields induced by thaw remain high for at least three months. The summer maximum, caused by rainfall is not that high and it is difficult to notice in the annual pattern of yields. This spring is characterised by the thaw regime.

The Albrechtičky spring has a very even yield pattern (Fig. 2). Maximum yields are recorded in autumn and in the early spring while minimum ones are observed in spring and summer. It is difficult to evaluate the impact of thaw and precipitation water on the yield of this spring. It can be suspected that the reaction of yield caused by thaw and precipitation water is considerably delayed in time and the maximum yields in the winter period may be the result.

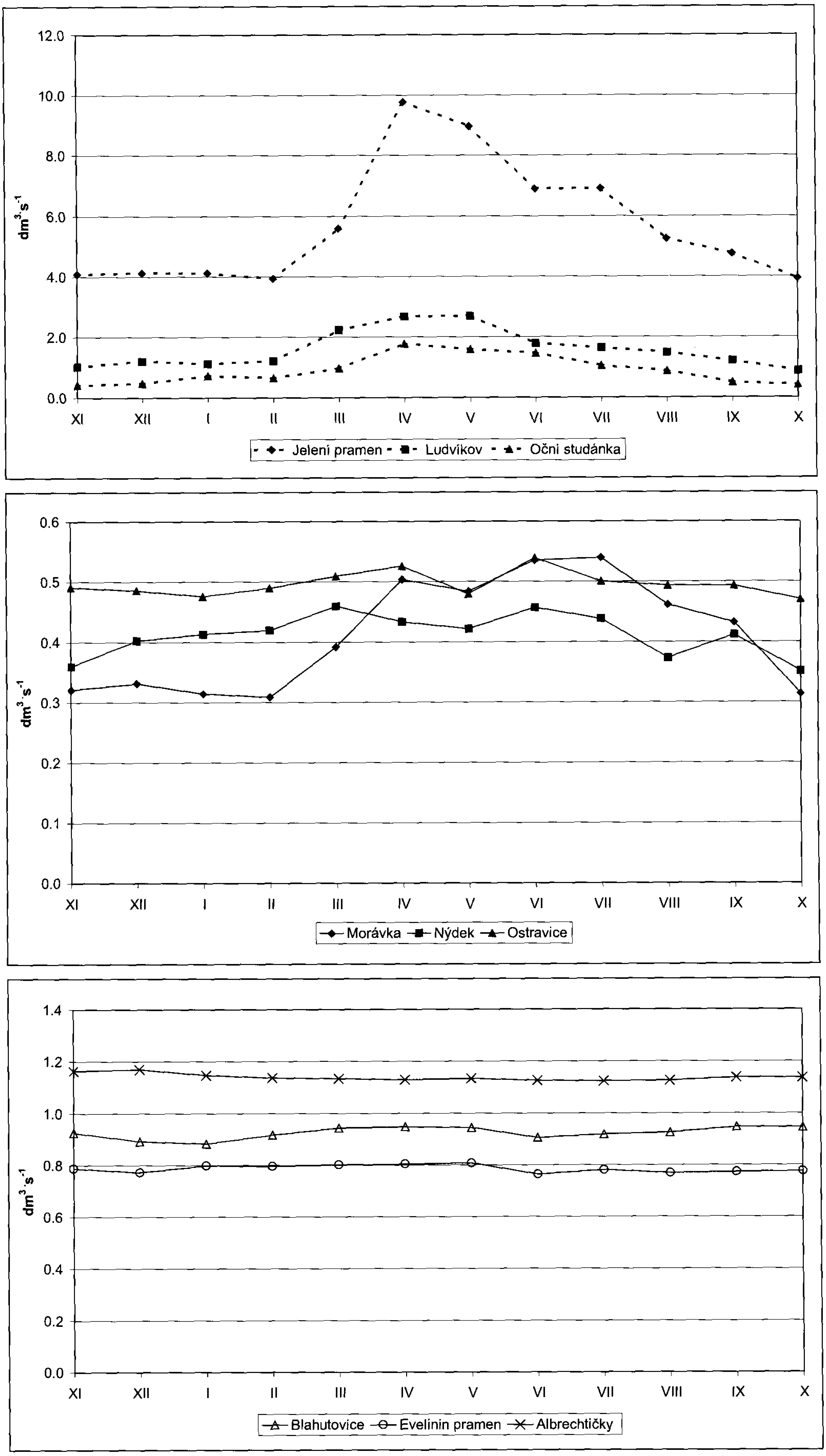


Fig. 2: Mean monthly yields of springs located in the Czech part of the Upper Oder River Basin.

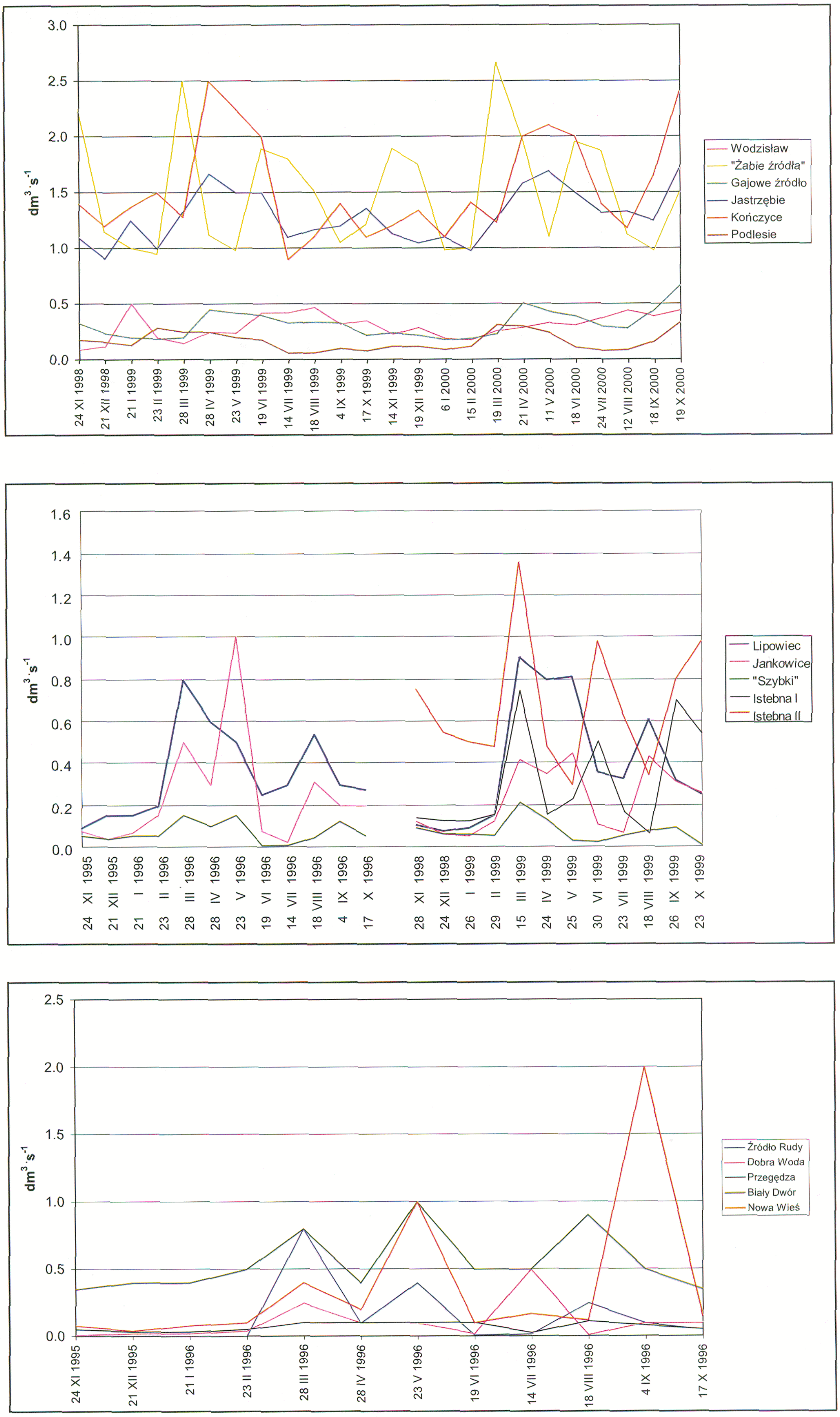


Fig. 3. Pattern of yields in some springs located in the Polish part of the Upper Oder River Basin.

Observations of the researched springs in the Polish part of the Upper Oder River Basin lasted between a year and three years. The yield of these springs varies, mean values are ranging from 0.07 $dm^3.s^{-1}$ (Przegędza, "Szybki") to 27.86 $dm^3.s^{-1}$ ("Zimne doły"). The yield pattern of these springs in annual cycle is diversified, most of the studied springs respond to the feeding of groundwater reservoirs with thaw-water by increasing their yields, and in the remaining months to the feeding from rainfall. In winter, when water alimentation is to a great extent limited, spring yields are lowest. In most springs the maximum caused by feeding from thaw water is bigger than the maxima in the summer period caused by rainfall. In the springs of Istebna I and II, Biały Dwór the impact of thaw water on the yield is smaller than that of the rainfall, these springs are characterised by the rain-precipitation regime. Only in the Wodzisław Śl. spring the maximum yield occurs in the summer season, with the yield increase in the spring being insignificant. We may therefore suppose that the spring regime is a rain-regime (Fig. 3). The hydrological regime was disturbed in two springs. In Wodzisław Śl. spring the outflow of water onto the surface was facilitated by the provision of a new lining, in the spring in Kończyce the water outflow was made difficult by silting up a part of the spring niche after the passage of a flood-wave on the Piotrówka river (Matysik, 2001).

The impact of thaw-water alimentation in most of the researched springs has the biggest significance during the year, the degree of this kind of spring alimentation depends first and foremost on the nature of the winter period: length of the snow-cover duration and thickness, degree of frost penetration into the ground, occurrence of mid-winter thaws and location of the spring. Thaw alimentation occurs when snow-cover melts and large quantities of water infiltrate deep into the ground, feeding the groundwater reservoir.

Another factor influencing the variability of spring yield is rainfall. Depending on its scale, amount and distribution during the year, alimentation of groundwater reservoirs may occur at various intensities.

Multi-annual variability coefficient – R is used for a quantitative evaluation of spring yield variability, as introduced by E. Maillet (1905), representing the maximum to minimum yield ratio in the multi-annual period of observation:

$$R = \frac{Q_{max}}{Q_{min}} \quad (2)$$

Applying the criteria of multi-annual variation, springs can be divided into: slightly variable (R = 2÷10), variable (R = 10÷50), highly variable (R > 50) (tab. 1). Slightly variable outflows are fed from deep water-bearing horizons or waters from vast and rich horizons situated in the zone near to the surface. Variable and highly variable springs drain small reservoirs and their variability documents a rapid groundwater circulation. In this case, the reservoirs are in the rock-mantle or they are fissure reservoirs in the rock.

E. Maillet's classification (1905) was also used for the evaluation of spring variability in the Polish part of the Upper Oder River Basin, accepting J. Tomaszewski's suggestion (1996), who claimed that it can also be used for shorter measurement periods such as hydrological year. On the basis of periodical and repeated yield measurements it is possible to put the studied outflows quite correctly into an order by the size of the R coefficient. According to this classification the researched springs may be grouped as: stable springs (R = 1 ÷ 2); slightly variable springs (R = 2÷10), variable springs (R = 10 ÷ 50), highly variable springs (R > 50) (Tab. 1, 2).

Spring	Yield [$dm^3.s^{-1}$] in the years 1978 – 1997			Multi-annual spring variability coefficient		
	Q_{max}	Q_{min}	Q_{mean}	R	E. Maillet's category	O. Meinzer's class
Albrechtičky	1.80	0.76	1.15	2.4	slightly variable	V
Blahutovice **	2.06	0.22	0.89	9.4	slightly variable	VI
Oční studánka*	7.18	0.08	0.94	90.0	highly variable	VI
Morávka	1.75	0.18	0.40	9.7	slightly variable	VI
Ostravice	1.91	0.26	0.50	7.3	slightly variable	VI
Nýdek	2.63	0.18	0.41	14.6	variable	VI
Evelinin pramen	2.18	0.34	0.77	6.4	slightly variable	VI
Jelení pramen	51.94	1.01	5.63	51.4	highly variable	V
Ludvíkov ***	12.94	0.29	1.61	44.6	variable	V

*Tab. 1: Breakdown of the basic hydrological parameters of springs in the Czech part of the upper Oder river basin. *Oční studánka – years 1980 – 2000, **Blahutovice – years 1978 – 1983, 1990 – 2000, ***Ludvíkov – years 1977 – 2000*

Based on O. Meinzer's classification (1923, 1932), the springs are classified according to their yield. Springs in the Upper Oder River Basin belong in the following classes: IV – (yield in the range 10-100 $dm^3.s^{-1}$), V – (1-10 $dm^3.s^{-1}$), VI – (0.1-1 $dm^3.s^{-1}$), VII - (0.01-0.1 $dm^3.s^{-1}$) (Tab. 1, 2). Springs predominant in the Upper Oder River Basin are those with small yields of up to 1.0 $dm^3.s^{-1}$.

Additionally, in order to characterize the spring regime in the Czech part of the Upper Oder River Basin a calculation was made of recession coefficients α. Spring yield depends directly on the amount of water collected in the reservoir which feeds a given spring. In the period when the reservoir is not fed, the springs have a so-called own regime, i.e. independent of precipitation (Pazdro, Kozerski, 1990). In this period the groundwater reservoir empties its water reserves and the spring's yield decreases according to the following equation (Maillet, 1905):

$$Q = Q_0 e^{-\alpha t} \quad (3)$$

Spring	Yield [$dm^3.s^{-1}$]			Spring variability coefficient		
	Q_{max}	Q_{min}	Q_{mean}	R	E. Maillet's category	O. Meinzer's class
Rogoźna	1.80	0.30	0.76	6	slightly variable	VI
Wodzisław Śl.	0.50	0.09	0.30	6	slightly variable	VI
„żabie źródła"	2.66	0.95	1.51	3	slightly variable	V
Gajowe źródło	0.66	0.18	0.32	4	slightly variable	VI
„Zimne doły"	61.20	10.5	27.86	6	slightly variable	IV
Jastrzębie	1.71	0.91	1.30	2	stable	V
Kończyce	2.50	0.90	1.54	3	slightly variable	V
Podlesie	0.33	0.06	0.17	6	slightly variable	VI
Lipowiec	0.90	0.08	0.37	11	variable	VI
Jankowice-kapl.	1.00	0.012	0.23	83	variable	VI
„Szybki"	0.21	0.01	0.07	21	variable	VII
Źródło Rudy	0.80	0.0015	0.14	533	highly variable	VI
Dobra Woda	0.50	0.01	0.11	9	slightly variable	VI
Przegędza	0.11	0.025	0.07	4	slightly variable	VII
Biały Dwór	1.00	0.35	0.55	3	slightly variable	VI
Nowa Wieś	2.00	0.04	0.37	50	highly variable	VI
Istebna I	0.74	0.06	0.30	12	variable	VI
Istebna II	1.36	0.30	0.68	4	slightly variable	VI

Tab. 2: Breakdown of the basic hydrological parameters of springs in the Polish part of the Upper Oder River Basin.

Spring	Mean spring recession coefficient α	α – minimum	α – maximum
Albrechtičky	0.00168	0.000248	0.00298
Blahutovice	0.01070	0.0023	0.0230
Oční studánka	0.01890	0.0050	0.0327
Morávka	0.02840	0.0021	0.0502
Ostravice	0.01570	0.0051	0.0300
Nýdek	0.02150	0.0076	0.0707
Evelinin pramen	0.01866	0.0108	0.0312
Jelení pramen	0.01740	0.0127	0.0212
Ludvíkov	0.01780	0.0055	0.0340

Tab. 3: Breakdown of spring recession coefficients mean and extreme values.

where: **Q** – predicted spring yield in time t in $m^3.s^{-1}$, $\mathbf{Q_0}$ – initial observed yield in the period of own regime $m^3.s^{-1}$, **e** – base of natural logarithm, α – coefficient of spring recession in time (t), **t** – time calculated in days, corresponding to the decrease in spring yield from Q_0 to Q.

The Albrechtičky spring has the lowest recession coefficient, where the mean value of α is 0.00168, and the extreme values are between 0.000248 and 0.00298. This spring exhibits the slowest response which suggests that its alimentation zone is the richest. Coefficients of other springs may be grouped as follows: 0.01 – 0.015 Blahutovice and Ostravice springs; 0.017 – 0.019 "Jelení pramen", Ludvíkov, "Evelinin pramen", "Oční studánka"; 0.021 – 0.028 Nýdek and Morávka (tab. 3). The Nýdek and Morávka springs react most quickly. The magnitude of recession coefficients points to differentiated rate of the emptying groundwater reservoirs feeding these springs.

Tendencies in yield variability were determined on the basis of spring yields in the Czech part of the Upper Oder River Basin, because only they have the yield measurement sequences sufficiently long. In order to determine yield variability of these springs in the considered period (for most springs 1978 – 2000) parameters of linear regression equation were calculated:

$$y = ax + b \qquad (4)$$

Regression lines were presented against the background of mean monthly yields. Significance of correlation between empirical and theoretical distribution was examined by using t-Student test.

Negative recession coefficients were found in seven springs, which is the sign of a downward trend in these springs' yield (Kaňok, Matysik, 1999). In the springs of Nýdek and Blahutovice the trend is not statistically significant. The declining tendencies in the yields of the Albrechtičky, Ludvíkov, „Oční studánka", Morávka, „Evelinin pramen", and Nýdek springs document a slow emptying of the groundwater reservoirs feeding the springs. The process is affected by long-term climatic variations which would be also an explanation to the declining tendency of atmospheric precipitation within the Upper Oder River Basin (Absalon, Czaja, Jankowski, Kaňok, Kříž, Leśniok, 1996). Two springs have the recession coefficient positive. However, in the Jelení pramen spring this trend is not statistically significant. In the Ostravice spring, the significance of correlation is at a level of 0.001, i.e. at 99.9 % (Fig. 4). Increase in the yield of this spring may be due to the fact that it simultaneously drains two groundwater reservoirs, one of which is located in the near-surface zone and fed directly from atmospheric precipitation and the other is connected with deep water bearing horizon with long-term alimentation.

The analysis of cumulative curves of springs occurring in the Czech part of the Upper Oder River Basin indicates a difference existing in periods of yield variability for each spring, probably caused and conditioned by climatic factors, combined with hydrogeological factors such as e.g. varied capacity and therefore varied inertia of groundwater reservoirs feeding the springs.

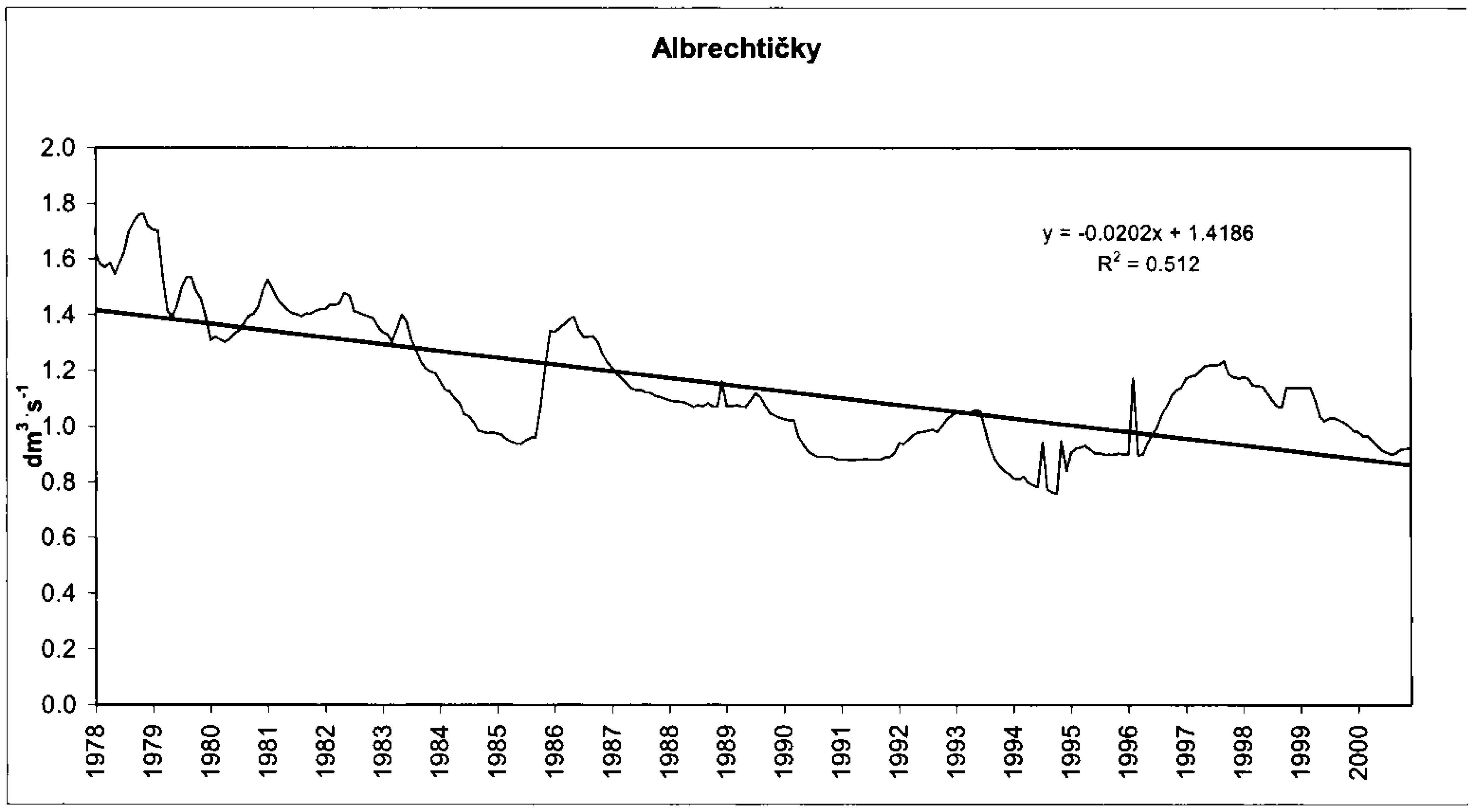
The period of studying the Polish springs is too short and does not allow application of the above mentioned methods. It can be stated from the field observations, however, that yield tendencies in most of the researched springs are unfavourable. Springs located in the areas under the influence of coal mines or in the built-up areas exhibit lower yields than some time ago. The evidence of higher yields in some springs in the past is provided by the existence of the spring niche itself, size of the bed which carries away water from the spring and information obtained from interviews with local people.

Spring	Trend	Coefficient of determination R2	Significance of regression line correlation
Albrechtičky	y = -0.002x+1.4186	0.512	0.001
Blahutovice*	y = -0.0004x+0.9642	0.0156	insignificant
Oční studánka**	y = -0.002x+1.1636	0.0242	0.02
Morávka	y = -0.0002x+0.4448	0.013	0.1
Ostravice	y = 0.0006x+0.4086	0.1672	0.001
Nýdek	y = -1E-04x+0.4255	0.0072	insignificant
Evelinin pramen	y = -0.0002x+0.8182	0.0137	0.05
Jelení pramen	y = 0.0016x+5.1733	0.0012	insignificant
Ludvíkov***	y = -0.0031x+2.0233	0.0425	0.001

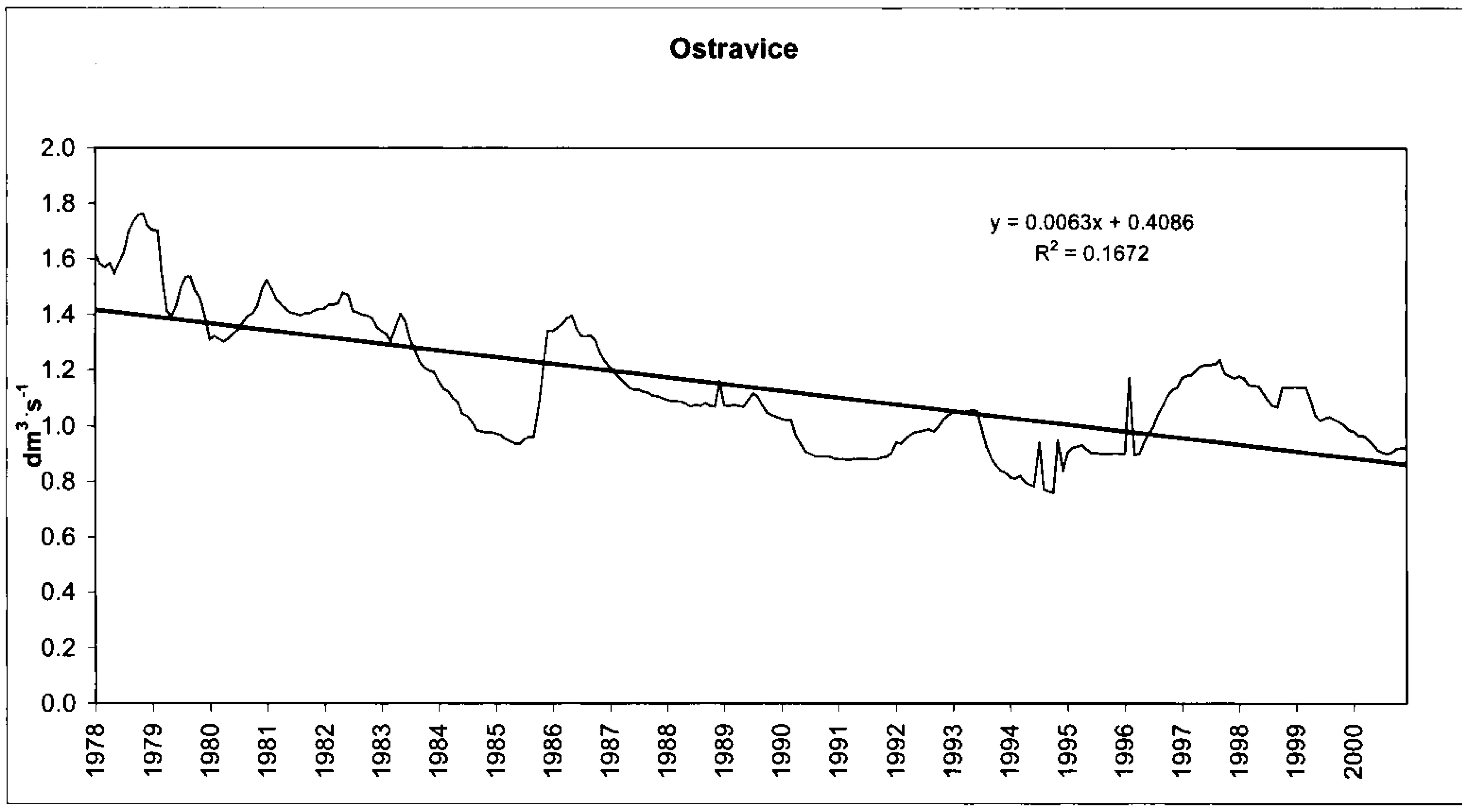
Tab. 4: Tendencies in the variability of mean monthly spring yields in the years 1978 – 2000.

