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Territorial differences in social capital – an empirical comparison of two regions

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Abstract

The contribution deals with the result of an empirical research probe establishing the state of so called collective social capital in an area of both the South Bohemian and North Bohemian regions. Collective capital is understood as trust in the social environment and in institutions (Putnam). The objective of the research is to verify the methodology of measuring this type of capital.The research probe established the existence of differences in orientation and strength of social capital in the compared regions.

Keywords: social capital; cultural capital; trust; local community; old industrial region

1. Introduction

The issue of social capital has been at the foreground of attention in the social sciences since the 1970s. Interest in the issue of all kinds of capital is increasing steadily. According to D. Halpern, the number of expert papers dealing with this issue was in the region of 300 in 2003, whereas in 1984 there were only 30 of them (Halpern 2005: 9). The number of expert studies and research in so called „non-economic“ capital, particularly social capital is increasing at an exponential rate, the number of the internet reference concerning this concept is in the region of over one million. Why such interest in this issue?

Apart from a certain trendiness with respect to this issue, it must involve something that actually brings new findings to the foreground and consequently pushes humanities research into a more productive and practical sphere. As a result of extensive research and theoretical work during the last decades, two basic concepts surrounding the understanding of social capital have gradually evolved: individual (relational) and collective.

The concept of individual social capital proceeds from the existence of social networks (including the possibility of gift exchange in a broad sense – economic interest is not expressed) as utilizeable relations between people. It proceeds from a concept originally employed by P. Bourdieu (1998) and is also described as *informal social capital*. Dealing with „private welfare“, it focuses on individuals.

Collective social capital is created by values and norms of social behaviour combined with the support of a functioning democracy. Involving civic commitment, they express mutual trust and trust in social institutions. Trust is a prerequisite of active social behaviour and participation as well as a necessary complement to the operation of public institutions (Putnam 2001). This type is described as *formal social capital* or as capital bringing about „public welfare“ (Matějů 2002).[1] It can be measured empirically through ascertaining information about mutual trust between people and their trust in institutions.

2. Social capital as trust

In this contribution I want to inform you of a few findings which have been called into being so far in connection with realizing the grant project *„The state and activation of the social potential in old industrial regions“*.[2] We proceed from the presumption that social capital depends on the specificity of the local community of the region . Or alternatively, that *collective social capital* in particular, is rather different in every region and can consequently be understood as one of many indicators of regional identity and differentiation.[3]

One of the objectives of the project is to find out the state of social capital and the structure of its bearers in an old industrial region (in this case the Most and Chomutov districts) and to carry out a comparison with the state of this capital in a region that is not affected by the deformations of the one-sided development of the industrialization process. In this case we have chosen the districts of Tábor and Písek (simply called Táborsko).

The method used for measuring the state of collective social capital was by means of a questionnaire.It included, among others, questions exploring social capital such as *trust* that people have in various social or professional groups and in some institutions.

It was the first research step to verify the possibilities of measuring social capital by this method.In these particular regions, a total of 612 research interviews were carried out with local inhabitants selected on the basis of quota specification with quota features being sex, age and education.

The initial hypothesis of our consideration assumes that regions (here delimitated by particular districts) differ from each other in the extent and size of social or even cultural capital. The key research question is whether there are really differences in the social potential of both regions.What are the differences and how are they presented?

Social capital is measured as the level of trust between people and trust in social institutions representing public arena for the local community of the region. The higher the trust and its universality, the higher the social capital a particular community posseses. A community with a high the level of universal trust can overcome various problems surrounding everyday life and development more easily. It acts as a sort of a guarantee for stability and advancement.

3. Measurement of „trust“

Evaluating statements on the state of trust in a particular community are the most frequently used indicators of the level of social capital.The interviewees express the extent of their agreement or disagreement with these statements.They are supposed to react on the basis of their experience with a particular community and to express the state of social climate in this way. In our survey, the two following statements served as basic indicators of the extent of social capital as trust: *(1) „We*

[1] This approach is often applied in the research into the impact of social capital in the countries going through postsocialist transformation. (Reiser et al. 2002)

[2] „The state and activation of social potential in old industrial regions“. GAČR no.403/08/1229

[3] I am leaving aside here the complex question and discussion of the concept of the region itself or its delimitation.

can trust most people around us.", (2) „If you are not cautious enough, other people will exploit you."

Tab. 1 The structure of agreement with the above mentioned statements (%) (source: author)

Statement	Region	Definite agreement 1	Agreement 2	Neither/ nor 3	Disagree-ment 4	Definite disagree ment 5	Do not know
„We can trust most people around us"	Mostecko	0,6	6,8	29,9	48,7	12,7	1,3
	Táborsko	1,0	21,0	29,7	40,7	5,9	1,7
„If you are not cautious enough, other people will exploit you"	Mostecko	15,9	54,9	20,8	7,5	0,3	0,6
	Táborsko	13,1	49,8	23,8	12,4	0,7	1,0

There is a clear disagreement with the first statement in Northern Bohemia, the difference being statistically significant. The average evaluation on this scale is 3,62, while in Southern Bohemia it is only 3,24.