* years 1978 – 1983, 1990 – 2000, ** years 1980 – 2000, *** years 1977 – 2000

a)



b)



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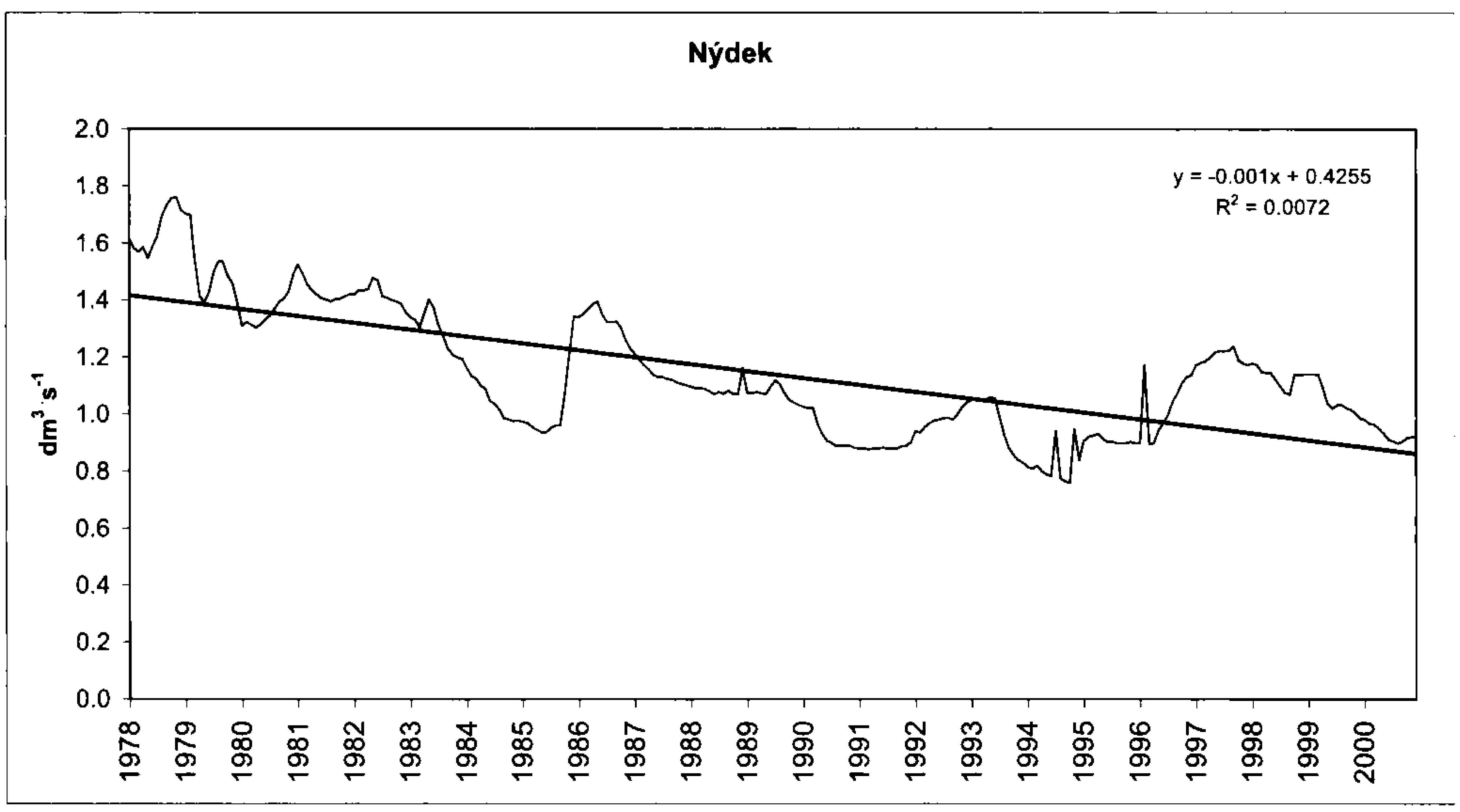

Fig. 4. Pattern of mean monthly yields of some springs in the Czech part of the Upper Oder River Basin. Regression lines are marked with a straight line. Examples of springs with a negative recession coefficient (a), positive (b) and insignificant (c).

5. Summary

The research of hydrological characteristics of springs under study can be concluded as follows:

- The yields of the researched springs are differentiated. It follows from the carried out analyses of measurement sequences of spring yields that in most of the objects the yield is predominantly influenced by thaw water alimentation, and to a lesser degree by rainwater. Most of the researched springs have the thaw-rain regime. The springs of Ostravice, Biały Dwór, Istebna I and II have the rain-thaw regime, the Wodzisław Śl. spring has the rain regime and the Ludvíkov spring shows the thaw regime. The pattern of yields in the Albrechtičky spring does not point unambiguously to a prevailing way of alimentation and therefore the regime of the spring has not been determined.
- Applying the variability criteria of E. Maillet's classification the studied springs can be divided into: stable – Jastrzębie, slightly variable – Albrechtičky, Blahutovice, „Evelinin pramen", Morávka, Ostravice, Rogoźna, Wodzisław Śl., „Żabie źródła", „Gajowe źródło", „Zimne doły", Kończyce, Podlesie, „Dobra Woda", Przegędza, Biały Dwór, Istebna II; variable – Ludvíkov and Nýdek, Lipowiec, Jankowice-kapliczka, „Szybki", Istebna I; highly variable – „Jelení pramen", „Oční studánka", Źródło Rudy and Nowa Wieś.
- According to O. Meinzer's classification the researched springs belong in the following classes:
- **IV** – „Zimne doły"; **V** - Albrechtičky, Jelení pramen, Ludvíkov, Kończyce, Jastrzębie; **VI** — Blahutovice, „Evelinin pramen", Nýdek, Morávka, Ostravice, „Oční studánka", Istebna I, Istebna II, Nowa Wieś, „Dobra Woda", Źródło Rudy, Jankowice-kapliczka, Lipowiec, Podlesie, „Gajowe źródło", Wodzisław Śl., Rogoźna; **VII** - „Szybki", Przegędza. The Upper Oder River Basin is predominated by the occurrence of springs with yields of up to 1 $dm^3.s^{-1}$.

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SOME ASPECTS OF THE BIOTIC POTENTIAL OF THE OSTRAVA REGION

Anna RAFAJOVÁ

Abstract

A brief evaluation of the biotic potential and the actual condition of the landscape in individual bioregions in the Ostrava region is presented. Ostrava is one of the regions in the Czech Republic most impacted by anthropogenic activities. The term biotic potential is understood here as expressing overall possibilities for the existence of biotically valuable landscape areas, with stabilization, regulation and regeneration functions. Attention is focused on ecologically important landscape segments, especially on the existing network of designated protected areas, and their significance in the necessary gradual improvement of ecological stability of the landscape in the Ostrava region.

Shrnutí

Vybrané aspekty biotického potenciálu Ostravského regionu

Předkládaný příspěvek se věnuje stručnému hodnocení biotického potenciálu a aktuálního stavu krajiny v jednotlivých bioregionech Ostravského regionu, který je jedním z antropicky nejvíce postižených regionů v České republice. Biotickým potenciálem jsou myšleny celkové možnosti existence bioticky hodnotných částí krajiny, které mají v krajině stabilizační, regulační a regenerační funkci. Pozornost je zaměřena na ekologicky významné segmenty krajiny, především na aktuální síť zvláště chráněných území, a na jejich význam při nezbytném postupném zvyšování ekologické stability krajiny Ostravského regionu.

Key words: *of coal mining landscapes, ecologically important landscape segment, designated protected areas, Ostrava Region, Czech Republic*

1. Introduction

Long-term intensification of anthropogenic activities resulted in an extensive disturbance of ecological stability of the landscape, which depends on the condition of the biotic component, vegetation in particular. A priority task in the effort to restore ecological stability consists in the determination and registration of all natural and near-natural ecosystems that have survived in the contemporary cultural landscape (Lacina, 1993).

A good example of extensive disturbance by human impact can be the Ostrava Region as one of regions most loaded with the anthropogenic activities in the Czech Republic (Fig.1). The main factor adversely affecting all components of environment is the intensive mining of bituminous coal and iron metallurgy. Although the coal mining has been passing through a transformation and downscaling since the 1990s, its consequences are still very much visible in the landscape.

Fig. 1: Demarcation of the researched area within the Czech Republic

The downscaling of deep mining has launched a range of changes in the existing landscape system (its natural and socio-economic subsystems). Coal mining – as the main factor inducing extensive changes of the original topography and consequent changes of other constituents of the natural landscape – is being gradually closed down and there is a scale of possibilities to regenerate the devastated natural landscape components and to enhance the general ecological stability of the area.

Research of the biotic component of the landscape, monitoring of natural and near-natural ecosystems and possibilities to regenerate the landscape of the Ostrava industrial agglomeration have been recently dealth with by a number of experts, e.g. Dolný (2000), Dolný & Ďuriš (2001), Koutecká et al. (1998), Koutecká (2001), Kupka (1999), Rafajová (2003), Smolík (1992), Stalmachová (1997), Stalmachová (2001) and other.

2. Demarcation and characteristic of the Ostrava Region

The Ostrava Region was for the purposes of the given research demarcated by the districts of Ostrava and Karviná, the eastern part of the Opava district, northern and western parts of the Frýdek-Místek district and by the northern part of the Nový Jičín district. Total area of the territory under study is approximately 790 km^2.

In geomorphological terms, the marginal NW section of the area under study is reached by the province of the Česká vysočina (Highland) with the complex of Nízký Jeseník Mts., and by the province of the Central-European Lowland with the Opavská pahorkatina (Hilly Land) complex. A greater part of the territory under study is however included in the province of the Western Carpathians with the complexes of Ostrava Basin, Moravská brána (Gateway) and Podbeskydská pahorkatina (Hilly Land).

Relief of the Ostrava Basin has the character of a flat hilly land with rounded ridges whose altitude ranges mostly between 200 – 300 m a.s.l. Wide spreading alluvia of rivers, especially those of the Odra and Olše Rivers, are dominated by plain sections lined with steep and not too high-reaching terraces with numerous spring areas. A characteristic feature of the relief in a greater part of the territory is its intensive anthropogenic transformation, numerous spoilbanks and subsidences. In the SW section of the territory under study the Ostrava Basin links up with the complex of Moravská brána (Gateway), characterized by a broad alluvium of the Odra River with adjacent riverine terraces and altitudes ranging from 200 – 280 m a.s.l.

The S and SE part of the territory, which is filled with the Podbeskydská pahorkatina (Hilly Land) is of a different character. It is a rather broken hilly land on soft sediments at altitudes ranging from 300 – 650 m a.s.l. with the prevailing arable land, a frequent occurrence of wet grasslands and cultural spruce stands with the remainders of beech stands in the forests.

Climate of the investigated territory is similarly as the whole country conditioned by the geographical location in central Europe where effects of the oceanic climate meet with those of the continental climate. The territory under study is situated in a slightly warm climatic zone with the long-term mean annual temperatures and total annual precipitation ranging from 7.5 °C – 8.5 °C and from 700 – 950 mm, respectively. The precipitation amounts increase towards the foothills of the Moravian-Silesian Beskids Mts. where the local relatively high precipitation totals are conditioned by the proximity of windward slopes of the Moravian-Silesian Beskids and by the linkage with the Silesian Lowland in the neighbouring Poland.

The Ostrava Region belongs in the Baltic Sea drainage area and it is a part of the Odra River watershed. River pattern is relatively dense but the rivers are mostly of torrent nature and their discharge is considerably variable. In order to protect the territory against floods and to achieve even discharge values throughout the year there is a system of dam water reservoirs constructed in the territory in addition to the network of fish ponds. Besides the Odra R., other important water courses in the investigated area are the Ostravice R. arriving to the Ostrava Region from the Moravian-Silesian Beskids Mts. and flowing through a rather river alluvium from Frýdek-Místek. One of its larger left tributaries is the Olešná R. in Paskov with a dam reservoir of Olešná built in the vicinity of Frýdek-Místek. The Lučina River which comes into the Ostrava Basin from the Moravian-Silesian Beskids Mts. opens from the right into the Ostravice R. in the downtown of Ostrava. The water reservoir of Žermanice was built on it in the south of Havířov. The Olše River arrives to the Ostrava Region in Český Těšín, playing a role of the state border river from Český Těšín up to Karviná and having the same function further on from Dětmarovice up to the confluence with the Odra River. From Karviná on, the Olše R. flows through a broad river floodplain. Its most important affluent is Stonávka on which the Těrlicko water reservoir was constructed near a village of the same name.

Soil conditions of the Ostrava Region are characterized by a significant share of Fluvisols in the floodplains of larger water courses, and Luvisols or Gleyic Luvisols linking with the Fluvisols in flat hilly lands. Less represented are Cambisols (in the surroundings of the Těrlicko and Žermanice water reservoirs) and Cambisols with Cambic Podzols on terrace deposits (in the surroundings of Hlučín, Michálkovice and Vratimov).

Altitudinal vegetation zones express the continuity in the sequence of variations in the natural vegetation with the sequence of variations in the altitudinal and exposure climate. Alluvia of larger water courses show the occurrence of plant and animal communities of the 3rd Oak-Beech altitudinal vegetation zone. The flat hilly land of the Ostrava Basin is taken up by the Oak-Coniferous variant of the 4th altitudinal vegetation zone (vegetation tier). A representative specimen of near-natural forest communities on water-logged substrates is a remainder of mainly the beech stand in the Nature Reserves of Černý les near Šilheřovice I and II. Communities of the 5th Fir-Beech vegetation tier can be found only at the highest altitudes of Palkovické hůrky (Hills) situated to the south-west of Frýdek-Místek (The Palkovické hůrky Nature Reserve).

As far as the potential natural vegetation is concerned (Neuhäuslová et al., 1998), the alluvia of rivers in the investigated area accommodate authochthonous floodplain forests, more precisely the Bird Cherry-Ash (*Pruno-Fraxinetum*) woodland, at some places in the complex with Carr-Alders (*Alnion glutinosae*), and the Odra R. floodplain accommodates the Elm-Pedunculate Oak woodlands (*Querco-Ulmetum*), approximately from the confluence with the Opava R. up to the confluence with the Olše R. The Ostrava Basin shows the occurrence of authochthonous Waterlogged Pedunculate Oak-Beech woodland with Carex brizoides (*Carici brizoidis-Quercetum*). The southern and south-western hilly part of the area should be dominated by Lime-Oak-Hornbeam woodland (*Tilio-Carpinetum*) and the higher altitudes should at some places exhibit the occurrence of the Carpathian Oak-Hornbeam woodland with Carex pilosa (*Carici pilosae-Carpinetum*) with an isle of Sedge-rich Beech woodland with Carex pilosa (*Carici pilosae-Fagetum*) in the Palkovické hůrky (Hills) area.

3. Biogeographical division and current use of the landscape

According to the current division of the Czech Republic (Culek ed., 1996), the territory under study belongs in the extensive province of Central European Deciduous Forests with the following three biogeographical sub-provinces: the **Hercynian Sub-Province** takes up only a small part of the territory in the western surroundings of villages Děhylov, Krásné Pole and Vřesina, being formed by the Nízkojesenický bioregion (Lower Jeseník Bioregion). The southern and the south-eastern parts of the territory are taken up by the **Carpathian Sub-Province**, represented here by the Podbeskydský bioregion (Beskids Piedmont Bioregion). The remaining and the largest part of the territory fills the **Polonian Sub-Province** consisting of three bioregions: Opava, Ostrava and Odra River Basin (see Fig. 2).

The geographical location of the Ostrava Region on the borderline of three biogeographical sub-provinces is unique in the Czech Republic. Thanks to the fact that the region shows a merge of natural elements from all three above mentioned sub-provinces, it also exhibits a higher potential species diversity of the landscape biotic component and an interesting geological and geomorphological diversity of the landscape. The existing landscape of the respective bioregions occurring in the area under study can be characterized as follows:

The Nízkojesenický bioregion (bioregion of the Nízký Jeseník Mts.) reaches the investigated area only marginally with the mildly descending to steeply falling foot of the Nízký Jeseník slopes, being characterized by the alternation of arable land with the remainders of natural forest vegetation on hill sides and along water courses.

The Podbeskydský bioregion (bioregion of Lower Beskids) takes up nearly a third of the investigated area, comprising a hilly land pediment declining from the Moravian-Silesian Beskids to the north. A prevailing part of the area is of the character of broken hilly land; only the zone of ridges and basins south-west of Frýdek-Místek is of he nature of broken upland up to flat highland. The highest point is the hill of Kubánkov (661 m a.s.l.). Predominating is rural landscape with arable land and permanent swards. Forest and grassland landscape can be found in the space between Frýdek-Místek and Hukvaldy. The species composition of the forests has been considerably altered to the benefit of Norway spruce.

The Opava bioregion is situated in the north-western part of the Ostrava Region near Hlučín and it is formed by a rounded undulating flat hilly land on glacial sediments with dominating arable land.

The Ostrava bioregion takes up the largest part of the area under study – the Ostrava Basin and a part of the Moravská brána (Gateway) with a range of waterlogged sites on loams with a severe anthropogenic disturbance by deep coal mining and by the concentration of towns and heavy industries. The topography has a character of flat hilly land with rounded ridges and sporadically occurring larger plain sections. Important are the relatively broad alluvia of rivers (e.g. Ostravice, Lučina). The open landscape is dominated by arable land, abundant are wet grasslands, alder stands and water surfaces. The anthropogenic relief is characterized by numerous spoilbanks, gated sludge beds and subsidence basins.

The Odra River Basin bioregion is formed by alluvia and by the lowest terraces of the Odra and Olše Rivers and their tributaries. The topography is of a typically alluvial character, with rarely preserved free meanders and old arms at a different stage of silting. At the present time, it has an abundant representation of hygric grasslands, fish pond systems and small floodplain forests, usually with a valuable biota.

4. Ecologically significant landscape segments

There are no more genuinely natural, by humans unaffected ecosystems to be found in the today's cultural landscape. There are however so called ecologically significant landscape segments whose important for the ensurance of landscape ecological stability is essential. According to Míchal et al. (1994), the segments are those parts of the landscape, which are either formed of or predominated by ecosystems with a relatively higher internal ecological stability. These parts of the landscape are characterized by permanent biodiversity and ecological conditions

Fig. 2: Biogeographical division and existing network of particularly protected areas of the Ostrava Region (Note: The numbers of particularly protected areas 2-23 correspond to the numbers of these areas in Tab. 1)

enabling the existence of species of the landscape natural genepool. These segments can be divided by spatially-structural criteria into the ecologically significant landscape elements, landscape units, landscape areas, and linear communities. The set of all ecologically significant landscape segments in the given region forms a region's skeleton of landscape ecological stability.

In the following chapters we are going to focus on the environmentally and biologically most interesting ecologically significant landscape segments in the Ostrava Region with the status of a particularly protected area (pursuant to § 14, Act no. 114/1992 Gaz. on nature and landscape protection), presenting an evaluation of some other ecologically significant landscape segments in the region under study.

4.1 Particularly protected areas

With respect to the severe disturbance of natural environment in the Ostrava Region, the particularly protected areas are relatively small in size. Altogether they take up 1812.36 hectares, which is only 2.3 % of the total area under study. The number of small-area protected areas is 22 and they represent a total area of 707.08 ha. A large-area protected area reaching into the investigated region is a northern part of the Poodří (Odra River Basin) Protected Landscape Area (PLA) of 1105.28 hectares in size. In terms of the main subject of protection, the existing particularly protected areas can be divided into several groups as follows:

– protection of wetland biotopes

Most of the particularly protected areas (11) are of wetland character, being situated in well-preserved parts of river alluvia. Protected are especially the remainders of floodplain forests with freely meandering water courses, floodplain meadows, wetlands, reed stands and fish ponds. They take up an area of 1558.26 ha (including the northern part of the Poodří (PLA), which is about 86 % of the total area of the particularly protected areas in the Ostrava Region. These wetland biotopes are a home for a range of rare and protected plant (e.g. *Trapa natans*, *Salvinia natans*, *Nymphaea candida*) and animal (*Lampetra planeri*, *Triturus cristatus*, *Botaurus stellaris*) species.

A typical example of the protected area of wetland character is the Štěpán Nature Reserve (Fig. 3). It is a pond situated in the immediate vicinity of the right bank of the Opava River, approximately 1 km north of the Ostrava-Martinovice city quarter. The locality was declared nature reserve thanks to the occurrence of very rare plants and animals characteristic of water and wetland environments and also for its historical value of the landscape.

As mentioned by Prymusová (1999), the pond originally belonged in the Jilešovice-Děhylov system of ponds which was – together with fish ponds in Děhylov – fed by a ditch from the Opava River and served to grow fish. After the end of fishery, the pond stopped to be drained and began to be gradually silted.

At the present time, the pond and its surroundings have the character of an extensive wetland with predominant reeds and high sedges. The most precious of 281 occurring higher plants are *Trapa natans*, *Salvinia natans*, *Nymphaea candida* and *Dactylorhiza majalis*. The area is very important for water birds. Extensive reed and reed-mace stands, manna grasses and sedges provide ideal conditions for the animal communities of reed swamps, the littoral zone is inhabited by mallards, grebes, coots, etc. The pond is one of traditional stops of water birds during their spring and autumn migrations. The surrounding stands of floodplain woody species with well-developed herb and shrub layers, and with the presence of old and dying trees with cavities are important for the nesting of birds. The quality of this wetland environment can be illustrated also by an abundant community of molluscs (with a number of typical wetland species) and a considerable species diversity of amphibians and reptiles.

– protection of forest biotopes

The particularly protected areas (7) with different types of forest communities (except for the floodplain forests which are included in the biotopes of wetland character) are protected on 201.60 hectares, which is approximately 11 % of the total area of the particularly protected areas. The areas in question are mostly the remainders of surviving beech woodlands in the Podbeskydská pahorkatina (Hilly Land) – the nature monument "Hradní vrch Hukvaldy" and the nature monument "Pod hukvaldskou oborou", in the eastern corner of Nízký Jeseník – the national nature monument "Landek", and in the Opavská nížina (Lowland) – the nature reserve "Černý les u Šilheřovic I and II" with rare plant (*Matteuccia struthiopteris*, *Galanthus nivalis*) and animal (*Anguis agilis*, *Ciconia nigra*) species (Fig. 4).

– protection of geological and geomorphological phenomena

The subject of protection in the following four particularly protected areas are specific geological and geomorphological phenomena. The landscapes take up an area of 49.67 ha, i.e. about 2.7 % of the total area of the particularly protected areas. A memorial of glaciation are protected erratic granite boulders in three localities in Ostrava.

The object of protection in the nature monument "Profil Morávky" near Frýdek-Místek (Fig. 5 – see cover p. 4) is an interesting, at some places deep-incised Morávka River canyon with numerous rock outcrops and rapids.

– protection of non-forest biotopes

The last one of the particularly protected areas in the Nature monument "Kamenná u Staříče" (Fig. 6), sized 2.83 ha, which is 0.3 % of the total area of the particularly protected areas. In the territory under study, this is an important non-forest biotope in which the object of protection are remainders of adrets with the thermophilic flora. Limestone soils bear a colourful thermophilic plant community dominated by *Linum flavum*. This representative of xerotherm flora with high demands has been observed to have its northernmost

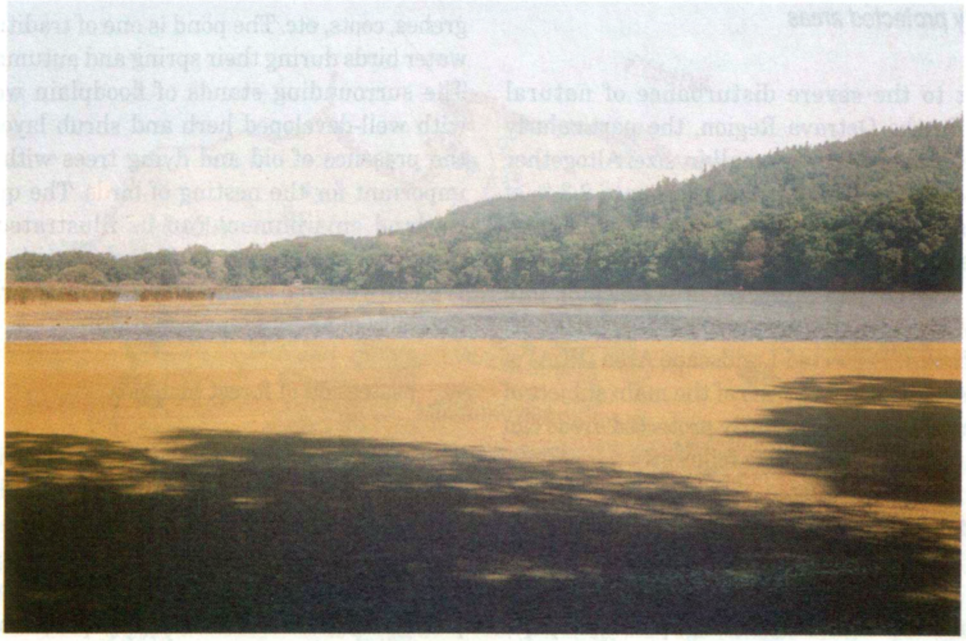

Fig. 3: The Štěpán Nature Reserve – pond of reed swamps, floating and submerged water plants

Photo: A. Rafajová

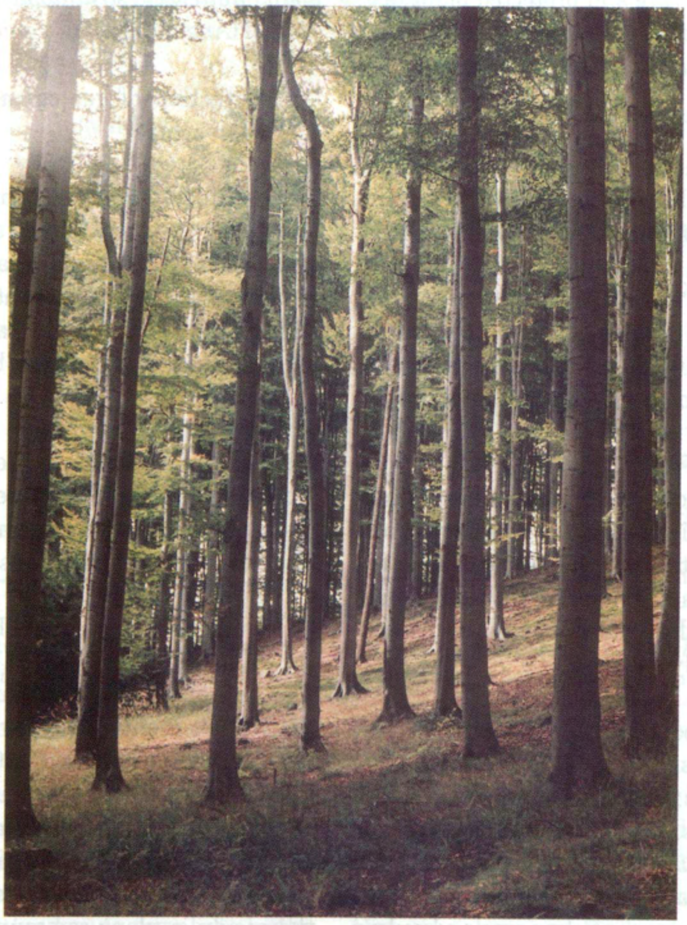

Fig. 4: Beech-Fir woodlands in the Nature Reserve of "Palkovické hůrky"

Photo: A. Rafajová

occurrence here in the Czech Republic (Vicherek, 1957). The nearest localities with *Linum flavum* can be found as far as in the surroundings of Olomouc.

Fig. 6: Linum flavum as a representative of xerotherm flora in the Nature monument "Kamenná u Staříče"
Photo: A. Rafajová

4.2 Other ecologically significant landscape segments

Other ecologically significant landscape segments can enjoy – pursuant to § 3 Act no. 114/1992 Gaz. on nature and landscape protection the statut of general protection as the significant landscape components. Pursuant to the law, these are forests, peatbogs, water courses, fish ponds, lakes and valley floodplains. Furthermore, the significant landscape components may become areas registered as such pursuant to § 6 Act no. 114/1992 Gaz. by an appurtenant nature conservation authority. Another possibility exists that the ecologically significant landscape components become a part of the Regional System of Ecological Stability documentation, and function – according to their character – as biocentres, biocorridors or interacting elements. The Regional Office has registered several hundred of significant landscape components occurring in the territory of the Ostrava Region. The Documentation of the Regional Systems of Ecological Stability of regional and supra-regional level has been elaborated for the entire territory under study and the components are at their greater part functional.

Although the Ostrava Region is generally perceived as a region with the devastated landscape and severely disturbed environment, there is still a range of these small ecologically significant landscape segments whose importance for the regeneration of ecological stability of the landscape is no lesser than the significance of the above listed particularly protected areas. Especially valuable are well-preserved segments of floodplain forests in the close vicinity of water courses (e.g. Olše R., Ostravice R.), near-natural riparian stands at small water courses and tiny streams (e.g. Stonávka, Lučina, Olešná, Ondřejnice, Petrůvka, etc.), near-natural parts of forest complexes, whose species composition has not experienced marked changes to the benefit of Norway spruce (e.g. forests in Palkovické hůrky, Brušperský les, Datyňský les, Pežgovský les, Loucký les, etc.), and semi-natural wetland biotopes (moist grasslands, reed swamps) which occur in the close vicinity of many fish ponds and water surfaces in the area under study.

A very interesting phenomenon is the spontaneous formation of new, ecologically valuable biotopes on fitted localities in areas which have been considerably devastated by coal mining. This applies to the space of the Ostrava-Karviná coal mining area in particular.

The most often and fastest forming biotopes are those of wetland character, which develop within unrecultivated subsided basins. Water-bearing subsided basins are being spontaneously colonized by wetland vegetation, thus taking over the function of refugia for plant and animal species of wetlands and shallow waters from wide surroundings, whose natural habitats were destroyed in the landscape distubed by humans. Rare plant and animal species occurring here are for example *Salvinia natans*, *Utricularia vulgaris*, *Batrachium aquatile*, *Potamogeton crispus*,

	Category	Name	Area (ha)	Cadaster	Characteristic
1	PLA	Poodří (northern part) – The Odra River Basin	1105.30	Polanka n/O., Poruba-jih, Proskovice, Stará Bělá, Zábřeh n/O., Stará Ves nad Ondřejnicí, Jistebník, Košatka n/O.	well-preserved river alluvium with the meandering Odra River, floodplain meadows, ponds and floodplain forests in good condition
2	NNR	Polanská niva (Floodplain)	123.30	Koblov, Polanka n/O.	well-preserved floodplain forest with the meandering Odra River
3	NNM	Landek	85.53	Petřkovice u Ostravy	hill with beech stands above the Odra R. and Ostravice R. confluence, natural outlet of a coal seam
4	NR	Černý les u Šilheřovic I	8.04	Šilheřovice	beech virgin forest typical of the Odra River plain
5	NR	Černý les u Šilheřovic II	7.69	Šilheřovice	overmature beech virgin forest
6	NR	Štěpán	46.99	Děhylov, Poruba-sever	silted up fish pond with reed swamps and important biota
7	NR	Přemyšov	30.79	Ostrava-Svinov, Polanka n/O.	well-preserved terrace of the Odra R. with a colourful biota
8	NR	Rezavka	83.68	Ostrava-Svinov	well-preserved complex of fish pond wetlands and incised Odra R. meanders
9	NR	Polanský les (Forest)	59.17	Poruba-jih	mixed floodplain forest with snowdrop
10	NR	Skučák	30.08	Rychvald	fish pond with rare flora and diverse avifauna
11	NR	Palkovické hůrky	18.33	Rychaltice, Sklenov	Beech-Fir woodland with linden and maple
12	NR	Rákosina	16.25	Jistebník	terrestrial reed swamp with tiny pools passing into wetland meadows and small floodplain stands
13	NM	Turkov	20.12	Poruba-sever	floodplain forest remainder, an important locality of amphibians and avifauna
14	NM	Porubský bludný balvan	0.01	Poruba	granite erratic boulder of 11 tons in weight
15	NM	Kunčický bludný balvan	0.01	Kunčice nad Ostravicí	the largest erratic block in Czech Republic (17.5 t)
16	NM	Rovninské balvany	0.01	Moravská Ostrava	erratic blocks
17	NM	Věřňovice	4.59	Věřňovice	riverine terrace with a mixed stand and abundant herb layer
18	NM	Meandry Lučiny	40.65	Havířov-město	floodplain with a meandering water course and well-preserved riparian stands
19	NM	Žermanický lom	1.95	Žermanice	flooded quarry and surrounding wetland with rare flora
20	NM	Kamenná u Staříče	2.83	Staříč	remainder of thermophilic flora with abundant insects
21	NM	Profil Morávky	49.64	Dobrá u Frýdku-Místku, Staré Město u Frýdku-Místku	profile of natural gravel carrying water course with a number of rick sills and rapids
22	NM	Pod hukvaldskou oborou	0.42	Kozlovice	Lokality of Ostrich Fern
23	PP	Hradní vrch Hukvaldy	77.00	Sklenov	unique complex of beech stands and natural landscape composition of historical game preserve near the castle

Tab. 1: List of particularly protected areas in the Ostrava Region
(PLA – Protected Landscape Area, NNR – National Nature Reserve, NNM – National Nature Monument, NR – Nature Reserve, NM – Nature Monument) – according to Kos & Maršálková (1997).

Anodonta cygnea, *Astacus fluviatilis*, *Triturus cristatus*, *Ixobrychus minutus*, *Circus aeroginosus*, *Alcedo atthis*, *Castor fiber* and many other. Most of these promising anthropogenically conditioned biotopes (Lacina, 2003) can be found in the Karviná region with extensive parts of the landscape being disturbed by subsidences.

With regard to the fact that the biotopes occur in regions which are still very severely disturbed due to the continuing coal mining or due to the follow up rehabilitation and recultivation works, their fate is often very unsure. A positive fact appears to be an ever incremental use of these newly arising biotopes in planning and implementation of the rehabilitation and recultivation measures for the damaged areas. If allowed by the future planned use of the territory, the newly developing biotopes would remain intact, their environmental value and eco-stabilizing effects on the surrounding landscape being further enhanced and supported by the controlled management (Fig. 7 – see cover p. 4).

5. Discussion and conclusions

There is a total of 22 small-scale protected landscape areas declared currently in the investigated territory whose south-western corner is being reached by a part of one large-scale protected landscape area – the Poodří (Odra River Basin) Protected Landscape Area. This network of areas particularly protected by the state combines with a number of other smaller but ecologically significant landscape segments such as small segments of floodplain forests, riparian stands along small water courses, game refuges, near-natural parts of forest complexes, semi-natural grasslands, wetland biotopes bound to fish ponds and other water surfaces, etc.

Ecologically significant landscape segments of the Ostrava Region can comprise also the prospective anthropogenically-conditioned biotopes which spontaneously develop in landscape parts impacted by humans. They develop in very different biotope types but they are observed to form most often in water-bearing subsided basins, being therefore biotopes of wetland character. There is a relatively large number of these biotopes at the present and many of them are used to regenerate the area through the method of controlled succession (Stalmachová & Frnka, 2003). It is most likely to be just a question of time when a prospective, anthropogenically conditioned biotope reaches a high environmental value to be granted the status of a particularly protected area.

The Ostrava Region has been experiencing a severe disturbance of natural environment and landscape character due to industrial and mining activities for about 150 years and this is why the existence of individual constituents of the skeleton of landscape ecological stability acquires such an extraordinary significance. The components are fundamental building stones for a gradual regeneration of the devastated landscape.

Regeneration of the landscape affected by coal mining is understood to be removal of losses in the landscape arisen due to coal mining and deposition of waste from the coal extraction on earth surface. The regeneration of these areas can be achieved by using two basic methods – natural revitalization and biotechnical recultivation (Stalmachová, 1996). However, the processes of natural revitalization take up a relatively long time and this is why arange of various methods of biotechnical recultivation were used until recently such as agricultural recultivation, forest recultivation, arbori-landscape recultivation or hydrological recultivation.

At the present time, it is possible to compare the success and suitability of incorporation of the already recultivated areas into the cultural landscape and to make a comparison between the recultivated areas with those which were not recultivated and which were a subject to natural revitalization. It is necessary to take into consideration at the assessment that the landscape in question is cultural landscape with a relatively high population density and high anthropogenic use. These are reasons why it is not advised to attempt only at a regeneration of the area in the sense of channeling its further development toward an absolute dominance of natural and near-natural types of ecosystems, but the regeneration should be rather directed toward a well-balanced cultural landscape with enough space both for socio-economic activities of the society and for the existence of ecologically valuable landscape segments.

The latest method of landscape regeneration is presently the method of controlled succession, which is a method of ecological landscape regeneration representing a near-natural approach in the rehabilitation of recent and damaged components in the open landscape. The method is based on autoregulative capacities of the vegetation and on natural processes occurring in regenerating biocoenoses. As mentioned by Stalmachová & Frnka (2003), the controlled succession can be classified in the group of so called special types of recultivation since it aims at the regeneration of natural and near-natural landscape components and constituents of diverse functional use such as forests, grasslands, wetlands, water surfaces, seats, etc.

It is therefore obvious that the regeneration of biodiversity and enhancement of ecological stability of the Ostrava Region landscape is realistic. It depends on us humans whether it is ever going to come true and in what ways.

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AIR POLLUTION IN THE OLOMOUC CITY IN THE PERIOD 1991 – 2000

Miroslav VYSOUDIL, Martin JUREK

Abstract

The nature and trends of air pollution in the city of Olomouc between 1991 and 2000 are discussed. This was a period of fundamental structural economic changes in the Czech Republic. The spatial distributions of SO_2, NO_x, particulate matter and O_3 were studied, and an air quality index was assessed. The ambient air quality of the city is most seriously affected by NO_x emissions, for which traffic is considered to be the principal source. Limit values of SO_2 and particulate matter are exceeded only in the case of considerably worsened pollutant dispersion conditions. During the decade studied, there was stagnation or even a decrease in the emission of SO_2 and suspended particulate matter. In the case of NO_x and ground-level O_3, the trend cannot be described unambiguously. According to the values of the annual air quality index IKO_r (SO_2, NO_x and suspended particulate matter values assessed), it is possible to consider air quality as relatively good in the city of Olomouc over the whole period 1991 – 2000. Values of IKO_r were mostly between 1 and 2, which is interpreted as a suitable air quality.

Shrnutí

Znečištění ovzduší v Olomouci v období 1991 – 2000

Příspěvek popisuje charakter a vývoj znečištění ovzduší ve městě Olomouci v letech 1991 – 2000, tj v období výrazných transformačních ekonomických změn v České republice. Bylo sledováno časoprostorové rozložení SO_2, NO_x, prašného aerosolu, O_3 a byl stanoven index kvality ovzduší. Ovzduší města nejvíce zatěžují emise NO_x. Jejich hlavním zdrojem je silniční doprava. Imisní limity SO_2 a prašného spadu bývají překračovány jen při značně nepříznivých rozptylových podmínkách. Během sledovaného desetiletí lze na území města u SO_2, a polétavého prachu pozorovat stagnaci až pokles hodnot imisních koncentrací, u NO_x a O_3, nelze stanovit jednoznačný trend. Podle hodnot ročního indexu kvality ovzduší IKO_r (SO_2 – NO_x – polétavý prach) lze označnit stav ovzduší v Olomouci v období 1991 – 2000 jako poměrně dobrý. Hodnota IKO_r se nejčastěji nacházela v intervalu < 1; 2), tj. vyhovující ovzduší, zdravé ovzduší.

***Key words**: air pollution, air quality, SO_2, NO_x, suspended particulate matter, ground-level O_3, Olomouc, air quality index*

1. Introduction

Air quality reached much better parameters during the decade 1991 – 2000 in the whole of the Czech Republic. Olomouc is situated in central Moravia (eastern part of the Czech Republic – Fig. 1). The city and its surroundings had rated as relatively unaffected by pollution already before the year 1990. Today the situation is satisfactory and local industry cannot be considered a serious source of air pollution. Nonetheless, significant changes in air quality occurred within the period 1991 – 2000; the aim of this paper is to describe the extent and type of these changes.

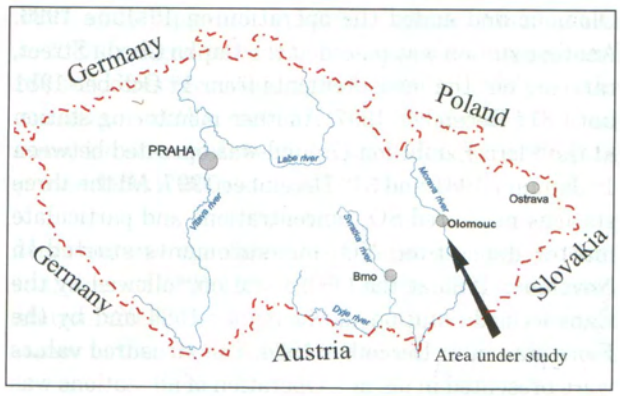

Fig. 1: Situation map

The article is based upon the analysis of data available from air quality measurements in the city, also using the data published by ČHMÚ (Czech Hydrometeorological Institute – CHMI), database of OHES (Public Health Service of the District) and database of the Municipal Authority of Olomouc. Stanislav Kadlčík dealt in detail with the problem in his dissertation of 2002.

2. History of air quality monitoring in the Olomouc City

Monitoring of air pollution began in Olomouc in 1969 as a manual measurement of concentrations of sulphur dioxide (SO_2) and particulate matter deposition. The measurements were made regularly for one year in five-year periods.

Station	Location	Responsible entity	Way of monitoring	Measured pollutants
Flora	city centre, nearby a large park	HS	stationary – manual	SO_2, NO_X, SPM
Čapka Choda	western part of the city	HS	stationary – manual	SO_2, NO_X, SPM
OHES	southern and south-eastern part of the city	HS	stationary – manual	SO_2, NO_X, SPM
CHMI	northern part of the city, sports ground	CHMI	stationary – AMS	SO_2, NO, NO_2, CO, NO_X, SPM, PM10 + meteorological measurements
Šmeralova	central part of the city, by the students' hostels	CHMI	stationary – AMS-HM	SO_2, NO, NO_2, O_3, NO_X, PM10, heavy metals
City Hall	city centre, City Hall building	MAO	stationary – semiautomatic	SO_2, NO_X
Hotelový dům	southern and south-eastern outskirts, nearby a frequented road	MAO	stationary – semiautomatic	SO_2, O_3, NO_X
Hodolany	eastern outskirts of the city	MAO	stationary – semiautomatic	SO_2, NO_X

Tab. 1: Air pollution monitoring stations in the Olomouc City in the period 1991 – 2000

Notes: HS – Public Health Service of the district, CHMI – Czech Hydrometeorological Institute, MAO – Municipal Authority of Olomouc

The manual measurement of particulate matter deposition was carried out by the sedimentation method. Data were recorded in milligrams per litre per day. Sulphur dioxide (SO_2) measurement used the method of absorption. Data were recorded in milligrams per litre and then transformed into milligrams per day.

Continuous monitoring stations launched their operation in Olomouc in 1981. The first of them was placed at the Public Health Service of the District (OHES), starting measurements on 1st January 1981. In 1989 the station was moved into ZTS (Závody těžkého strojírenství) Olomouc and ended the operation on 1st June 1990. Another station was placed at the Čapka Choda Street, carrying out the measurements from 1st October 1981 until 31st December 1997. Another monitoring station at the Flora Exhibition Ground was operated between 1st January 1981 and 31st December 1997. All the three stations measured SO_2 concentrations and particulate matter deposition. NO_x measurements started in November 1983 at the OHES station, followed by the Čapka Choda station in November 1984 and by the Flora station in December 1984. The measured values were presented in $\mu g. m^{-3}$. Operation of all stations was guaranteed by OHES.

Two stations were established in 1994. The CHMI station began to work on 26th January 1994 and the station at the Šmeralova Street began its operation on 1st February 1994. On 1st January 1995, the network of air pollution monitoring stations in the city of Olomouc was added a station in the City Hall, another one at the Hotelový dům and the third one in the Hodolany quarter.

3. Sources of air pollution

Stationary sources are the most important sources of air pollution in the city of Olomouc. Emissions of all observed pollutants (SO_2, NO_x, particulate matter, CO and C_xH_y) decreased in the period 1991 – 1999. The most significant decrease was recorded for SO_2: 87.7 %. Particulate matter emissions decreased by 86.7 %, CO emissions by 84.5 % and NO_x emissions by 72.5 %.

Air pollution sources are categorised by REZZO (Register of Emissions and Air Pollution Sources) into four classes (REZZO 1 – Large pollution sources, output more than 5 MW; REZZO 2 – Medium-sized pollution sources, output between 0.2 and 5.0 MW; REZZO 3 – Small pollution sources, output less than 0.2 MW; REZZO 4 – Mobile emission sources). Contribution of the respective categories to aggregate emissions of observed pollutants is shown in tables 2 and 3 for the years 1991 and 1999. The decrease in emissions from large and medium-sized pollution sources was a result of various programmes aimed at air quality improvement (modernisation of production plants, combustion of gas and light fuel oil instead of coal). Another influence on air pollution came with the reduction programmes in industry. Small pollution sources showed a certain decrease in emissions particularly resulting from the substitution of coal with gas in local heating.

Large and medium-sized sources are significant for emissions of SO_2 a NO_x. Small pollution sources represent a major source of CO, solid particles and hydrocarbons (there were 21,250 households in Olomouc in 1991).

Category of sources	SO_2	NO_X	Solid particles	CO	C_xH_y
REZZO 1	9,535.85	2,098.43	2,325.57	10,870.87	95.36
REZZO 2	945.24	168.50	434.93	1,038.65	9.45
REZZO 3	3,567.30	1,337.74	1,640.90	5,493.60	35.67
Total	14,048.40	3,604.40	4,401.40	17,403.12	140.48

Tab. 2: Overall emissions (in tons per year) in the Olomouc City in 1991 by REZZO categories
(according to Study material of the Olomouc City for the layout of municipal air-quality monitoring stations, 1993)

Teplárna Olomouc (Heating Plant Olomouc) and Špičková výtopna Olomouc (Peak Heating Plant Olomouc) were the most important sources of air pollution in Olomouc within the category REZZO 1. In 1999 their contribution in total emissions (from categories REZZO 1–3) reached 58.3 % for SO_2, 56.5 % for NO_x, 6.5 % for solid particles, 1.6 % for CO, and 6.7 % for hydrocarbons. Corresponding shares in REZZO 1 emissions were 95.2 % for SO_2, 85.3 % for NO_x, 39.4 % for solid particles, 18.2 % for CO, and 24.4 % for hydrocarbons.

Other significant sources of emissions can be named, the most important of them being Milo S. P. Olomouc, Mora – Moravia a. s. Hlubočky, Moravské železárny (Moravian Ironworks) and Sigma Slévárny Lutín a. s. (Sigma Iron Foundries Lutín).

As to mobile emission sources, a direct connection between the growing intensity of traffic and the NO_x + CO concentration increase was demonstrated (Study material of the Olomouc city for the layout of municipal air-quality monitoring stations, 1993). Maximum values of concentrations correspond to the traffic rush hours, especially from 3 to 5 p. m.

The number of vehicles passing the streets may be used to describe the traffic intensity in the Olomouc City. Traffic in some busy roads was observed, showing an extreme increase between 1990 and 1995. In 1995 there were 32,115 vehicles per day passing along the busiest road of Olomouc, the Velkomoravská Street (as compared to 15,553 vehicles per day in 1990). There is a general expectation of a continuing five-percent annual increase in the number of passing vehicles.

4. Ambient air pollution in the city of Olomouc in the period from 1991 – 2000

Sulphur dioxide (SO_2)

Interannual Variations (Fig. 2)

In 1991, SO_2 concentrations were monitored only at the stations of Flora (45 µg. m^{-3}) and Čapka Choda (48 µg. m^{-3}). There was a decrease in concentration levels recorded at the both stations between 1991 and 1992, then a slight increase occurred between 1992 and 1993, changing into a new decrease between 1993 and 1994, and reaching down to less than a half of the concentration values recorded in 1991.

In 1994, five new automatic stations started to monitor sulphur dioxide, while the Flora and Čapka Choda stations ended their operation in 1997. There was a steep decline of SO_2 concentration levels recorded at all of the stations, except for the City Hall station, where the mean annual concentration remained almost unchanged. Within the period 1991 – 2000, maximum values of mean annual concentrations were recorded at the Čapka Choda station (48 µg. m^{-3} in 1991) and at the Hodolany station (48 µg. m^{-3} in 1997 and 46 µg. m^{-3} in 1996). Concentration values in 2000 ranged between just a quarter and a third of the values recorded in 1997. The limit value of the mean annual SO_2 concentration (60 µg. m^{-3}) was not exceeded an any of the monitoring stations during the period 1991 – 2000.

Maximum average of the mean annual SO_2 concentrations in the period 1991 – 2000 was recorded at the Hodolany station (29.36 µg. m^{-3}), while the minimum average comes to the CHMI station (15.35 µg. m^{-3}).

Category of sources	SO_2	NO_X	Solid particles	CO	C_xH_y
REZZO 1	1,060.800	656.200	95.800	235.000	228.300
REZZO 2	144.591	130.216	131.290	243.089	98.420
REZZO 3	525.700	203.700	358.800	2,223.900	497.800
Total	1,731.091	990.116	585.890	2,701.989	824.520

Tab. 3: Total emissions (in tons per year) in the Olomouc City in 1999 by REZZO categories (according to Office of the District of Olomouc, 2000)

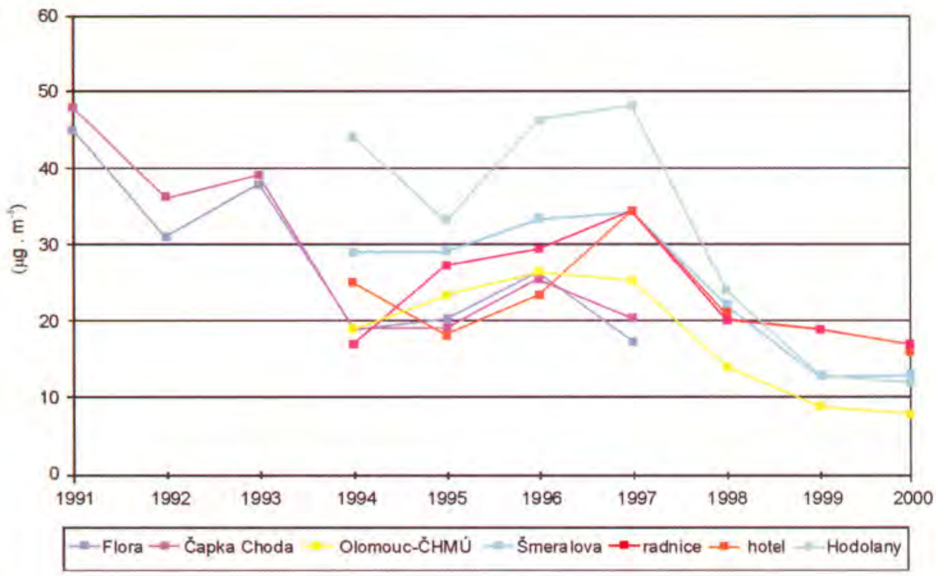

Fig. 2: Average annual SO_2 concentrations (in µg. m^{-3}) in the monitoring stations of Olomouc (1991 – 2000)

Cold and warm half a year characteristics

Higher values of the average monthly SO_2 concentrations occur in the cold half a year (October–March) as compared with the warm half a year (April–September). The least significant difference was recorded at the Hodolany station, while the most significant difference occurred at the Čapka Choda station. There is an obvious long-term decrease in average SO_2 concentrations in the winter season. The highest averages of the cold half a year were recorded at the Čapka Choda station (51.3 µg. m^{-3}) and at the Flora station (50.2 µg m^{-3}). The lowest average was measured at the CHMI station (24.8 µg. m^{-3}). Interannual course in the warm half a years was quite balanced at all stations within the studied period. There was just one exception – at the Hodolany station, which was showing maximum levels of average air pollution during the whole period 1991–2000 (37.7 µg. m^{-3}). The lowest average concentrations were recorded at the CHMI station (8.5 µg. m^{-3}).

Annual course

There is an obvious growth in air pollutant concentrations in the months of the cold half a year and a parallel decline in the warm half a year. The annual course was similar or nearly the same at all of the stations, the closest shape being recorded at the Flora and Čapka Choda stations. At the mentioned two stations the steepest increase was also recorded in the cold half a year (October–March) and the most significant decrease in the period from February–April. From April to October the highest concentrations were recorded at the Hodolany station.

Extreme values

The maximum averaged 24-hour concentration of SO_2 was recorded in December 1991 at the Čapka Choda station (512 µg. m^{-3}), while the minimum of 1 µg. m^{-3} was reached down at various stations in a wide range of months during the period under study.

Spatial distribution of SO_2 concentrations (Fig. 3 – see cover p. 2)

Spatial distribution of mean annual SO_2 concentrations was studied in a more detailed look for the years 1994, 1997 and 2000.

In the year 1994, the eastern part of the city was the most seriously affected area. Mean annual SO_2 concentrations were 32.0–44.1 µg. m^{-3}. Medium mean annual SO_2 concentrations were recorded in the southern and south-eastern part of the city (20–32 µg. m^{-3}). The least polluted parts of the city were the historical core and the north-west (17–20 µg. m^{-3}).

In 1997, the eastern part of the city (areas eastwards of the Morava River) was the most polluted again. Mean annual SO_2 concentrations ranged between 36–48 µg. m^{-3}, with the intensity of pollution increasing from the east to the west. In the northern and southern parts together with the historical core, the concentrations of SO_2 reached 28–36 µg. m^{-3}. The least affected parts of the city were the west and the north-west (concentrations ranging between 20–28 µg. m^{-3}).

In 2000, mean annual SO_2 concentrations ranged between 8.0–17.3 µg. m^{-3}. Concentrations between

14.0–17.3 µg. m^{-3} were recorded in the historical core and in the south-west. The western part of the city showed the concentrations of 12.0–14.0 µg. m^{-3}. In other parts of the city, the concentrations were as low as 7.0–12.0 µg. m^{-3}.

Nitrogen oxides (NO_x)

Interannual variations (Fig. 4)

An almost balanced interannual course occurred at the Flora and Čapka Choda stations (monitoring between 1991–1997). Stagnation at the Flora station, increase at Hotelový dům and CHMI and decrease at the other four stations were recorded in years 1994 and 1995. In 1995 – 1996, the NO_x concentrations declined at the CHMI, Hotelový dům, Flora and Čapka Choda stations, but increased at the City Hall, Hodolany and Šmeralova stations. The period of 1996 – 1997 showed a slight increase or stagnation at the Flora, Čapka Choda and Šmeralova stations, but a steep growth at the other ones. In the years 1997 and 1998, the concentrations increased at the Šmeralova and Hotelový dům stations, while decreasing at the other ones. A steep decrease occurred at the Hodolany station between 1998–1999, but the concentrations showed a general decrease at all monitoring stations. A new increase started between 1999 and 2000, except for the Hotelový dům station.

The highest mean annual NO_x concentration in 1991 – 2000 was recorded at the Hotelový dům station (64.17 µg. m^{-3}), and the lowest one was recorded at the Čapka Choda station (23.7 µg. m^{-3}).

As compared with the long-term period of measurements, the interannual course between the years 1991 – 1994 was quite balanced. There was a decrease between 1994 and 1996, followed by a new steep increase until 1997, then a decrease again (reaching down to the situation of 1995, except for the Hotelový dům station), turning into a slight increase between 1999 and 2000. The limit for annual NO_x concentration (80 µg. m^{-3}) was exceeded only once – at the Hotelový dům station in 1998 (87 µg. m^{-3}). The highest mean annual concentrations were recorded at this station during the whole studied period and resulted most likely from the proximity of the station to the main traffic lines stretching through the city of Olomouc.

Cold and warm half a year characteristics

Similarly as the SO_2 concentrations, their levels were higher at the cold half a year. The least significant difference occurred at the Čapka Choda station, the most significant one at the Šmeralova station. The interannual course appears similar at all stations. The highest average concentrations in the cold half a year (82.2 µg. m^{-3}) were recorded at the Hotelový dům station during the whole period, while the lowest average concentrations were measured at the Čapka Choda station (29.1 µg. m^{-3}). In the warm half a years of 1991 – 2000 there was a balanced course at the Flora, Čapka Choda, CHMI and Šmeralova stations. A wider range of concentrations was recorded at other stations. A steep growth occurred between 1995 and 1997 at the Hodolany station and between 1996 and 1998 at the Hotelový dům station. The most significant decrease was observed at the Hodolany station in the period of 1997 – 1998 and at the Hotelový dům station in the period from 1998 – 1999. The highest average concentrations during the warm half a years of 1991 – 2000 were recorded at the Hotelový dům station (56.8 µg. m^{-3}), except for just one value higher at the Hodolany station (in 1996). The

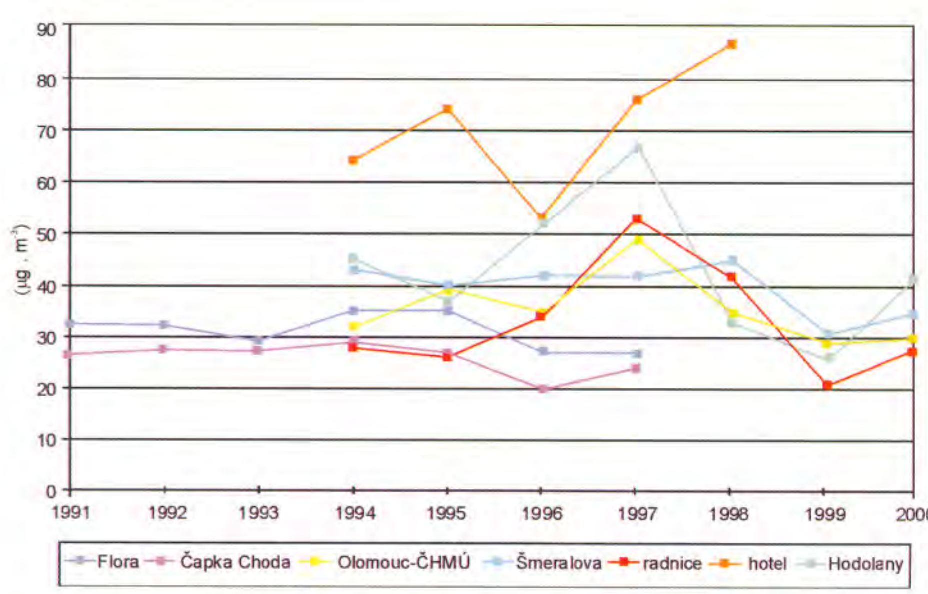

Fig. 4: Mean annual NO_x concentrations (in µg. m^{-3}) at the monitoring stations in Olomouc (1991 – 2000)

lowest average concentrations were recorded at the Čapka Choda and CHMI stations (20.8 µg. m^{-3}).

Annual course

The average monthly NO_x concentrations were increasing regularly in the cold half a years, but this feature is not as significant as in the case of SO_2. There is an exception at the Hotelový dům station, where the steepest growth was bound to January – February and August – November. The highest NO_x concentrations were recorded at the Hotelový dům station during the period 1991 – 2000 all year round.

Extreme values

The maximum average diurnal NO_x concentration of 368 µg. m^{-3} was reached in January 1993 at the Flora station, and the minimum average diurnal concentration of 1 µg. m^{-3} was recorded in May 1995 at the Hodolany station.

Spatial distribution of NO_x concentrations (Fig.5 – see cover p. 2)

Spatial distribution of mean annual NO_x concentrations was measured for the years 1994, 1997 and 2000.

In 1994, the highest mean annual NO_x concentrations in the south-western part of the city were bound to the proximity of main road crossings. There was a belt of concentrations between 36 – 50 µg. m^{-3} neighbouring to the most affected area, and the eastern part of the city reached 36 – 46 µg. m^{-3}. The mean annual concentrations were showing an increase in the direction from the east to the west, the lowest values having been recorded in the historical core and in the north-western part of Olomouc.

In 1997, the most affected area was that around the Hotelový dům station (55 – 76 µg. m^{-3}). Another severely polluted part of the city was the area east of the Morava River (55 – 67 µg. m^{-3}). Least polluted were the eastern and north-western parts of the city (23 – 40 µg. m^{-3}) and the areas located to the south and south-west of the town centre (27 – 40 µg. m^{-3}). In the remaining parts of the city, the concentrations amounted to 40 – 55 µg. m^{-3}.

The situation in 2000 was similar to the situations of 1994 and 1997. The most polluted area was the south-western part of the city (50 – 59 µg. m^{-3}). Medium NO_x pollution was bound to a belt bordering with the area mentioned above (44 – 50 µg. m^{-3}) and the eastern half of the city (37 – 44 µg. m^{-3}). Least polluted were the historical core, and the north or north-west (27.5 – 37 µg. m^{-3}).

Suspended particulate matter (SPM)

Interannual variations (Fig 6)

In the period 1991 – 1994, SPM was monitored only at the Flora and Čapka Choda stations. Two other stations were added in 1994: the CHMI and the Šmeralova station. It is possible to read a similar trend of interannual variations – a stagnation and a slight decrease, except for the period between 1995 and 1996. A steep decline occurred at the CHMI station, while there was a certain increase at the Flora, Čapka Choda and Šmeralova stations.

The highest mean annual SPM concentration for the period 1991 – 2000 was recorded at the Flora station (53.92 µg. m^{-3}), and the lowest one at the Šmeralova station (36.27 µg. m^{-3}).

Month	518	519	1075	1197
I	74.8	59	51.8	52.3
II	83.5	66.3	59.8	53.7
III	75.5	56.7	47	43.8
IV	66.5	40.3	41	33.6
V	48.4	33.8	39.4	29.6
VI	45.0	33.2	31.3	29
VII	45.0	33.3	35.2	31.5
VIII	45.4	35.3	34	35.2
IX	43.4	33.8	30.1	36
X	59.2	45.5	36	41.6
XI	54.3	41.3	46.1	43.2
XII	60.0	43	47.3	42
year	53.92	40.12	38.38	36.27
X – III	67.9	52.0	48.0	46.1
IV – IX	49.0	35.0	35.2	33.8

Tab. 4: Mean monthly SPM concentrations (µg. m^{-3}) in Olomouc (1991 – 2000)

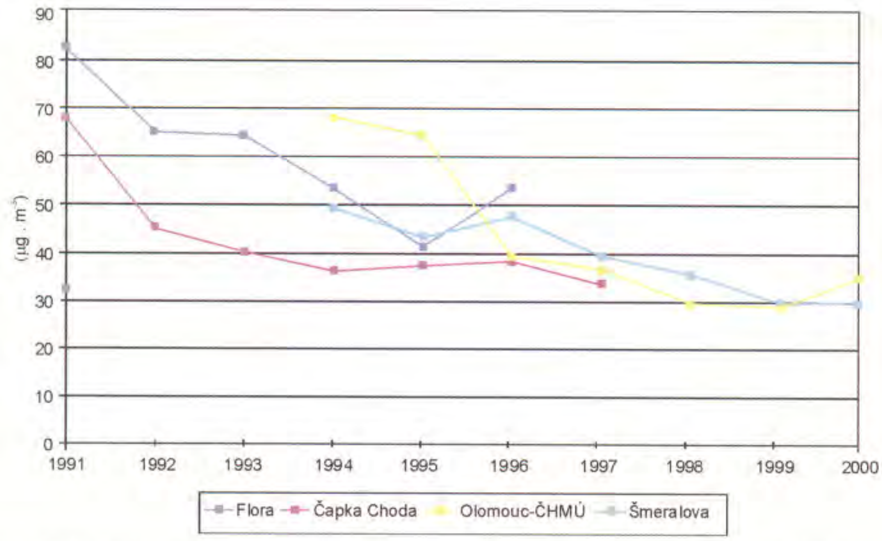

Fig. 6: Mean annual SPM concentrations (µg. m⁻³) measured at the monitoring stations in Olomouc (1991 – 2000)

The annual concentration limit (60 µg. m^{-3}) was exceeded six times during the period 1991 – 2000. In 1991, such an extreme occurred at the Flora (83 µg. m^{-3}) and Čapka Choda stations (68 µg. m^{-3}), in 1992 at the Flora station again (65 µg. m^{-3}), in 1993 also at the Flora station, while in 1994 – 1995 the limit value was exceeded at the CHMI station (68 µg. m^{-3} in 1994 µg. m^{-3} and 64 µg. m^{-3} in 1995).

Cold and warm half a year characteristics

The SPM concentrations were higher in the cold half a year, but the range of extreme concentrations is almost the same at all stations. Interannual variations of the average SPM concentrations were similar at all stations as well. Only at the Flora station, the increase in 1996 – 1997 was going against the decrease recorded at all other stations. The highest average concentrations in the cold half a year were reached at the Flora station (68.1 µg. m^{-3}), the lowest at Šmeralova station (46.5 µg. m^{-3}). The variations of average SPM concentrations in the warm half a years 1991 – 2000 are similar to the variations in 1991 – 1994 and 1996 – 2000 (except for the Flora station in the years 1996 – 1997). A steep decline in the concentrations recorded at the Flora station in 1994 – 1995 turned into a steep growth between 1995–1996. A significant decrease occurred at the CHMI station in 1995–1996. The highest average monthly SPM concentrations in the warm half a year were reached in a long-term period at the Flora station (50 µg. m^{-3}), the lowest ones at the Šmeralova station (32.3 µg. m^{-3}).

Annual course

The annual course appears very similar for all stations. The highest concentrations were reached in February, then there was a decrease starting in May, followed by a stagnation until October, which turned into a new increase again. The highest values throughout the year were recorded at the Flora station in the period 1991 – 2000.

Extreme values

The maximum diurnal SPM concentration was reached at the Flora station in January 1991 (390 µg. m^{-3}). On the other hand, SPM concentrations were very close to zero in some months.

Spatial distribution

Spatial distribution of mean annual SPM concentrations was assessed for the years 1994 and 1997.

In 1994 isolines marking the constant SPM concentration levels were running approximately in the east-west direction, turning to the north-east and to the north at the eastern margin. The most affected areas were the south-western, southern, south-eastern and eastern parts of the city (56 – 64 µg. m^{-3}). The concentrations were decreasing to the north (42 – 56 µg. m^{-3}), reaching the lowest values of 42 – 34 µg. m^{-3}.

In 1997, the most affected parts of the city were the east, the historical core and the area to the north of it. Mean annual concentrations ranged between 64 – 70 µg. m^{-3}. These areas were bordered by a belt of slightly lower concentrations (56 – 64 µg. m^{-3}). Least affected were the eastern areas next to the historical core and the southern areas (48 – 56 µg. m^{-3}). The lowest concentrations (36 – 56 µg. m^{-3}) were recorded in the western part of the city. In general, the concentrations were decreasing from the east to the west.

Ground-level ozone (O_3)

Ground-level ozone, unlike its stratospheric relative, rises in chemical reactions from precursors such as nitrogen oxides or volatile organic compounds, making use of the sunshine and oxygen.

Interannual variations (Fig.7)

The ground-level ozone concentrations were monitored in Olomouc during 1991 – 2000 at two stations only: Šmeralova station (in 1995 – 2000) and Hotelový dům station (in 1996 – 1998). Šmeralova station exhibited some growth in the values between 1995 and 1996, which was followed by a decrease in 1996 – 1997 and a new growth in 1997 – 2000. Hotelový dům station exhibited an increase in 1996 – 1997 and a slight decrease in 1997 – 1998. As compared with Station Hotelový dům, Šmeralova station recorded higher concentrations during the whole period 1991 – 2000.

The higher O_3 concentration in 1995 – 2000 was bound to the Šmeralova station (47.15 µg. m^{-3}), while the concentrations were lower at the Hotelový dům (35.18 µg. m^{-3}).

Cold and warm half a year characteristics

The concentrations were higher in the winter half a year. In the average O_3 concentrations for the winter half a years of the period from 1995 – 2000 there are two clear points of the maximum (in 1996 and 1999), bridged by a balanced period of 1997 – 1998. At the Hotelový dům station, there was an increase in the period 1996 – 1997, followed by a stagnation between 1997 and 1998. Average monthly concentrations for the winter half a years of 1995 – 2000 were ranging between 25 – 40 µg. m^{-3} (Šmeralova station 32.2 µg. m^{-3}, Hotelový dům station 34.8 µg. m^{-3}). Average monthly concentrations for the summer half a years of 1995 – 2000 follow a balanced trend at the Šmeralova station during the whole studied period. At the Hotelový dům station, the increase in1996 – 1997 changed into a stagnation in 1997 – 1998. At the Šmeralova station, the average monthly concentration for the summer half a year was 70 µg. m^{-3}, at the Hotelový dům it amounted to 41.2 µg. m^{-3}.

Annual course

The period of monitoring the ground-level ozone concentrations in Olomouc is not long enough to obtain a representative analysis of the annual course of average monthly O_3 concentrations. At Šmeralova station, there was a typical increase in the concentrations between January and April, maximum levels having been reached in April and May and the high level of concentration continued between May and August. A steep decline started in August.

Extreme values

The maximum average diurnal O_3 concentration reached 153 µg. m^{-3} in April 1996 at the Šmeralova station, and the minimum average diurnal O_3 concentration of 3 µg. m^{-3} occurred several times at both the Šmeralova and the Hotelový dům stations.

Spatial distribution of ground-level ozone concentrations

There is no possibility to draw maps that would represent the situation in the O_3 concentrations during 1995 – 2000, the reason being lack of data available. It may

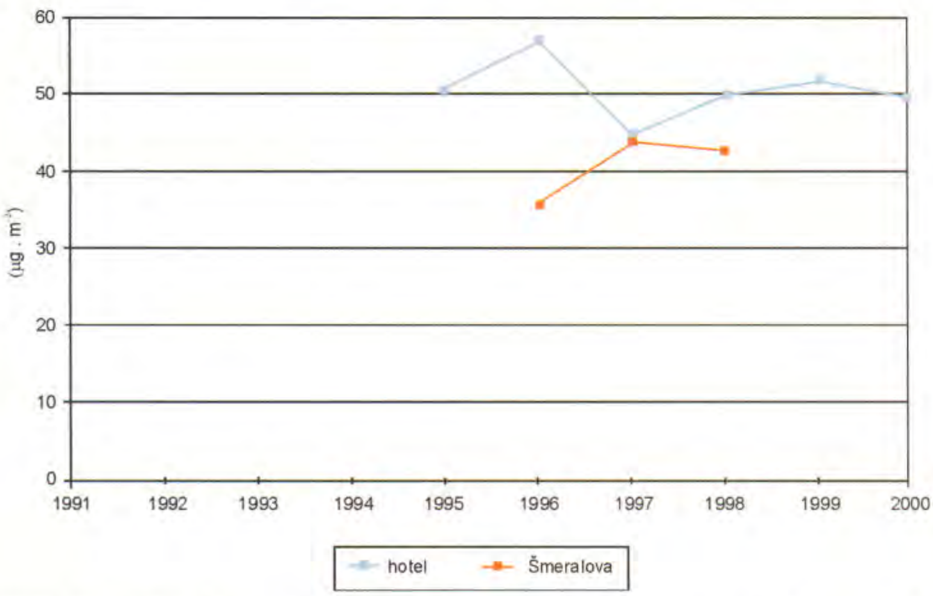

Fig. 7: Mean annual ground-level ozone concentrations (in µg. m^{-3}) at the monitoring stations in Olomouc (1995 – 2000)

be expected that the ground-level ozone concentrations were increasing from the north-western parts to the south-eastern parts of the city.

5. Air quality index

Air quality index (IKO) is a standard tool to assess the complex influence of pollutants in the ambient air onto the population's health. Methodology of calculating the index was among other things described by B. Kotlík (1997). The index helps in the assessment of air quality based on pollutant concentration measurements. It has both a numerical and a verbal expression to quantify the amounts at which the studied pollutants can affect the population:

- IKO_r 0 to 1 = clean, healthy ambient air,
- IKO_r 1 to 2 = health-suitable ambient air,
- IKO_r 2 to 3 = slightly polluted, health-acceptable ambient air,
- IKO_r 3 to 4 = polluted ambient air, sensitive persons endangered.

The air quality index is calculated from annual, diurnal or short-term concentrations of the monitored pollutants. All pollutants with a stated concentration limit value can be incorporated into the IKO assessment.

IKO_r (SO_2 + NO_x)

The IKO_r (SO_2 + NO_x) values developed in a similar way at all stations during the period 1991 – 2000. There was a slow decrease in 1991 – 1994, followed by a balanced course in 1994 – 1996. A new increase occurred in 1996, reaching to a maximum in 1997 and decreasing again, turning into another increase in 1999 – 2000. The maximum levels of IKO_r (SO_2 + NO_x) were reached at Hotelový dům and Hodolany during the studied period.

Spatial distribution (Fig. 8)

In 1994, the IKO_r field values ranged between 0.95 – 1.95 (health-suitable ambient air). The values were increasing in the direction from the north-west to the south-east or east. The maximum values were recorded around Hodolany (1.95) and Hotelový dům (1.82), the lowest values were bound to the south-western part of the city.

In 1997 the IKO_r(SO_2 + NO_x) ranged between 0.95 and 2.45. The values were increasing from the north-west to the south-east. Areas around Hotelový dům (index values 2.0 – 2.3) and around Hodolany in the eastern part of the city (index values 2.0 – 2.45) were classified into the category of *slightly polluted, health-acceptable ambient air*. Most of the city showed values ranging between 1.0 and 2.0 which means *health-suitable ambient air*. The lowest values of IKO_r, not exceeding

Station	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Flora	1.73	1.38	1.50	1.13	1.16	1.7	0.93	-	-	-
Čapka Choda	1.69	1.25	1.48	1.01	0.97	0.97	0.95	-	-	-
CHMI	-	-	-	1.07	1.38	1.08	1.54	1.01	0.77	0.76
Šmeralova	-	-	-	1.52	1.40	1.64	1.61	1.38	0.91	0.98
City Hall	-	-	-	0.95	1.14	1.36	1.83	1.28	0.84	0.95
Hotelový dům	-	-	-	1.82	1.84	1.57	2.30	2.15	-	1.51
Hodolany	-	-	-	1.95	1.48	2.14	2.45	1.20	0.82	1.08

Tab. 5: Annual air quality index – IKO_r (SO_2 + NO_x) at the stations in Olomouc in 1991 – 2000 (according to the Historical analysis of SO_2, NO_x and SPM data measured in the city of Olomouc (1999) and S. Kadlčík (2002)

Station	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Flora	3.17	2.69	2.83	2.12	1.85	2.23	2.15	-	-	-
Čapka Choda	3.05	2.13	2.22	1.64	1.64	1.74	1.57	-	-	-
CHMI	-	-	-	2.47	2.61	1.73	1.98	1.40	1.21	1.05
Šmeralova	-	-	-	2.33	2.09	2.42	2.20	1.82	1.34	1.38
City Hall	-	-	-	2.35	-	-	2.47	1.45	-	-
Hotelový dům	-	-	-	2.62	-	-	3.06	2.43	-	-
Hodolany	-	-	-	3.10	-	-	3.08	1.98	-	-

Tab. 6: Annual air quality index – IKO_r (SO_2 + NO_x + SPM) at the stations in Olomouc in 1991 – 2000 (according to the Historical analysis of SO_2, NO_x and SPM data measured in the city of Olomouc (1999) and S. Kadlčík (2002)

1.0 (*clean, healthy ambient air*), were recorded around the stations of Flora (0.93) and Čapka Choda (0.95) in 1997.

In the year 2000, the IKO_r values were lower as compared with the values of 1994 and 1997 all around the city. They were ranging between 0.76 to 1.51 (categories *clean, healthy ambient air* and *health-suitable ambient air*). The highest values were reached at the stations Hotelový dům (1.51) and Hodolany (1.08).

IKO_r (SO_2 + NO_x + SPM)

Values of IKO_r (SO_2 + NO_x + SPM) were decreasing gradually in the whole period from 1991 – 2000. The most significant decrease occurred between 1997 – 1998. Concerning the average values of IKOr, the order of the stations is as follows: Hodolany (2.72), Hotelový dům (2.70), Flora (2.43), City Hall (2.09), Čapka Choda (2.00), Šmeralova (1.94) and CHMI (1.78).

The IKO_r values ranged between 1.57 and 3.08 in 1997, increasing in the direction from the north-west to the south-east. The highest levels, corresponding to the category of *polluted ambient air, sensitive persons endangered* (index values between 3 and 4), were recorded around the stations of Hodolany (3.08) and Hotelový dům (3.06). In most parts of the city, the index values were ranging between 2 and 3 (*slightly polluted, health-acceptable ambient air*). Only the value recorded for the Čapka Choda station and its surroundings (1.54) was classified as *health-suitable ambient air*.

6. Conclusion

Spatial distribution and air pollution values in the city of Olomouc are determined by the location and structure of air pollution sources and also by the character of the prevailing dispersion conditions. The largest sources of air pollution in the Olomouc area included traffic (road traffic in particular), Heating

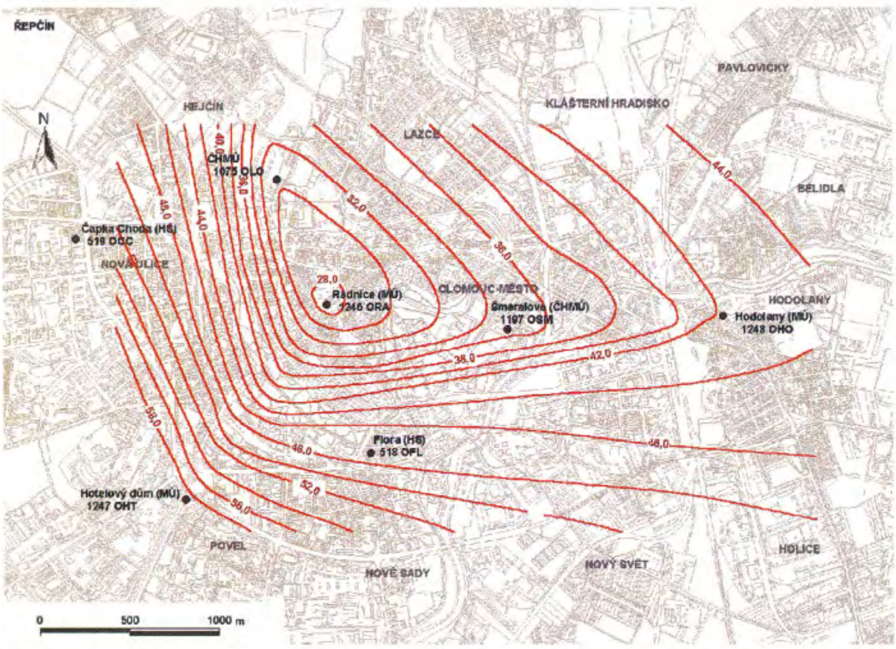

Fig. 8: Spatial distribution of IKOr (air quality index- annual) in Olomouc 1991-2000

Spatial distribution

Index values ranged between 1.64 and 3.1 in 1994, increasing in the direction from the west to the east. The maximum value (3.10) was recorded around Hodolany (*polluted ambient air, sensitive persons endangered*), followed by the value around Hotelový dům (2.62). In most parts of the city, the IKO_r values ranged between 2 and 3 which is *slightly polluted, health-acceptable ambient air*. Areas around the Čapka Choda station were characterised by values ranging between 1 and 2 which is *health-suitable ambient air*.

Plant Olomouc, Peak Heating Plant Olomouc, local heating and construction works. According to the meteorological characteristics, the most significant feature is the prevailing north-western wind, resulting in a gradual increase of air pollutant concentrations in the direction from the north-west to the south-east. Also the more often occurring inversions during the cold half a year result in higher air pollutant concentrations and possibly exceeded air pollution limits. Both the prevailing wind direction and the occurrence of inversions are partly given by the terrain features in Olomouc and its surroundings.

The most severe impact on the ambient air in the city comes from the emissions of NO_x, both the half an hour concentration limits and the average diurnal concentration limits being exceeded. The largest source of the emissions is traffic (contributing up to 70 % of the whole amount). A certain improvement can be expected after a new road bypass is completed. Air pollution limits for SO_2 and suspended particulate matter (secondary suspension prevailing) were exceeded only under extremely unfavourable dispersion conditions. A current issue is pollution by ground-level ozone; the monitoring of its concentrations needs to be further extended. In a long-term comparison, stagnation or decrease occur in air pollution with SO_2 and SPM, but no significant trend can be recognised for NO_x and ground-level ozone.

Air quality index $IKO_r(SO_2 + NO_x + SPM)$ indicates a relatively good air quality in the city of Olomouc during the period 1991 – 2000. The index values were reaching up to 2 or 3 during the studied period, which means a *slightly polluted, health-acceptable ambient* air. The most frequent IKO_r values ranged between 1 and 2, which is *health-suitable ambient air*. The maximum IKO_r values were reaching up to the interval of 3 to 4 (*polluted ambient air, sensitive persons endangered*), but this was only episodic. The most seriously affected parts of the city were areas in the east and south-east (Hodolany and the areas close to the crossing of Velkomoravská and Brněnská streets, by the Hotelový dům).

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SEASONAL ASPECT OF URBAN CRIME IN SLOVAKIA

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Abstract

The pronounced increase in the incidence of crime in Slovakia after 1989 is a serious negative consequence of the political and economic changes. The increasing trend in crime, as evidenced by detailed monthly analyses, shows periodic oscillations, i.e., a seasonal effect. The oscillations result from the continuing effects of the transformation, especially those of an economic and social nature. An estimation of the significance of seasonality and the selection of relevant information on laws of seasonal effects, for the sample of towns in Slovakia and for some types of crimes, contributes to both theory and methodology, as well as to the practical control of crime in the towns analyzed. The derived SI [seasonal index] values make possible the identification of important temporal horizons of crime incidence and to classify the risk periods (months) in the towns under study. The information gained from this research can be used in future sociological studies focusing on the social and temporal determinants of crime in urban environments.

Shrnutí

Sezónnost kriminality ve slovenských městech

Vážným negativním důsledkem politicko-ekonomických změn na Slovensku pro roce 1989 je výrazný nárůst kriminality. Stoupající tendence zločinnosti vykazují při detailních měsíčních analýzách periodické výkyvy (sezónní vlivy). Tyto výkyvy jsou výsledkem objektivních transformačních vlivů, zejména sociálního a ekonomického charakteru. Zhodnocení významu sezónnosti vybraných druhů kriminality a získání relevantních informací o zákonitostech sezónních vlivů ve vybraných městech Slovenska má mimo teoreticko-metodologického přínosu i praktický význam při kontrole a potlačování kriminality v analyzovaných městech. Získané hodnoty sezónních indexů umožňují identifikovat důležité časové horizonty páchání zločinnosti a klasifikovat riziková období ve vybraných městech. Poznatky této studie mohou zároveň sloužit pro další, především sociologické výzkumy zaměřené především na sociálně-časové podmíněnosti kriminality v městském prostředí.

Key words: *urban crime, spatial and temporal differentiation, seasonal index, risk period, Slovakia*

A significant increase of numerous negative socio-pathological phenomena has been observed in Slovakia after the year 1989. Crime that of course had existed before 1990, but due to its extraordinary increase and serious consequences for individuals, families and the whole society, is considered to become one of the most important problems of the present time. This fact was corroborated also by a recent public inquiry carried out by the Institute for Public Opinion Research, a body of the Statistical Office of the Slovak Republic. The question is which of the four presented problems (unemployment, health care, crime and standard of living) should be tackled first. A distinct deterioration of safety in some regions and urbanized areas provokes a justified concern of the population in the security of their properties and lives.

An important task of the integrated research of crime is to know its development at time. Manifestations of crime can be observed in short or long time spans and classified by the nature of individual criminal acts. For instance, the rate of accidents can be followed in very short intervals (hours or days), while a greater part of criminal acts can be monitored over longer intervals, month or year and more. Dynamics of crime development over long or short intervals is a subject to observation of changes of the statistics of the particular type of crime i.e. how quickly they have been changing, whether they grew or dropped. Less attention is paid to the research of seasonal nature of the particular criminal acts although the contribution to its practical control has improved. The generally known increasing trends of crime development in Slovakia as based on monitoring yearly time orders and detailed monthly analyses show certain periodic oscillations caused by seasonal effects. These oscillations or periodicity result from the objective influences of economic and social nature (Pusztai, 1995). The aim of this study is to point at a significance of the seasonal nature of some selected types of crime (general violence, property, larceny, burglary) and to express the quantitative empirical data by means of seasonal indices with an accompanying analysis of the results and selection of relevant information on laws controlling the seasonal influences of the studied crime in the Slovak towns under study.

The informative value of the chosen set can be considered sufficiently representative as the followed single types of crime in these towns represent more than 90 % of total registered crime on a national scale. The analyzed set of 43 towns consists of the administrative centers of 38 districts, the rest being towns with higher population numbers. The population of these towns represented 41.2 % of total Slovak population by the end of 1996. The chosen towns are also the largest settlements in their respective regions and their population amounts to 11-60 % of the population of their respective districts. Two municipal districts, Bratislava and Košice represent an exception with a 100 % share of population, being both districts. Compared to the share of population as stated above the share of crime is, however, much higher. In spite of the fact that the population of our set of towns constitutes less than a half of the total Slovak population, its share in the total number of criminal acts in Slovakia is 97 %; individual proportions of violence, burglaries, property crime and larceny being 93.5 %, 96.9 %, 97.7 %, and 98.3 %, respectively.

Theoretical and methodological basis

Besides the basic steady and permanently acting factors, the development of crime and especially of some of its types is influenced also by periodically acting factors, which cause occasional oscillations. If the period appears during the year, we speak of seasonal influences. It means that the seasonal component occurs only in a short-term order, i.e. such where the time variable represents periods shorter than a year. As generally known, most of the seasonal influences are always acting under more or less intensive seasonal effect. In addition to the effects provoked indirectly by natural agents, there are also other oscillations provoked by usages, tradition and the like (periods around Christmas are remarkable for a distinct drop of crime in Slovakia, for instance). We tried to measure the seasonal effects by seasonal indices (SI). They are proportional figures and their empirical data of short-term time order are compared to annual averages. SI and their application are rather important. Methodology of Cyhelský et al. (1978) was used for the calculation of SI. Before the calculation of moving averages and SI it was necessary to find a comparable basis for the analyzed data with regard to the different number of days in individual months of the year, as well as the different number of days in February 1996. The data for each month were then calculated for a standardized month of 30-days. Firstly the moving annual totals as sequential sums of an order of twelve values were calculated. These values rendered centered annual moving totals as an arithmetical mean of two contiguous values of annual moving total. Using the centered annual moving totals we calculated annual moving averages (centered annual moving totals divided by twelve). Dividing the real values for "normalized" 30 day months by annual moving averages SI were obtained. Out of seasonal indices for any single month arithmetic mean was calculated and the result are the proper SI for any month of year which are mutually comparable and make it possible to arrive at basic conclusions concerning the seasonal oscillation of values in the chosen types of crime.

The quoted method was used for processing data of the chosen types of crime in 43 Slovak towns and for a comparison with the 1995-1997 data on the Slovak Republic (SR) as a whole. The aim of our research is to verify whether the general theories of property and violent crime are also applicable in the Slovak towns. One of the ways of application of SI is classification of towns of the SR which analyses and clusters towns on the basis of obtained seasonal indices, i.e. it selects certain groups of towns with approximately the same level of crime or with the same time occurrence of the particular crime studied. The outlined algorithm of town clustering represents what is called a division variation and above all it makes it possible to obtain a certain idea on the rate of risk in the selected towns during the year.

Development and spatial differentiation of crime in Slovakia

The period after 1989 is remarkable for a rapid increase of crime in Slovakia. Both the quantity (volume) and the quality (structure, methods and composition of offenders) have changed. Development of crime in general and successful criminal investigation in years 1988 – 1997 are represented in Fig. 1 and 2 showing the quantity ceiling of the registered crime in 1993. Decrease of crime incidence in the years to follow was much determined by changes in statistics (amendment of the Criminal Code, it does not comprise/prosecute the caused offenses or damage below the value of 5,000 Slovak Crowns). The real drop of crime rather concerns serious types of offenses, namely those that are characterized by a higher rate of successful criminal investigation. Another trend detectable after 1994 was the rapid increase in damage due to crime, i.e. the danger of crime increased. In the study period also the structure of crime changed while new forms of crime (drugs, racketeering, organized crime, hijacking, and the like) emerged, often in an environment of the absence of legal measures, when the facts of cases legally did not exist. Also the methods and composition of offenders was rapidly changing after 1989. The relative number of "old lags" was dropping in

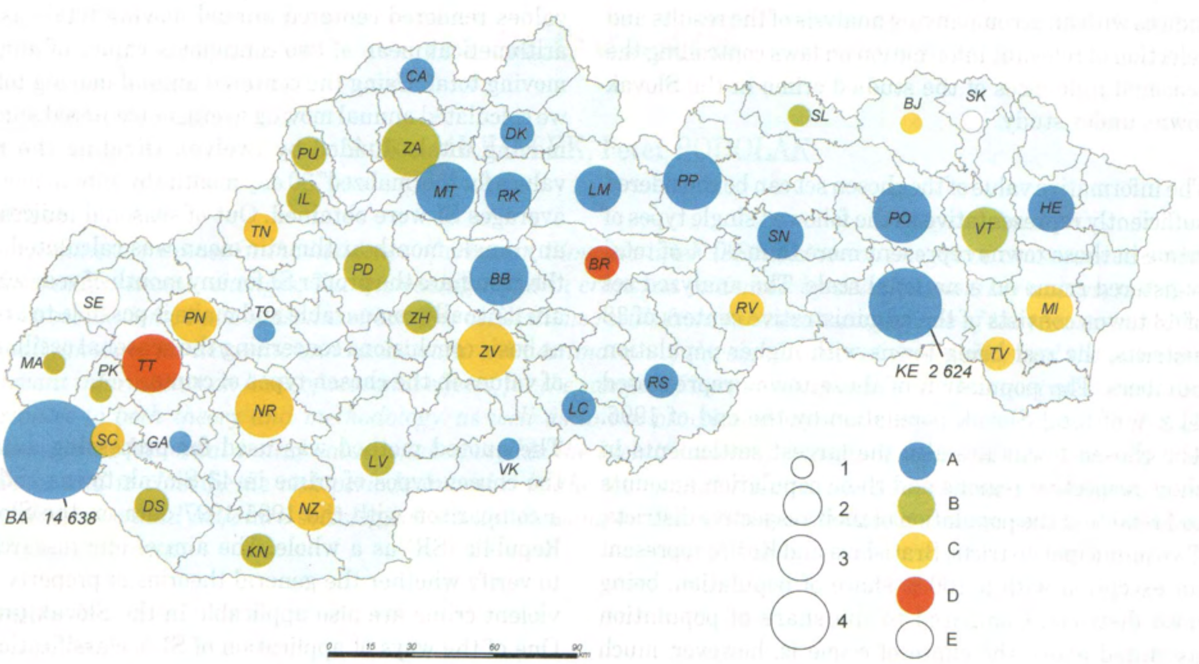

Fig. 1: Seasonality of overall crime in Slovakia

Number of acts of violence (second half of the 90's, annual average): 1 – below 100; 2 – 100 – 199; 3 – 200 – 299; 4 – 300 and more

Risk season of robberies: A – winter; B – spring; C – summer; D – autumn; E – without seasonality

LIST OF ABBREVIATIONS OF OBSERVED TOWNS (Fig. 1 ,2 ,4 and 5)

BA - Bratislava, BB - Banská Bystrica, BJ - Bardejov, BR - Brezno, CA - Čadca, DK - Dolný Kubín, DS - Dunajská Streda, GA - Galanta, HE - Humenné, KE - Košice, KN - Komárno, LC - Lučenec, LM - Liptovský Mikuláš, LV - Levice, MA - Malacky, MI - Michalovce, MT - Martin, NR- Nitra, NZ - Nové Zámky, PK - Pezinok, PB - Považská Bystrica, PD - Prievidza, PN - Piešťany, PO - Prešov, PP - Poprad, PU - Púchov, RK - Ružomberok, RS - Rimavská Sobota, RV - Rožňava, SC - Senec, SE - Senica, SK - Svidník, SL - Stará Lubovňa, SN - Spišská Nová Ves, TN - Trenčín, TO - Topoľčany, TT - Trnava, TV Trebišov, VK - Veľký Krtíš, VT - Vranov Nad Topľou, ZA - Žilina,ZH - Žiar Nad Hronom, ZV - Zvolen

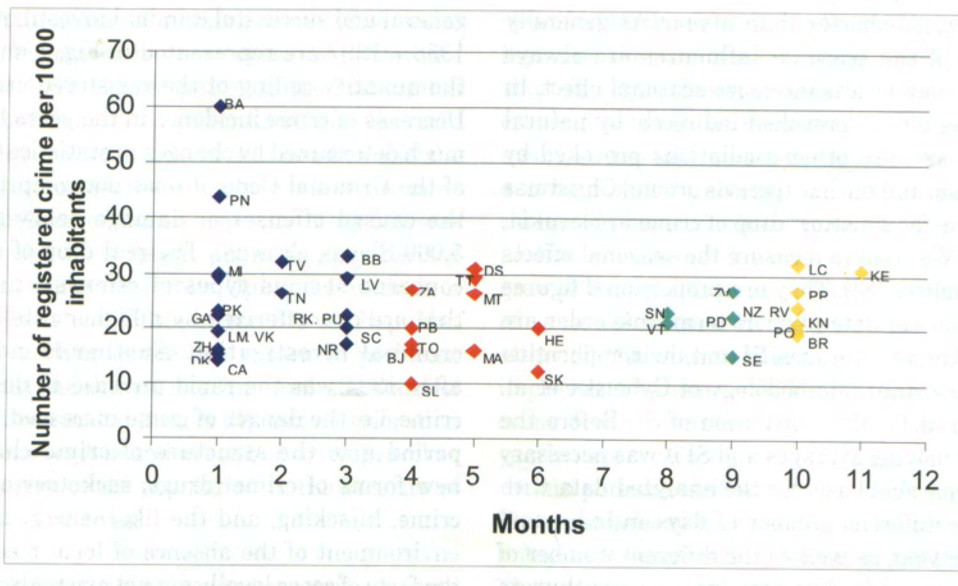

Fig. 2: Number of registered crime per 1,000 inhabitants in observed towns

abbreviations – see Fig. 1

favour of new, young prime delinquents whose methods (better organization, aggressiveness, etc.) lead to higher professional skills (Ivantyšyn-Tóth, 1997).

Crime occurs in all parts of Slovakia, but there are pronounced differences between individual districts, and between the towns and the rural area. This spatial differentiation is determined by numerous factors (situation, social, economic and demographic conditions, urbanization, etc.) that encourage or hamper its development. There are big differences at a socio-economic level between the northern and eastern parts of the country which lag behind the south-western parts of the country with more favourable values of the indices of the socio-economic development. The mentioned differences are somewhat smaller at a level of towns, but in spite of this some socio-economic and demographic features (high unemployment rate, high representation of the Romany population, etc.) favouring crime are also here manifested in a different manner.

The highest incidence of crime in absolute figures at a level of districts in 1997 was in the district of Bratislava with 19,479 offenses. High absolute figures of general crime (over 2,500 registered offenses) were recorded also in the districts of Košice (5,191), Banská Bystrica (2,990), and Žilina (2,946). The high absolute level of crime in the mentioned districts is determined by their nature. They are either urban (Bratislava and Košice) or their nature is determined by their district towns. On the other hand, a low crime incidence (below 500 offenses) was recorded in a rather big group of 24 small districts. The most critical situation in the urban district of Bratislava appears rather alarming also with respect to relative figures as there are 43.1 registered offenses per 1,000 inhabitants. The second worst situation can be seen in Banská Bystrica with 26.5 offenses per 1,000 inhabitants. Also the districts where all spheres of socio-economic life are under the influence of the size and position of the district towns which determine the character of the whole district, are characterized as highly risky. The lowest relative crime incidence and generally good safety are recorded in less urbanized districts with small district towns.

Urban crime

Similarly as in districts also in the towns of the SR there are conspicuous disproportions in the quantitative and qualitative indices of crime. As far as the absolute figures are concerned the worst situation is in the capital of Slovakia Bratislava where 19,479 offenses were registered in 1997. The group of risk towns i.e. towns with more than 1,500 offenses committed in 1997 includes also Košice (5,134), Banská Bystrica (2,361) and Žilina (2,068). It is also in a long-term aspect where these big towns appear as centres of crime with a high level of general crime. On the other hand, the lowest crime incidence (below 100 offenses) was registered in 15 smallest district towns. These findings confirmed that the generally known high rate of dependence between the size of a town and the level of crime (Haynes, 1973; Harries, 1976; etc.) is true also in the case of Slovak towns.

As far as the relative figures are concerned, Bratislava and Banská Bystrica are the most endangered towns in Slovakia and this group of risk towns (with 25 and more offenses per 1,000 inhabitants) also includes Piešťany (27.8), Trebišov (25.5), and Zvolen (25.2), i.e. towns with a certain specific potential which is not further analyzed in this study. The group of the towns with the lowest incidence of crime (under 5 offenses per 1,000 inhabitants) includes above all small towns with the population number below 20,000.

Seasonal index values allow for identification of important time horizons of crime incidence and classification of risk periods or months in individual towns. SI values obtained in the monitored towns point at marked disproportions in the seasonal character of crime and importance of the seasonal effects. This was the reason why we monitored a risk period represented by the one with the highest absolute SI number. A risk month is the month with the highest SI value. As far as the observation of the established criteria is concerned, the group of towns under study can be divided into two different sub-groups. While the first sub-group is remarkable for a continuous two or three month increase of SI which means an easily identifiable seasonal period, such period is not identifiable in the second sub-group of towns due to the oscillation of SI values and accumulation of crime in one (risk) month is rather typical for this group. Interestingly enough the prevailing part of the towns is characterized by a disagreement between the risk month and the risk period.

Seasonality of overall crime

The study of crime seasonality in Slovakia, much alike in other countries, disclosed important facts on risk (safe) periods or months of the year. The calculated data suggest that e.g. general crime in Slovakia shows a relatively regular development with the SI values oscillating very little. In spite of this fact we can say that January is the most risky month and December (with the 77.6 % of the average level of overall crime) is the safest month in the study period. The highest and lowest incidences of the offenses were observed in winter and autumn seasons respectively. A similar situation in overall crime can be seen if we analyze its changes at a level of towns into more details. The first quarter of the year is dangerous for almost a half

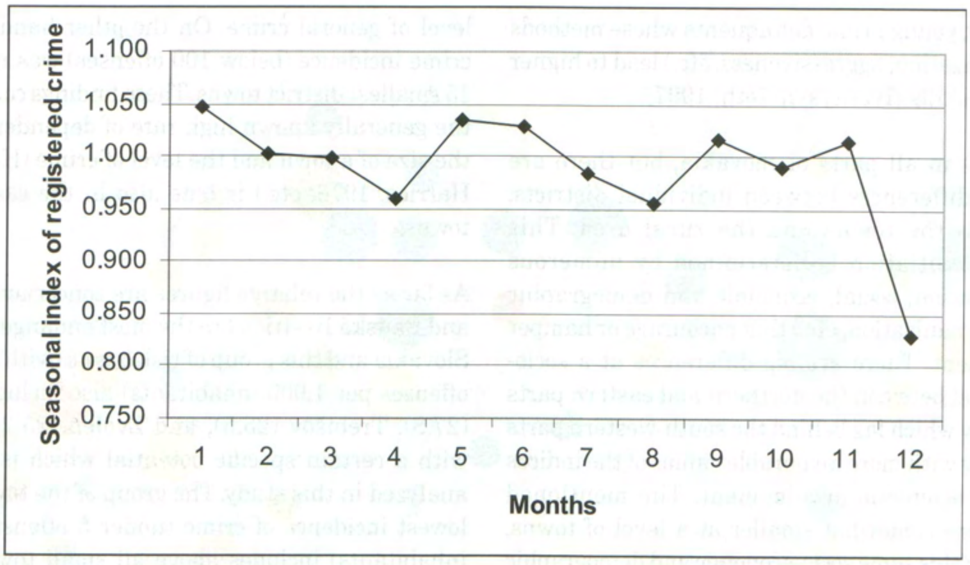

Fig. 3: Seasonal index of overall crime in Bratislava

of the towns (19) while ten of these are characterized by an important winter seasonality. Spring is a risky period for six, summer for one and autumn for one town. January is the riskiest month for 11 towns. On the other hand, the safest month with respect to overall crime is December: as much as 26 towns are characterized by a minimum crime incidence (the lowest SI value). This fact is partly determined by Christmas, the season which is generally accepted as peaceful in this country.

In terms of regions, the fact that while for a majority of towns in central Slovakia the worst situation can be seen in the first quarter of the year, most towns in western Slovakia are at the highest risk in spring, and the season of autumn and winter is most risky for towns in eastern Slovakia, is rather important. A similar situation can be seen in big cities. Winter season is the worst period for Bratislava, Nitra and Banská Bystrica, autumn is risky for cities of eastern Slovakia – Košice and Prešov. The largest oscillations during the year were recorded in

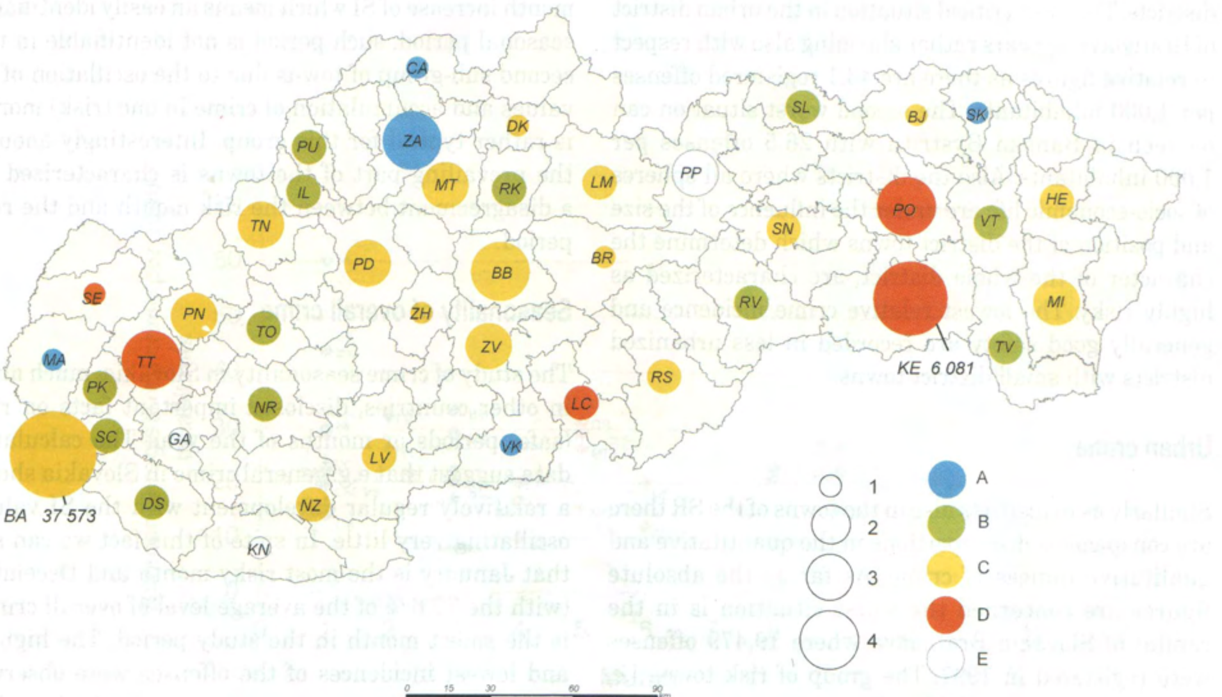

Fig. 4: Seasonality of violence crime in Slovakia

legend - see Fig. 1

small towns included in the selected set of towns, where a level of overall crime, hence also SI, is very high in some months (Dolný Kubín 1.73, Svidník, 1.65, Púchov and Senica 1.59, Stará Ľubovňa 1.57) and in some it is very low (Senec 0.40, Topoľčany 0.47). Seasonality of overall crime (months with maximum values of SI index during 1995-97 period) is highlighted in Fig. 1 and 2. More than 1/4 of all crimes in Slovakia were registered in Bratislava. Fig. 3 shows the seasonal index values in the capital.

The criminalists, however, consider the data and analyses dealing with single types of crime, which facilitate prevention much more important and necessary. This was the reason why we investigated the seasonal nature of selected types of crime in the same group of towns while we also tried to generalize the most important facts and laws on the basis of the obtained result.

Seasonality of violence

Similarly as with the crime in general, acts of violence in Slovakia are characterized by comparably regular values during the year. January is the most risky month and December the safest month of the year, even though the difference of the limit SI values between the two months is fairly higher. Most of violent crimes were committed again in winter months, autumn was remarkable for the least incidence of this type of crime.

But the situation is completely different at a level of towns. Most of them suffered from an irregular acts of violence occurring during the year. In Malacky, Senec, Topoľčany, for instance, no acts of violence were recorded in some months in contrast to other six towns where crime concentrated into certain month with its mean level doubled (Senica 2.31, Piešťany 2.28, Zvolen 2.23, Stará Ľubovňa 2.10, Pezinok 2.10, Žiar nad Hronom 2.01). The

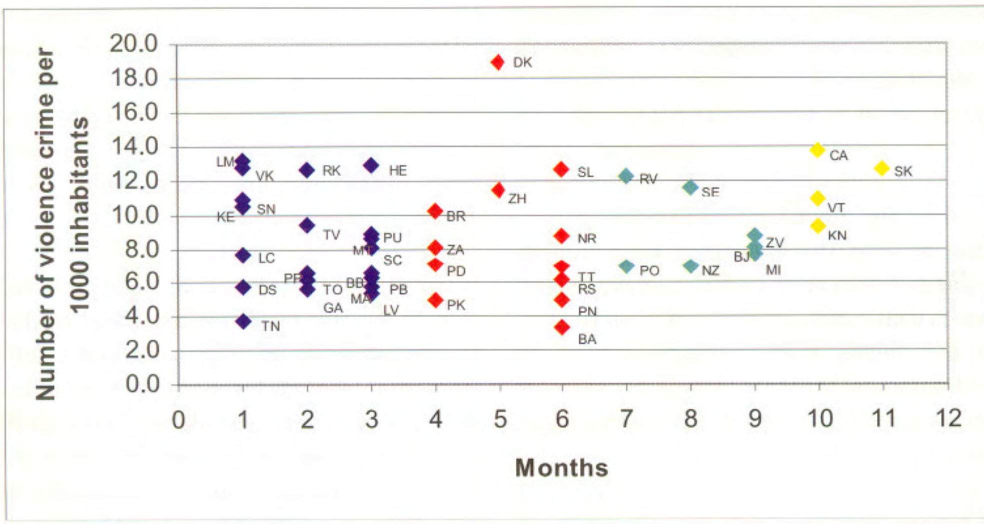

Fig. 5: Number of violence crime per 1,000 habitants in observed towns
abbreviations - see Fig. 1

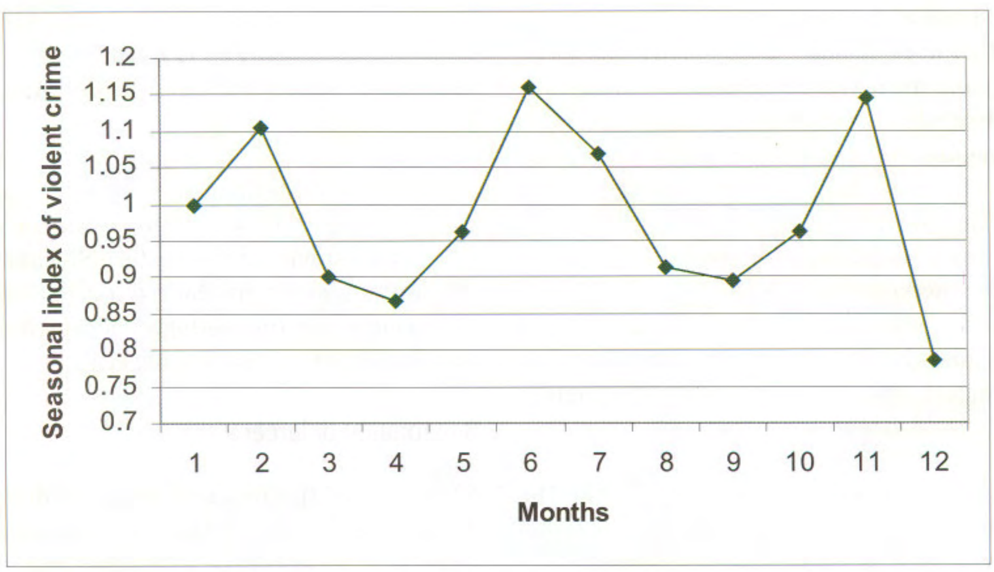

Fig. 6: Seasonal index of violence crime in Bratislava

range of SI values of violent crime compared to overall crime SI values was then considerably widened. Violence was concentrated into one or two months in most of the towns, and the above mentioned months represented the risky months for the towns in question. We can say that most towns (17) recorded increased violence in the 1st quarter of the year while distinct winter seasonal effects were observed in six towns. An important spring and summer seasonality was detected in five and four towns of the SR respectively. March is risky for eight and January for 7 towns. The safest month is again December when as much as 20 towns experienced the lowest incidence of violent crime. In the majority of all three regions the most risky month in the first quarter suggests that the violent crime in the Slovak towns culminates in winter period. While the winter-spring seasonality predominates in the towns of central and eastern Slovakia, the spring-summer period dominates in the towns of western Slovakia. Risky period could not be identified in two towns – Senica and Svidník – due to a high SI value oscillation and it means that a continuously increased crime level was not observed in any study period. Seasonality of violence in the monitored Slovak towns is illustrated in Fig. 4 and 5. Fig. 6 presents the values of Seasonal Index recorded in Bratislava.

A distinct share of big Slovak cities in this type of crime, the same as with the overall crime, changes the situation. The safest season in four biggest towns (except for Nitra) is winter, while the violence culminated in three of the five biggest towns in June-July, i.e. at the beginning of summer. This fact largely depends on different conditions, position and importance of the particular towns.

Seasonality of property crime

Study of property crime revealed a different situation. While January was the most risky month in overall crime and violence, most of the property crime was observed to be committed in September. Even though the range of the highest and the lowest SI value is not as big as in violence, the irregular distribution of SI values indicated risky (safe) months in the respective towns. Spring and summer are the most risky and the safest periods, respectively. The first year quarter is a risky period for most of the towns (17) while a pronounced seasonal nature of crime can be observed in three towns. September is the riskiest month for 7 towns and April is the riskiest month for six towns. Also the fact that beside December, July was another month when no town recorded the highest property crime incidence is interesting.

Eastern Slovakian towns are remarkable for the generally lowest seasonality as it was not possible to identify the risk periods due to the irregular oscillations of SI values. Spring time is risky for most of towns in western Slovakia, and winter is the riskiest season for the towns in central Slovakia. Seven small towns recorded more than one and a half fold level of property crime while the mean level more than doubled (2.03) in Stará Ľubovňa in the risk month. Only two of the five biggest cities (Bratislava and Prešov) are characterized by spring seasonality of property crime.

As the property crime represents a big group within overall crime and it causes that some substantial aspects of analyses get lost, it is much more important to pay attention to the partial types of this crime. This was the reason why its two qualitatively and quantitatively most important types were analyzed in the work.

Seasonality of burglary

As expected, this type of crime in Slovakia has features different from those of the preceding ones. The riskiest month in this respect is February which is rather a surprise, and the safest month is August. Statements that the summer months are the riskiest ones were not confirmed. The contrary is true in Slovakia: summer months are surprisingly the most secure season and the winter months in turn the most risky season as far as this type of crime is concerned.

Burglaries are remarkable for high seasonality, as proven by the fact that as many as 17 towns were characterized by more than one and a half fold increase above the acerage level of this type of crime during a risk month, while Svidník reached 2.13 SI value. Only three towns had the highest incidence of burglaries in the summer time, while the first quarter was the safest period for 20 towns. Seven towns are characterized by a significant winter seasonality.

The highest number of towns (9) recorded the highest incidence of burglaries in January. Also the fact is notable that as many as 12 towns (most of all) recorded the lowest incidence of burglaries in August, a typical holiday month.

In all parts of Slovakia there prevail the towns with winter-spring crime seasonality while the winter period is the riskiest one for the western Slovakian towns and the spring months are the riskiest ones of the eastern Slovakian towns. Interestingly enough, the winter period is risky for none of the five big cities.

Seasonality of larceny

Character of the property crime is determined to a certain extent also by larceny (representing a bigger share of it) as evidenced by the fact that the two types agree in the risky September and safe December.

The distinct oscillations of values in individual months and accumulation of larceny in summer months shows that the summer period and namely September is for 18 towns the period when their property is most threatened. Seasonal oscillations are also pointed at by the fact that as many as 14 towns suffer more than one and a half fold mean level and 3 towns even a double mean level of larceny incidence in risky month. Generally, we can say though that the period of larceny is that immediately before the start and after the end of a typical holiday season. In this time more than a half (25 towns) experience the highest incidence of larceny probably connected with increased mobility of population in preparation for holiday, the beginning of school term, etc. An explicit summer seasonality is proper to six towns and the same number recorded a significant spring seasonality.

This situation exists in the towns of the western and central Slovakia, where summer is the risky period for 14 towns, while September is the riskiest month. Towns of eastern Slovakia recorded an earlier onset of larceny incidence and it culminated in a transitory spring-summer period. Out of big cities only Bratislava and Banská Bystrica are characterized by this summer seasonality.

Conclusion

The effort to study the time-spatial aspects of chosen types of crime in Slovakia brought about many interesting results, some of them having been expected, other not. Issuing out from the calculated seasonal indices and from the observed risk months and periods we acquired an idea on the course of the observed crime during the year. The most important information on crime in general is that it is characterized by a low level of seasonal effects, the significance of which increases indirect proportional with the size of town, i.e. the seasonal effects are obvious above all in small towns. Overall crime concentrates to winter period in the majority of the central Slovakian towns, winter and autumn are dangerous for the towns of western and eastern Slovakia.

Much more pronounced and greater seasonal effects were detected for acts of violence which are committed in most of the towns in winter time while there are also regional differences and indications of dependence on the town size. Limited seasonality was observed for a large group of property crime which culminated above all in winter months. The phenomenon of risky month in the consequence of proportional representation of towns is not pronounced, which means that the level of property crime changes, with the exception of July and December, from town to town. Burglary, as a part of the property crime, is characterized by a higher seasonality and contrary to it the criminal acts are committed above all in the winter period, which is a surprise. Significant seasonality was observed for larceny, where its highest rate was confirmed for the spring and above all summer months. The finding that September is the riskiest month for most towns as far as larceny is concerned, is a surprise.

Research of urban crime in Slovakia shows, that geographical position and size of the town play the most significant role in the level of seasonality in the investigated types of crime.

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SPATIAL DISTRIBUTION CHANGES OF CZECH NATIONALS IN SLOVAKIA AND SLOVAK NATIONALS IN CZECHIA WITH AN EMPHASIS ON THE PERIOD FROM 1991 – 2001

Vladimír IRA, Jana ZAPLETALOVÁ

Abstract

The paper deals with the spatial distribution of Czech / Slovak population in the Slovak / Czech Republic. Before the division of the former Czechoslovakia into two separate independent countries in 1992, Czech and Slovak nationals constituted together a major ethnic group in the common state and the question of their geographical distribution was not a frequented theme in geographical literature. Since 1993 (after the split of the common state), the Slovak and Czech nationals became minor ethnic groups in the Czech and Slovak Republics, resp., their migrations between the Czech Republic and Slovakia becoming of international character. The work contributes to learn the development of the geographical distribution of Czech / Slovak population in the Slovak / Czech Republic, respectively.

Shrnutí

Změny v prostorovém rozložení obyvatelstva české národnosti ve Slovenské republice a slovenské národnosti v České republice s důrazem na období 1991 – 2001

Příspěvek se zabývá prostorovým rozložením obyvatelstva české / slovenské národnosti ve Slovenské / České republice. Až do roku 1992 (do rozdělení Československa na dva samostatné státy) byli Češi a Slováci ve společném státě majoritním etnikem a otázka jejich geografického rozmístění nepatřila v geografické literatuře k frekventovaným tématům. V roce 1993 po rozdělení společného státu se Slováci v České republice a Češi na Slovensku stali minoritními etniky a jejich stěhování mezi Českou republikou a Slovenskem se staly mezinárodními migracemi. Tento článek přispívá k poznání vývoje geografického rozmístění Čechů / Slováků ve Slovenské / České republice.

Key words: *Slovak nationals, Czech nationals, spatial distribution, Czech Republic, Slovak Republic, Czechoslovakia*

1. Introduction

The structure of nationalities was an issue not very much dealt with by either geographers or scientists and research workers of other disciplines in the former Czechoslovakia of 1945-1990. In this period of time, the geographical data on the structure of nationalities could be found mainly in school textbooks of geography. More detailed studies were made for examples by E. Mazúr (1974) for Slovakia and by V. Häufler (1976) for the Czech Republic. Czech and Slovak nationals formed together a major ethnic group in the former Czechoslovakia and there was no need to study their spatial distribution. Works were rather focused on inland migration flows, problems of education systems for the respective ethnic groups (Srb, 1986; 1990), or labour force (Brinke, 1980). A somewhat greater representation was that of sociological studies in regions of mixed ethnics (Ostrava, Těšín, north-western Bohemia) conducted by the Silesian Institute of the Silesian Regional Museum in Opava. A number of sociological works focused on the issue of ethnic groups in the Ostrava region were published by the Institute in the second half of the 1980s (e.g. Hernová, 1985; Steiner, 1988; Bakala, 1990; Staněk, 1990a, 1990b). The same issue was studied in Slovakia for example by J. Žudel and Š. Očovský (1991), Š. Očovský (1992, 1992a).

More geographical works focused directly onto the study of Slovak nationals in the Czech Republic started to appear after the split-up of Czechoslovakia after the year of 1993. They mainly dealt with the spatial distribution of Slovak nationals in the Czech Republic, with the development of population numbers declaring Slovak nationality and their position in the Czech Republic, with the possibilities of the ethnic to have schools where their national language is spoken and taught, cultural activities, etc. More comprehensive studies to be mentioned here are for example those by R. Prokop et al. (1998), P. Vranovský et al. (1999, 2001) and other. Examples of works focused onto this issue in Slovakia can be those by O. Dostál (2003, 1996), V. Ira (1996, 1997), P. Podolák (1997) and other.

2. Historical development of migration between the Czech lands and Slovakia until 1961

Migration of Slovaks in the historical territory of the today's Czech Republic and Czech nationals in the historical territory of Slovakia date back much earlier than the year of 1918 (coming into existence of the common Czechoslovak Republic) although the statistic significance of the migrations was negligible. Intensive contacts and migration between the two parts of the former Czechoslovakia started to develop already at the end of the 19th century when a number of initiatives and organizations appeared in the Czech lands, which financially supported Slovak publications and provided scholarships to Slovak students at Czech universities (Šrajerová, 1999).

After the establishment of the Czechoslovak Republic in 1918, the migrations between the two parts of the country increased. At the very beginning of the existence of the common state, people were rather moving from the western regions of the country to the east. A gradual increase of the Czech ethnic in Slovakia was partly resulting from mixed marriages, being however mainly contributed to by immigration from Bohemia, Moravia and Silesia. Czech people were coming to work in state administration, at schools, in hospitals etc. Migration flows from Slovakia to the Czech lands were considerably lower at that time; Slovak workers were coming to work in industries particularly in the Ostrava region, in northern Bohemia, Brno and Zlín, some were coming to work at farms as a seasonal labour, and there were also some Slovak clerks working at the central government authorities in Prague. Results from the first census conducted in the independent Czechoslovak Republic (15 February, 1921) speak of 72,635 Czech nationals[2] living in the territory of the today's Slovak Republic (2.4 % of total residents) and 15,732 Slovak nationals living in the territory of the today's Czech Republic (0.15 % of total residents). In the census of 1930, Czech nationality was claimed already by 121,696 persons living in Slovakia (3.7 % of total residents), and Slovak nationality was claimed by 44,451 persons living in the Czech lands (0.4 % of total residents). Converted figures of 1937 speak of 161 thousand Czech nationals in Slovakia (4.5 %) and 65 thousand Slovak nationals in the Czech lands (CSSR Year Book of Historical Statistics, 1985).

Re-emigration of the Czech population from Slovakia back to the Czech lands started in 1938 due to events going on the international political scene. When the independent Slovak State was established in 1939, the Czech population living in Slovakia was forced out back to the Protectorate of Bohemia and Moravia (78 % of Czech nationals were ousted from Slovakia). Re-emigration of the Slovak population back to Slovakia was much less important (23 % of Slovak nationals living in the Czech lands returned to Slovakia). After the end of the War and after the re-establishment of Czechoslovakia in 1945, it is estimated that 35,000 Czech nationals were living in Slovakia and about 50,000 Slovak nationals were living in the Czech lands (CSSR Year Book of Historical Statistics, 1985).

First years after the War saw a statistically significant inland migration in consequence to the evacuation of German nationals. The migration flows led up mostly to depopulated Bohemian and Moravian-Silesian borderland districts. Apart from inhabitants of Czech

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[2] The definition of "nationality" passed through a certain development in the former Czechoslovakia in the course of the 20th century. In the first Czechoslovak census, nationality was defined as tribal affiliation whose main external sign is mother tongue. It was established by means of a "direct free admission of each present and added inhabitant over 14 years of age". In the second Czechoslovak census conducted in 1930, nationality was established indirectly according to mother tongue. In 1950 and 1961, nationality was defined as affiliation to a nation the cultural and working community of which is felt by the censed person as internally related to and avowed. In 1970 and 1980, nationality was understood to be affiliation to a nation or a nationality with each person being left free to register according to their own belief. The situation was similar in the census of 1991 when an effervescent discussion occurred due atmosphere in the society about a possibility to register Moravian and Silesian nationality in the census sheet. Based on the requirement, the Statistical Office extended the nomenclature of nationalities by adding these two nationalities which were summed-up separately. Mother tongue was established by means of a separate question. The census of 2001 was similar both in the Czech and Slovak Republics. Legend to the census sheet of persons in the Czech Republic encouraged everybody to fill in nationality according to decision of their own. Nationality was understood to be affiliation to a nation, ethnic group or ethnic minority. Conclusive for the determination of nationality was neither mother tongue nor language predominantly used by the citizen. A possibility was provided to register for more nationalities or not to register nationality at all. Children up to 15 years of age were registered the nationality of their parents (Ethnic Composition of Population, ČSU, Praha, 2004). Analyses of population's ethnic composition in the Czech Republic report the Moravian and Silesian nationalities together with the Czech nationality. In the census of 2001, the Moravian and Silesian nationalities were claimed by only about a quarter of those who declared it in the census of 1991.

In the Slovak Republic, the census of 2001 understood nationality to be the person's affiliation to a nation, ethnic group or ethnic minority. Conclusive for the determination of nationality was neither mother tongue nor language used or better mastered by the citizen but rather his/her own decision. Children up to 15 years of age were registered according to the nationality of their parents. If the parents claimed different nationalities, one of them was registered for the child according to their mutual agreement (Legend to the census sheet, 2001).

Fig. 1: Orientation map

interior it was also the Slovak population that moved to these regions. Only in 1946, available historical records speak of 30,252 Slovak nationals coming to north-western Bohemia, nearly 23,000 Slovaks to north-eastern Bohemia, and about 22,000 Slovaks to eastern Bohemia, northern Moravia and Silesia (Šrajerová, 1999). There were more than 110,000 Slovaks coming to these additionally peopled areas before the mid-year of 1947 (Prokop, 1998). Another wave of migration was recorded after the February upheaval of 1948 when the Czechoslovak economy was unambiguously concentrated on heavy industries. At this time, the Slovak population was moving mainly to traditional industrial centres in the Ostrava region and in north-western Bohemia.

Migration flows from the Czech lands to Slovakia were less pronounced in this period of time and the number of Czech nationals living in Slovakia was increasing only slowly. Czechs returning back to Slovakia were some of those who lived there before World War II and those who married there. The number of people coming to work in Slovakia was considerably lower. The first census after the War was conducted as at 1 March 1950 and recorded 40,356 inhabitants declaring Czech nationality in Slovakia (1.17 % of total population living in Slovakia) and 258,025 inhabitants claiming Slovak nationality in the territory of Bohemia and Moravia (Czech lands) (2.90 % of total population living in the Czech lands).

3. Development of migration in 1961 – 1991

The number of inhabitants claiming Slovak nationality in the Czech lands and Czech nationality in Slovakia kept a gradually increasing trend even in the following decades (Tab. 1).

The Slovak census of 1961 speaks of 45,721 persons declaring Czech nationality. In the period between the censi of 1961 – 1970, the number of residents declaring Czech nationality increased by 1,681 to total 47,402 persons. In the following ten years, the number of persons claiming Czech nationality grew by nearly other 10 thousand (57,197 persons in 1980). In the census of 1991, there were 59,326 residents in Slovakia declaring Czech nationality (1.12 % of total population in Slovak Republic). Of the total number of 59,326 persons referred to generally as Czech nationals, 89.1 % (52,884) – 10.2 % (6,037) and 0.7 % (405) declared Czech – Moravian and silesian nationality, respectively. Of the total number of 59,326 Czech nationals 85.5 % – 11.9 % and 1.2 % claimed Czech – Slovak and Hungarian to be their mother tongue. Czech language was declared mother tongue by 5,045 Slovak nationals (1.1 %).

In Bohemian and Moravian regions the number of residents declaring Slovak nationality was increasing

Year	Czech lands[3]			Slovakia		
	Total population	of this Slovak nationals	% of Slovaks in total population	Total population	of this Czech nationals	% of Czechs in total population*
1921	10 005 734	15 732	0.15	3 000 870	72 635	2.42
1930	10 674 386	44 451	0.41	3 329 793	121 695	3.65
1937	10 885 540	65 000	0.60	3 540 175	161 000	4.55
1945	10 629 912	50 000	0.47	3 459 058	35 000	1.01
1950	8 896 133	258 025	2.90	3 442 317	40 365	1.17
1961	9 571 531	275 997	2.88	4 174 046	45 721	1.09
1970	9 807 697	320 998	3.27	4 537 290	47 402	1.04
1980	10 291 927	359 370	3.49	4 991 168	57 197	1.14
1991	10 302 215	314 877	3.07	5 274 335	59 326*	1.12
2001	10 230 060	193 190	1.88	5 379 455	49 990*	0.93

Tab 1: Development of Slovak / Czech national numbers in Czech lands / Slovakia

* Aggregate for Czech, Moravian and Silesian nationalities

Source: CSSR Year Book of Historical Statistics, Results from the censi of 1991 and 2001

[3] Historical territory of Bohemia, Moravia and the Czech part of Silesia

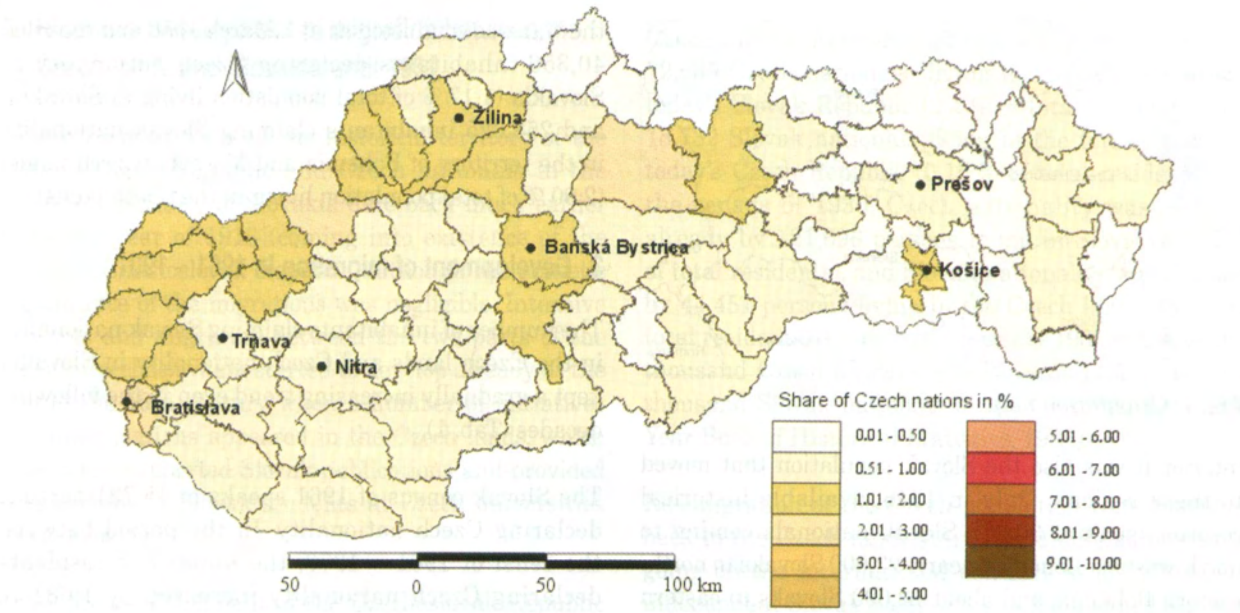

Fig. 2: Share of Czech nationals in the total population of Slovak districts in 1991

in absolute figures until the 1980s. The censi of 1961 and 1970 speak of 275 997 and 320 998 Slovak nationals (2.88% and 3.27% of total residents), resp. living in the Czech lands. The historically highest number of Slovak nationals in the Czech lands was recorded in the census of 1980 (nearly 360 000 – 3.49%). However, the number of residents in regions of Bohemia and Moravia claiming Slovak nationality fell by more than 44 000 in the intracensal period of 1980 – 1991. In the census of 1991, Slovak nationality was claimed by 314 877 inhabitants (3.05% of total residents).

Age structure was changing too in this period of time with the population declaring Czech nationality in Slovakia and Slovak nationality in the today's Czech Republic gradually getting older. In 1970 for example, the pre-productive age group was represented by 22.1% in the total number of Slovak nationals living in the regions of Bohemia and Moravia, the shares of the productive and post-productive age groups being 68.5 and 9.4%. In 1991, the proportion of pre- and post-productive age groups was reversed with the pre-productive age group representation being only 8.6% and that of the post-productive age group amounting to 23.5%. The group of Slovak nationals at productive age did not show any significant change (68.5% and 67.9%, resp.). The shift is generally explained by a so called "ethnic inclination" which shows in the fact that children born to mixed married couples usually claim Czech nationality (Prokop et al., 1998). A similar situation is recorded in Czech nationals resident in Slovakia.

3.1 Spatial distribution of Czech nationals in Slovakia (Census 1991)

Czech nationals resident in Slovakia were never clearly concentrated in certain regions during the existence of the common state. This is corroborated also by analyses of the share of Czech nationals in the total resident population as well as by analyses of the degree of regional concentration of Czech nationals in 1991 (Ira, 1996).

The highest numbers of Czech nationals in total resident population in the census of 1991 were recorded in the districts of Bratislava (4.6 % – for the purposes of our study districts Bratislava 1-5), Trenčín and Martin (over 2 %). The lowest numbers of Czech nationals in total resident population were recorded in the Prešov and Košice regions and in the northern portion of the Žilina region (less than 0.5 % – Fig. 2).

For the purposes of our study, the degree of regional concentration was determined on the basis of a concentration index. The concentration index for Czech nationals in Slovakia was calculated for individual Slovak regions in such a way that the total number of Czech nationals was divided into two identical parts and a survey was made in how many of total districts in Slovakia and in what area a half of the Czech nationals are concentrated and what proportion they make of total residents. The districts were then arranged by the number of Czech nationals living in them. The number of districts, their area and total residents were summed-up in order to reach the calculated half. The districts which contributed to the sum formed a concentration area of Czech nationals to be investigated. Results obtained were detracted from the whole, i.e. 100.

In absolute figures, more than a half of Czech nationals resident in Slovakia lived in the districts of Bratislava (1-5), Košice (1-4), Trenčín, Žilina, Skalica, Martin, Banská Bystrica, Nitra, Liptovský Mikuláš and Poprad (Fig. 3). Index of Czech ethnic minority concentration

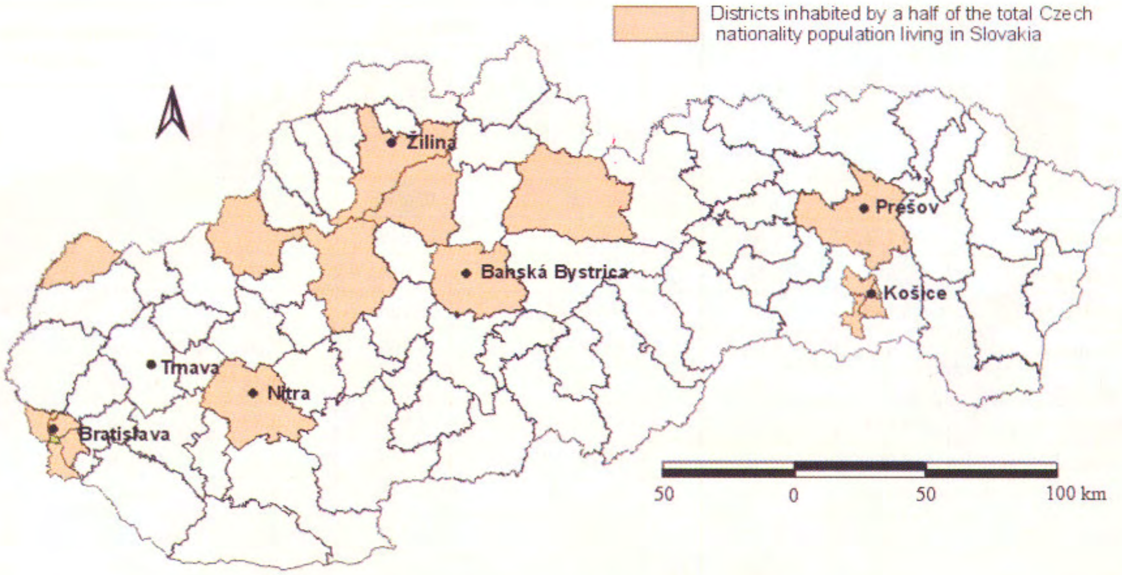

Fig. 3: Regional concentration degrese of Czech nationals in Slovak Republic in 1991

was 71 as related to total population, 85 as related to area, and 86 as related to the number of territorial administrative units (72 districts – with the districts of Bratislava and Košice being expressed as separate units) (Tab. 2).

3.2 Spatial distribution of Slovak nationals in Czech lands (Census 1991)

Spatial distribution of persons declaring Slovak nationality in the Czech lands was much more concentrated in comparison to Czech nationals in Slovakia. The fact follows out of the above mentioned reasons – additional settlement of borderland regions and organized recruitment of workers in heavy industries.

The census conducted in 1991 speaks of 314,877 Slovak nationals living in the Czech Republic with the absolutely highest numbers of Slovak nationality residents being recorded in the capital of Prague (23,906 persons) and a nearly same number of Slovaks (23,774) living in the Karviná district. The third district with the absolutely highest number of Slovak nationals was that of Ostrava-City with 15,948 Slovaks. These three districts which account for 1.34 % of total area of the Czech Republic concentrated a fifth of Slovak nationals (20.2 %) living in the Czech Republic. Other districts

1991				2001				Shrinkage of Czech nationals	
Order	District	Czech nationalss	% of total Czech residents in Slovakia	Order	District	Czech nationals	% of total Czech residents in Slovakia	abs.	per cent
1.	Bratislava	11 437	19.27	1.	Bratislava	8 607	18.32	-2 830	24.74
2.	Košice	3 927	6.62	2.	Košice	2 946	6.27	-981	24.98
3.	Trenčín	2 460	4.14	3.	Trenčín	2 038	4.33	-422	17.15
4.	Žilina	2 398	4.05	4.	Žilina	1 806	3.84	-592	24.69
5.	Skalica	1 872	3.15	5.	B. Bystrica	1 399	2.98	-387	21.67
6.	Martin	1 820	3.06	6.	Martin	1 348	2.87	-472	25.93
7.	B. Bystrica	1 786	3.01	7.	Skalica	1 250	2.66	-622	33.23
8.	Nitra	1 578	2.66	8.	Nitra	1 234	2.26	-344	21.80
9.	L. Mikuláš	1 494	2.52	9.	L. Mikuláš	1 094	2.33	-400	26.77
10.	Poprad	1 317	2.22	10.	Prievidza	1 054	2.24	-168	13.75
				11.	Prešov	995	2.11	-145	12.72
	Prievidza	1 222	2.06						
	Prešov	1 140	1.92		Poprad	959	2.04	-338	25.66

Tab. 2: Slovak districts in which a half of the total Czech nationality claiming population lived in 1991 (2001)

Source: Results from the Slovak censi of 1991 and 2001

1991				2001				Shrinkage of Slovak nationals	
Order	District	Slovak nationals	% of total Slovak residents in Czechia	Order	District	Slovak nationals	% of total Slovak residents in Czechia	abs.	%
1.	Praha	23 906	7.59	1.	Praha	19 275	9.98	4 631	19.37
2.	Karviná	23 774	7.55	2.	Karviná	15 948	8.26	7 826	32.92
3.	Ostrava-město	17 508	5.56	3.	Ostrava-město	11 016	5.70	6 492	37.08
4.	Frýdek-Místek	9 689	3.08	4.	Frýdek-Místek	6 728	3.48	2 961	30.56
5.	Chomutov	9 451	3.00	5.	Brno-město	5 795	3.00	1 336	14.14
6.	Sokolov	9 191	2.92	6.	Sokolov	4 983	2.58	4 208	45.78
7.	Karlovy Vary	9 014	2.86	7.	Chomutov	4 876	2.52	4 575	50.75
8.	Bruntál	8 854	2.81	8.	Karlovy Vary	4 788	2.48	4 226	47.73
9.	Most	8 449	2.68	9.	Bruntál	4 447	2.23	4 407	52.16
10.	Cheb	8 080	2.57	10.	Cheb	4 308	2.23	3 772	46.68
11.	Teplice	7 318	2.32	11.	Most	3 810	1.97	4 639	63.39
12.	Brno-město	7 131	2.27	12.	Liberec	3 755	1.94	5 802	81.36
13.	Liberec	9 557	2.08	13.	Teplice	3 428	1.77	3 890	40.70
14.	Děčín	6 193	1.97	13.	Olomouc	3 393	1.76	1 617	32.27
15.	Ústí nad Labem	5 629	1.78	15.	Nový Jičín	3 143	1.63	2 039	39.34
17.	Nový Jičín	5 182	1.64	16.	Děčín	3 122	1.62	3 071	49.59
18.	Olomouc	5 010	1.59	17.	Ústí nad Labem	2 793	1.45	2 836	50.38

Tab. 3: Czech districts in which a half of the total Slovak nationality claiming population lived in 1991 (2001)
Source: Results from the Czech censi of 1991 and 2001

with high absolute numbers of Slovak nationals resident in the Czech Republic were those of Frýdek-Místek (9,689), Chomutov (9,451), Sokolov (9,191), Karlovy Vary (9,014), Bruntál (8,854), Most (8,449) and Cheb (8,449). While the share of Slovak nationality residents in Prague accounted only for 1.97 % of total residents, their share in the district of Karviná amounted to 8.35 % of total residents. The highest per cent representation of Slovak nationals was recorded in the Sokolov and Jeseník districts (9.92 % of total residents each), in the districts of Cheb (9.29 %), Karviná (8.35 %), Český Krumlov (8.32 %) and Bruntál (8.13 %). The lowest numbers of Slovak nationals in absolute figures were recorded in the districts of Pelhřimov (713), Pilsen-South (918), Blansko and Strakonice (936 each) and Havlíčkův Brod (983). The lowest per cent representation of Slovak nationals below 1 % of total residents) was recorded in the districts of Blansko, Žďár nad Sázavou and Pelhřimov (Tab. 3, Fig. 4).

The regional concentration degree of Slovaks resident in the Czech Republic (calculated in the same manner as the regional concentration degree of Czech residents in Slovakia) in 1991 as related to total population, area and number of territorial administrative units was 76, 85 and 80, respectively (Fig. 5).

4. Development of Slovak/Czech nationals in Czechia/Slovakia in the period from 1991 – 2001

This period was a turning point for Czechs/Slovaks in Slovakia/Czechia. Czechoslovakia split up into two separate states on 1 January 1993 and the two ethnic minorities which came into existence in the sense of international law were youngest in central Europe. They came into being under unusual conditions and their characteristic features are atypical for minorities in the common sense of the word (Majtánová, 1999). Both the Czech national living in Slovakia and the Slovaks living in the Czech Republic had to face a principal decision: to move back to the Czech/Slovak Republic, to stay living as foreigners in their hitherto abodes, or to apply for a change of nationality. Dual nationality (Slovak and Czech) was possible in the Slovak Republic; in the Czech Republic this possibility was introduced only in 1999. The facts were most likely the main reason to a considerable change in the number of residents claiming Slovak/Czech nationality in the both newly arisen sovereign republics (Fig.10, 11 – see cover p. 3).

In Slovakia, Czech nationality was declared by 44,620 persons, Moravian nationality by 2,348 persons and Silesian nationality by 22 persons in the census of 2001, i.e. by a total of 46,990 persons[4]. This indicates that the

[4] In the previous censi, the persons of Czech, Moravian and Silesian nationality were registered as Czech nationals.

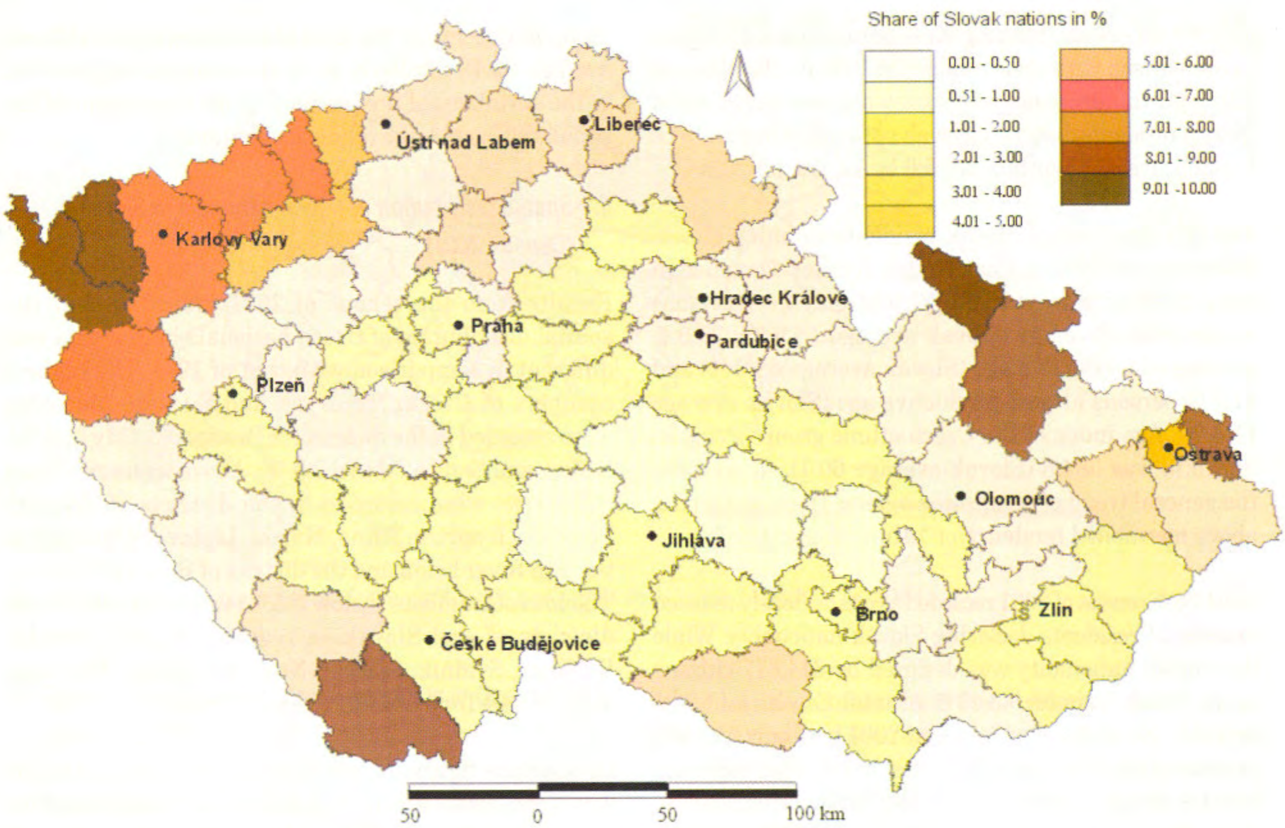

Fig. 4: Share of Slovak nationals in total population in the districts in the Czech Republic in 1991

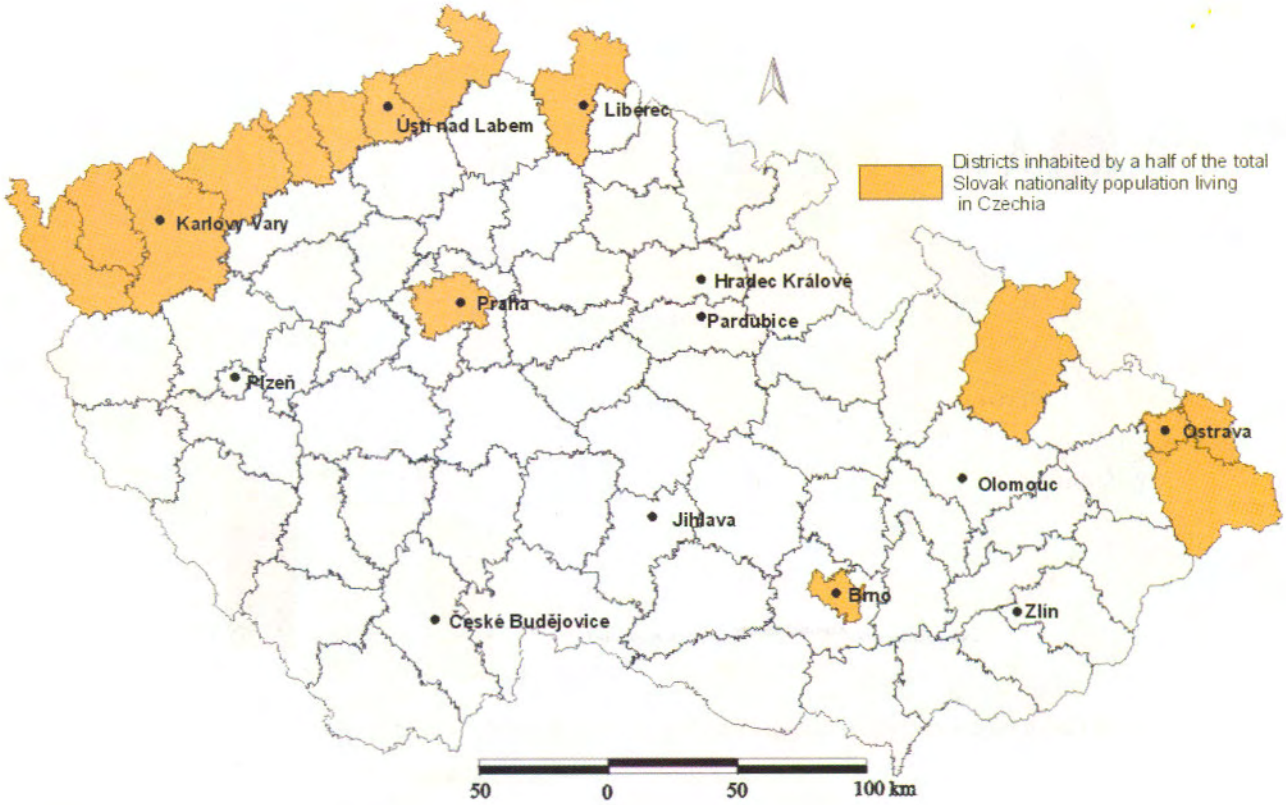

Fig. 5: Regional concentration degrese of Slovak nationals in Czech Republic in 1991

number of persons claiming these nationalities decreased in comparison with their number in 1991 in Slovakia, too although the decrease was somewhat less pronounced than in residents declaring Slovak nationality in the Czech Republic where their number fell by 12,336, i.e. 20.8 %.

The age structure of Slovak residents claiming Czech, Moravian and Silesian nationality further worsened in comparison with the year of 1991, with only 4.6 % persons at pre-productive age (Slovak average 18.9 %), 76.9 % persons at productive age (Slovak average 68.9 %) and 17.7 % persons at post-productive age (Slovak average 11.4 %). Age index of the Czech ethnic group[5] living in Slovakia was 384.8 (Slovak average 60.1). Apart from the general trend of population ageing, there is also the above mentioned tendency of "ethnic inclination".

The Czech census of 2001 recorded a conspicuously reduced number of residents declaring Slovak nationality. While the Slovak nationality was declared by 314,877 citizens of the Czech Republic (3.07 % of total Czech residents) in 1991, the number recorded in 2001 was only 193,190 persons (1.88 % of total Czech residents). This indicates that the shrinkage of persons declaring Slovak nationality in the Czech Republic amounted to over 120,000 (38.6 %). Age structure of Slovak nationals in the Czech Republic continued its worsening trend. In 2001, there were only 3.6 %, 76.3 % and 20.1 % Slovak nationals at pre-productive, productive and post-productive age, resp. living in the Czech Republic. Age index[5] of the Slovak ethnic group in Czechia at the time of census was 558.6 (Czech average 85.4). Similarly as in Slovakia, an explanation to the shrinkage of pre-productive age constituent of the population can be the ethnic inclination.

4.1 Spatial distribution of Czech nationals in Slovakia (Census 2001)

Results from the census of 2001 indicated that the spatial distribution of Czech nationals in Slovakia was different in comparison with that of 1991. The highest numbers of Czech, Moravian and Silesian nationals were recorded in the districts of Bratislava-City (2.6 %), Košice and Senica (above 2.0 %). Above-average values (1.1-2.0 %) were recorded in the districts of Trenčín, Považská Bystrica, Žilina, Martin, Liptovský Mikuláš in the Váh River basin and the district of Banská Bystrica. The lowest numbers (below 0.5 %) were recorded in the districts of east-Slovakian region – Stará Ľubovňa, Bardejov, Svidník, Spišská Nová Ves, Košice-Province, Vranov nad Topľou and Trebišov (Fig. 6).

In absolute figures, more than 50 % Czech nationals were concentrated in 11 Slovak districts: Bratislava-City, Košice-City, Trenčín, Žilina, Banská Bystrica, Martin, Skalica, Nitra, Liptovský Mikuláš, Prievidza and Prešov (Fig. 7). With respect to total population the concentration index was relatively low – 67, amounting to 85 with respect to the number of territorial administrative units and 83 with respect to area (Tab. 2).

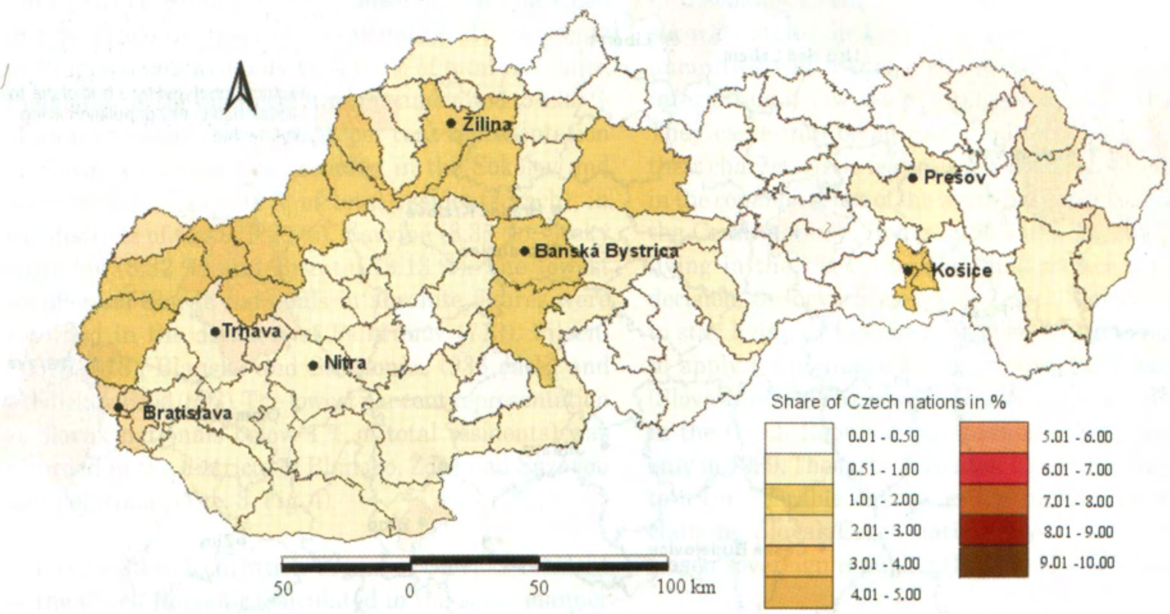

Fig. 6: Share of Czech nationals in the total population of Slovak districts in 2001

[5] Number of persons at an age of 65 and more years per 100 persons at an age of 0 – 14 years.

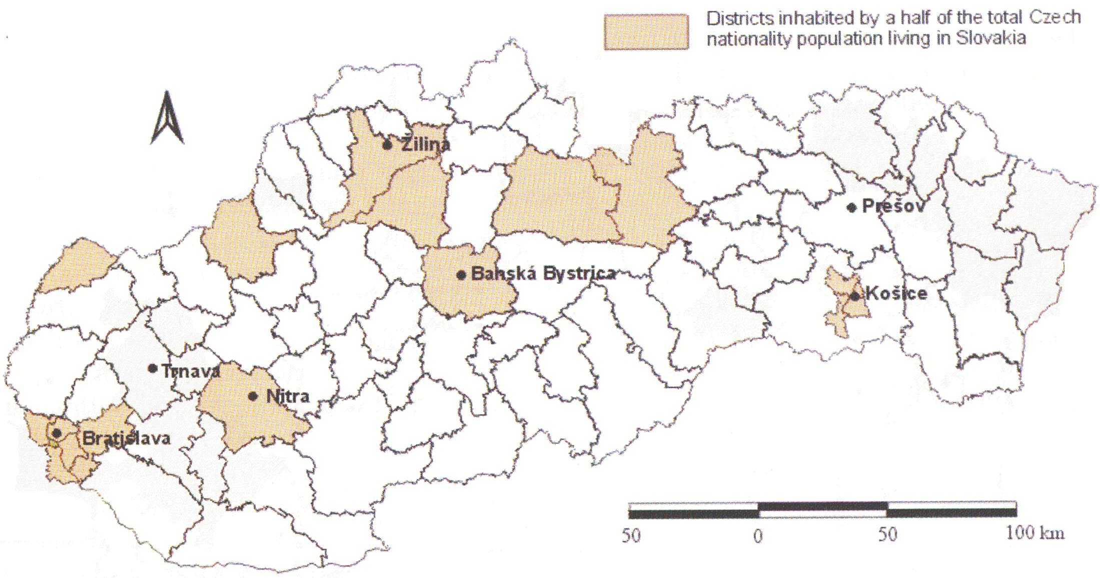

Fig. 7: Regional concentration degree of Czech nationals in Slovak Republic in 2001

4.2 Spatial distribution of Slovak nationals in Czechia (Census 2001)

In spite of the fact that the loss of persons declaring Slovak nationality in the Czech Republic was considerable, there were no principal changes in the concentration and distribution of Slovaks in Czech districts. The index of regional concentration of Slovak nationals was 66 as related to total population, 80 as related to the number of territorial administrative units, and 84 as related to area (Fig. 8).

In 1991, a half of Slovak nationality population lived in 15 Czech districts (fig. 5); in 2001 the number of districts remained identical (Fig. 9). The order of the first four districts (Prague, Karviná, Ostrava-City, Frýdek-Místek) did not change; some shifts were recorded on the following positions but the first thirteen districts

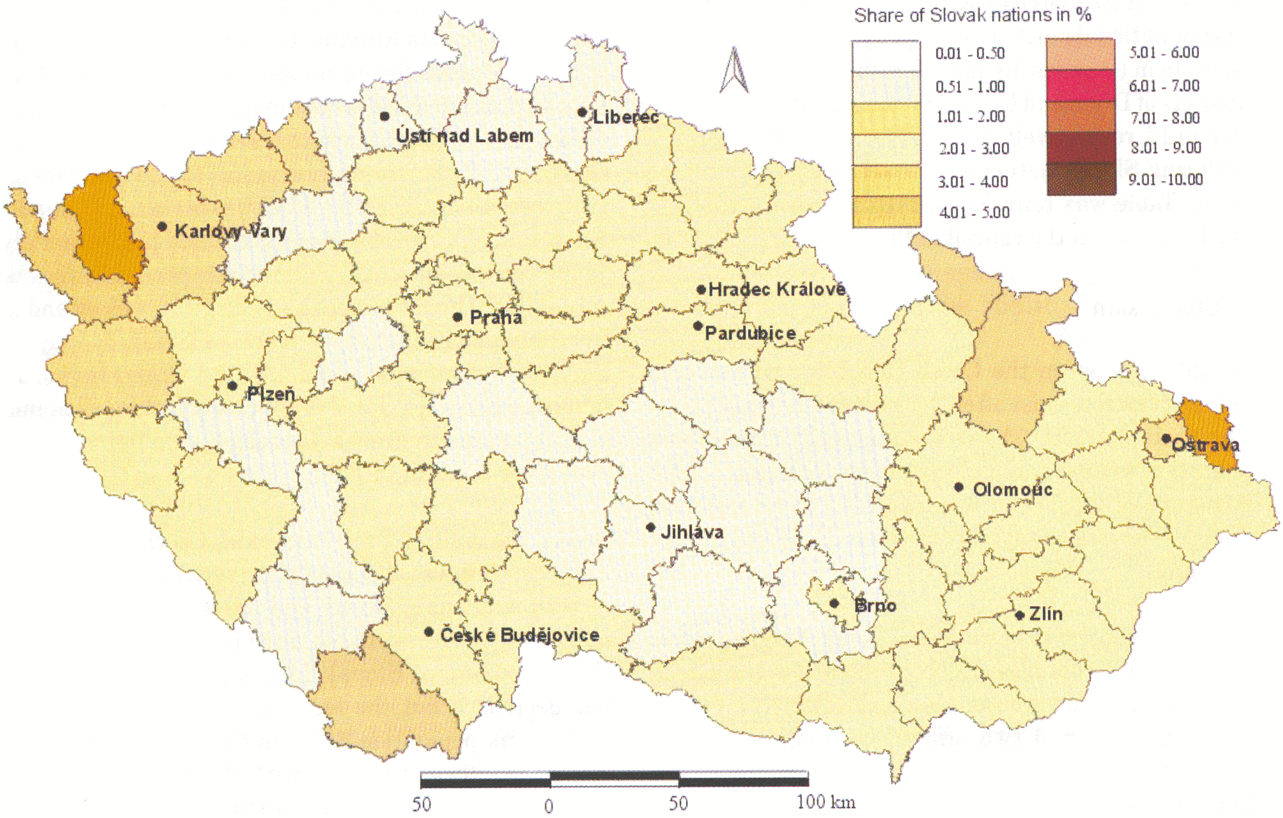

Fig. 8: Share of Slovak nationals in total population in the districts in the Czech Republic in 2001

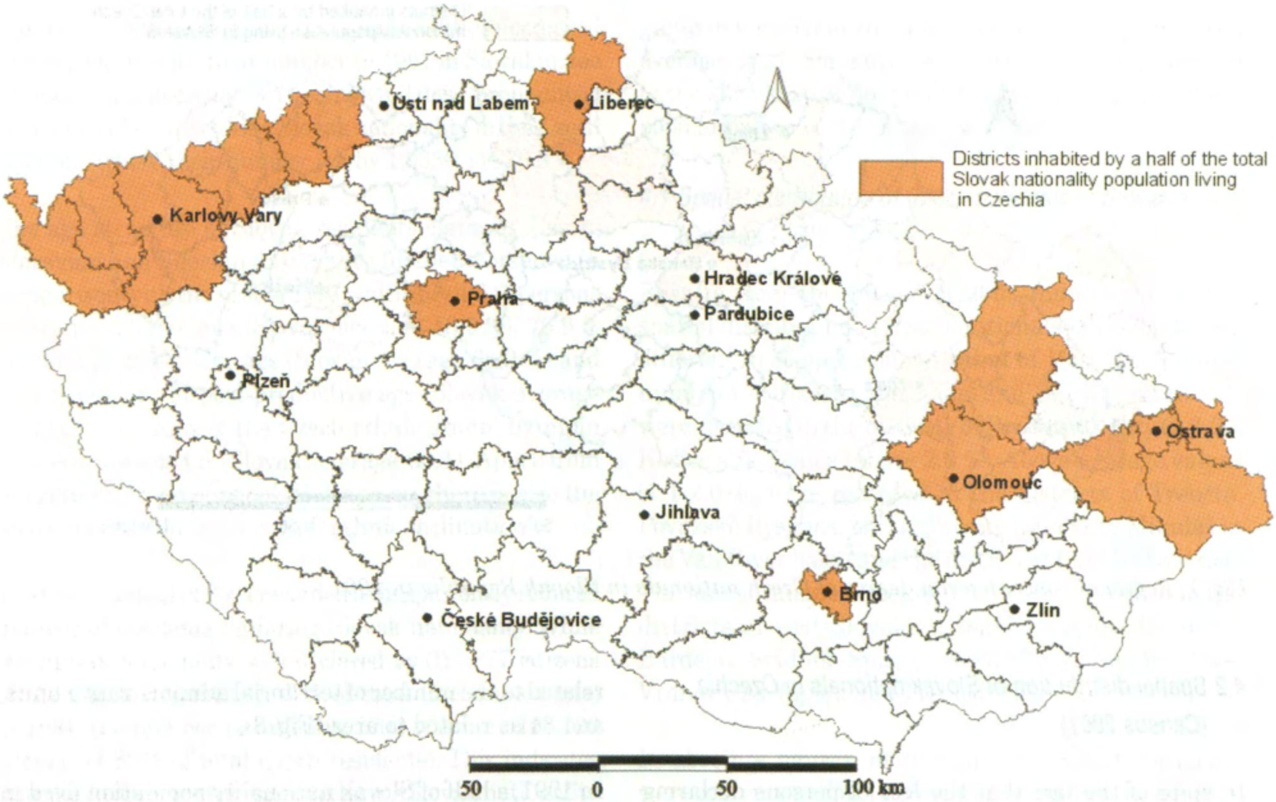

Fig. 9: Regional concentration of Slovak nationals in Czech Republic in 2001

with the highest numbers of persons declaring Slovak nationality remained the same (Tab. 3). The first fifteen Czech districts with the highest number of Slovak nationals included the districts of Olomouc and Nový Jičín (Position 18 and 17, resp. in 1991) while the districts of Děčín and Ústí nad Labem shifted to Position 16 and 17, respectively. A relatively least loss of persons declaring Slovak nationality of all districts contained in the Table was recorded in the district of Brno-City (14.14 %) and in the capital of Prague (19.37 %).

5. Conclusion

Migration between the Czech Republic and Slovakia did not ceased to exist after the split of Czechoslovakia, only their character changed statistically from inland migration to international migration. The volume and structure of migration was recorded to be reduced, though. The migration concerns both Czech and Slovak nationals.

Language similarity of the two national languages has never been a communication problem for the Czech and Slovak ethnic groups. Czechoslovakia as a former common state had two official languages – Czech and Slovak; this has not been changed in the Czech Republic. Nevertheless, as early as in the 1950s there were localities occurring in the today's Czech Republic where the number of Slovak children of school age was sufficiently high and parents concerned with their children to attend Slovak schools where the Slovak schools were established. A Slovak school was for instance opened in Karviná in the school year 1956/1957 with two classes for 46 pupils. The interest in school lessons presented in Slovak language culminated in the school year 1970/1971 where there were two schools in the Czech Republic with lessons taught in Slovak language, 46 classes and a total number of 1 297 pupils. The interest in Slovak schools decreased proportionally to the decreasing school children component in Slovak population. The Slovak school in Karviná was attended by 211 pupils in the school year of 1988/89, by only 28 pupils ten years later, and finally the lessons in Slovak language had to be closed down due to lacking demand. School lessons in Slovak language were not required even after the year of 1993.

Before the split of Czechoslovakia, Czech and Slovak broadcasting and TV media presented programmes in both languages, Slovak and Czech newspapers and magazines were available anywhere. After the split, the frequency of Slovak language in Czech media has decreased but the language is still represented. The Slovak population living in Czechia may however feel an insufficient contact with their mother tongue. After the split of the common state, Slovaks living in the Czech Republic are observed to show an increasing interest in the development of their own cultural life, especially in localities of their higher concentration (Šrajerová, 1999). In compliance with legal regulations of the Czech and Slovak Republics, members of ethnic minorities have a guaranteed right to conserve and develop their national identities, which reflects in the right for the development of their own culture, spread and reception of information in their mother tongues, association into their own national associations and political parties, education in their mother tongue, use of their mother tongue in contact with authorities and their participation in the solution of issues concerning ethnic minorities. There is a range of Slovak ethnic associations established in the Czech Republic – e.g. Slovak Community in the Czech Republic (with branches in Prague, Kladno, Karlovy Vary, Karviná, Tábor, Sokolov, Pilsen, Kroměříž), Democratic Alliance of Slovaks in the Czech Republic, Slovak Union in the Czech Republic, etc. And there are also special-interest associations of Slovak nationals in Czechia such as the Foundation of M.R.Štefánik, Historical Group of Direct Participants in the Slovak National Upheaval, Folklore Group Limbora (Prague), Folklore Association Púčik (Brno), Community of University Students Detva (Prague), etc. Activities of the Local Division of Matica slovenská which were launched in 1969 have been restored under a new name of the organization – Club of Slovak Culture. Slovak Community in the Czech Republic issues a monthly named Korene (Roots), broadcasting media have special programmes for Slovaks in Slovak language.

The situation of the Czech community in Slovakia was more complicated after the split. Before the extinction of Czechoslovakia as a common state, Czechs living in Slovakia (similarly as Slovaks living in Czechia) did not consider themselves an ethnic minority and the Czech community was never organized there. As compared with the concentrations of Slovak ethnic in Czech towns and villages the concentration of Czechs in Slovakia has always been considerably lower (There is no Slovak municipality in which the share of Czech ethnic would be higher than 2%). With respect to the similarity of languages and the above mentioned low territorial concentration, the Czech ethnic group in Slovakia has never raised any requirement for the establishment of a Czech kindergarten, basic or secondary school with lesson in their mother tongue. Neither there were any Czech cultural and ethnic societies coming into existence in Slovakia before 1993.

The very first organization of Czech nationals living in Slovakia as an ethnic minority was registered as the Czech Confederation in Slovakia as late as in 1994 as a socio-cultural organization associating inhabitants of the Czech, Moravian and Silesian origin and their families living in the Slovak Republic with no respect of their state citizenship. The organization has some 3 000 members and its regional branches are located in Bratislava, Košice, Humenné, Rožňava, Liptovský Hrádok, Martin, Nitra, Poprad, Trenčín, Trnava, Zvolen, Banská Bystrica and Žilina. It organizes various social events and cultural programmes for its members and issues a monthly named Česká beseda. Another similar association is the Club of Czech citizens in the Slovak Republic, established in 1994. Activities of these organizations are subsidized from the state budget (chapter Cultural Activities of Ethnic Minorities) (Dostál, 2003). Slovak media, too, have included broadcasting for the Czech ethnic minority (e.g. TV programme Czech National Magazine).

As demonstrated by the results of sociological research studies, most Slovak nationals resident in the Czech Republic and Czech nationals living in the Slovak Republic do not suffer with the syndrom of ethnic minority thanks to familiar language and cultural environment, family and social bonds and historical context (see e.g. Šrajerová, 2001).

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DOC.ING. JAN LACINA, CSC. (60)

Chief scientist and member of the Scientific Board at the Institute of Geonics of the Czech Academy of Sciences, Jan Lacina celebrated his life anniversary on 9 January 2004. Having graduated from the Faculty of Forestry at the University of Agriculture in Brno (1966), he was conferred the title of the Candidate of Sciences (CSc.) after having defended his Dissertation at the Czechoslovak Academy of Sciences in 1986. In 2003, he was qualified Associate Professor at the Faculty of Forestry and Wood Technology, Mendel University of Agriculture and Forestry (MZLU) in Brno.

In the period from 1966 – 1974, Doc. Lacina worked at the Institute of Management Planning in Military Forests and Farms, and in the period from 1974 – 1993 he was employed at the Institute of Geography, Czechoslovak Academy of Sciences. Since 1993 he has been working at the Institute of Geonics ASCR. J. Lacina deals with biogeography within the framework of the geobiocoenological school of Prof. Zlatník, his scientific activities being focused on theoretical, application and teaching work. He was member of a team appointed with the development of a Czech conception and methodological approach for the creation of the territorial systems of ecological stability.

At the present time, he deals with an analysis of the effect of natural disasters on the biotic constituent of the landscape and in the evaluation of vegetation changes under the influence of the construction of extensive engineering works. He is member of the Scientific Board at the Brno Branch of the Research Institute of Water Management of T. G.Masaryk, member of the technical board for post-graduate studies of ecology at MZLU Brno, vice-chairman of the Editorial Board of the Veronica periodical. He is also involved in the practical issues of nature conservation and its popularization. He is author or co-author of more than a hundred scientific works and tens of expert opinions.

Members of the Editorial Board of the Moravian Geographical Reports wish Jan Lacina good health and much success in his further professional work.

IN MEMORIAM DR. PETER MARIOT, CSc. (1940 – 2004)

RNDr. Peter Mariot, CSc. – Member of the MGR Editorial Board – died after serious disease on 8 January 2004. We have lost in him a good companion, friend and irreplaceable colleague. From 1962 to the very last day of his life he worked as a chief scientist in the Institute of Geography at the Slovak Academy of Sciences. He was an excellent geographer specialized in the geography of tourism, a traveller, participant to scientific and sports expeditions in Europe, Asia, Africa, America and to the Northern pole, author and co-author of a whole range of scientific and popularizing educational articles and book publications.

We knew him as a highly sociable, amiable, modest and attentive man who was lucky to perceive the world from a viewpoint of the good which he tried to radiate into his surroundings.

For which he deserves our thanks. Honour to his memory.

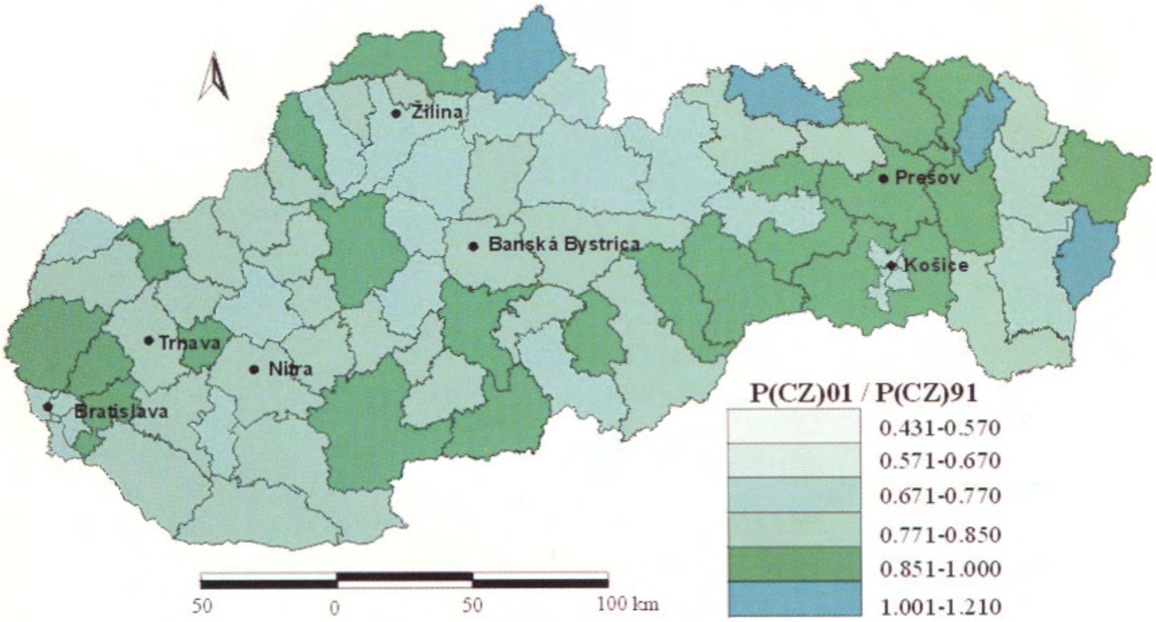

Fig. 10: Changes in the share of Czech nationals in Slovakia in 1991 – 2001.

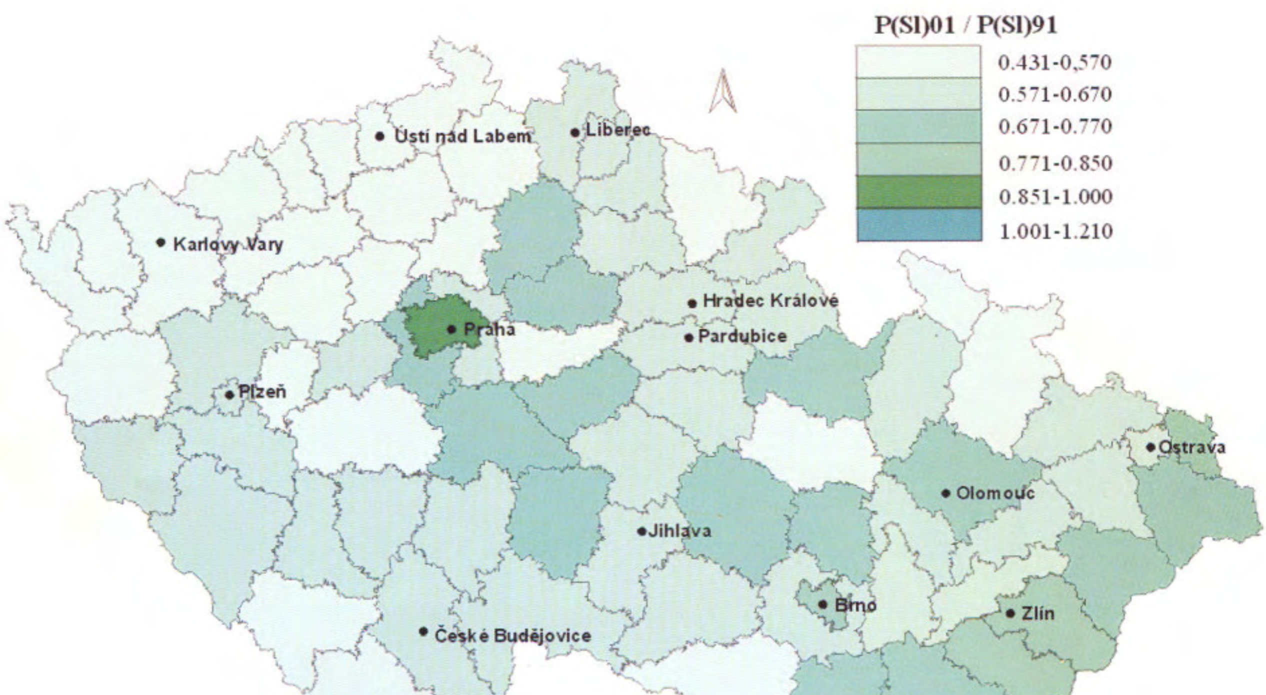

Fig. 11: Changes in the share of Slovak nationals in Czechia in 1991 – 2001.

Illustration to the V. Ira´s and J. Zapletalová´s paper.

Fig. 5: The nature monument of "Profil Morávka" – rock outcrops in the Morávka R. canyon.

Photo A. Rafajová

Fig. 7: Accomplished recultivation of the area with the use of a spontaneously developed wetland biotope in the extraction space of the "ČSA" Coal Mine, cadastral area Karviná-Doly.

Photo A. Rafajová

Illustrations to the Rafajová's paper.