The evaluation of the second statement is also different in the observed regions. There is a little more agreement in the region of Mostecko. The difference in average evaluation is not statistically significant (Mostecko 2,19, Táborsko 2,35). A higher average figure, which means a higher rate of disagreement with the negative statement, shows a higher rate of expressed trust. On the whole it proves that in the North Bohemian region,a generally lower trust in other people prevails. Although this result coincides with the hypothesis deduced from everyday practical experience, the question arises not only concerning the reasons for the difference but also about the appropriacy and applicability of these procedures, also in relation to other regions and social units.

Another way of measuring trust is by a direct question: „How much trust do you have in ...? followed by a list of groups of people and selected institutions creating part of the public arena of the community. The choice of objects was based on comparison with a procedure already applied elsewhere.[4] In our opinion, the selected objects represent important dimensions of the public arena in which people need a necessary extent of trust for a rational and efficient choice with respect to their activities. However, they do not involve economic institutions such as banks and firms. Only partly the questionnaire examined confidence in job security or enterprise stability. At the time of preparing and carrying out the field investigation, this area of public life was stabilized and without any doubts. In the light of current global economic problems, the research of trust in these institutions would certainly be interesting. . It seems that especially the public trust in economic institutions is a significant if not essential dimension of the stability of the whole economic system and consequently of the whole society.

As an object of trust evaluation the research employs, aside from groups of people, institutions of local government and politics or their representatives (see the list in the **tab. 1**).The respondents expressed the extent of their confidence in these objects on a four-grade scale

[4] Compare e.g. Crossborder influences in the Czech borderland,UJEP,Ústí nad Labem, 2007.

whose extreme points were:“very great trust“ and „no trust at all“.

First, let us look at the examined objects from the point of view of the evaluation of the whole group of interviewees (612). A factor analysis confirmed the difference between particular groups of objects which represent relatively independent dimensions of trust in the public space of the examined regions.

The following dimensions delimitating public arena were defined by way of a factor analysis of individual responses as significant:

a) *political institutions* (parliament, political parties, the current government, the European Union). These are institutions constituting the substance of political and administrative power in the state, which, in relation to the region, function as an external framework of the local community. The index of trust expressed as an average of evaluations of particular indicators on a four-grade scale (from very high = 1, to none at all = 4) is 3,32.

b) groups of *further non-identified (anonymous) individuals* (Czech citizens, foreigners, neighbours) – index of trust 3,10

c) *public institutions* (media, courts of justice, trade unions, churches) – index 3,0.

d) *entrepreneurs* (local, foreign) - index 3,13

e) *representatives of local institutions* (clerks, elected officials, local policemen)- index 3,05

f) *social institutions* (health care, police) – index 2,63

g) *non-anonymous individuals* (family members, colleagues)- index 1,84

These dimensions represent 69 % of the variance in responses. The comparison of the indices with the applied scale shows that most examined dimensions of public space (objects - groups of people and institutions) enjoy rather limited trust. The least trust is that in the framework of political institutions (parliament, government, political parties). The center of their evaluation lies in one third of the scale, i.e. they have rather limited or even no trust. At the same time, a majority of respondents expressed their trust in political institutions (only about 9 % said that they did not know or could not evaluate their trust in relation to these institutions).

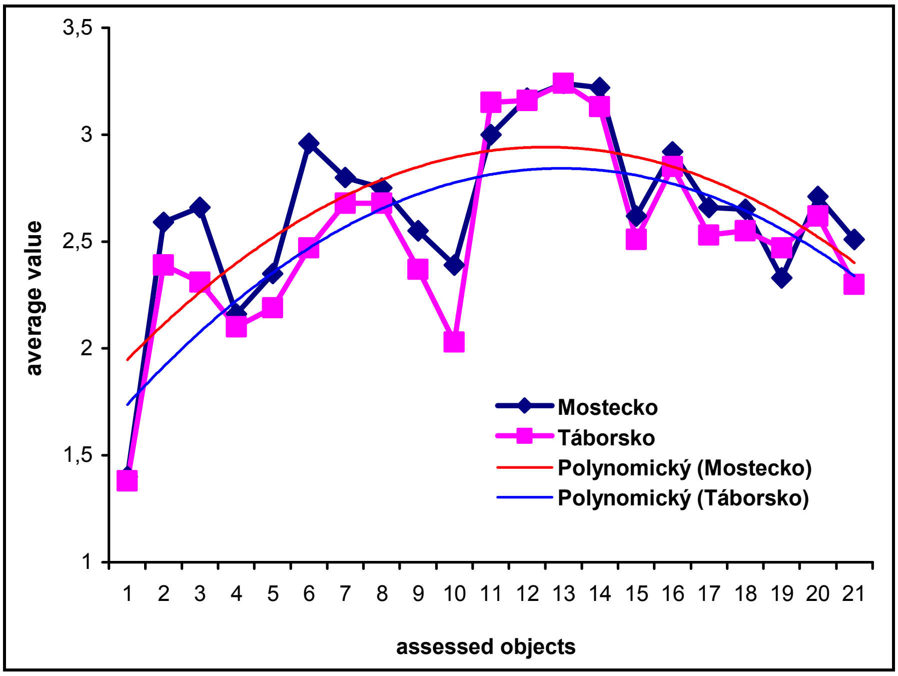
As expected, the highest extent of trust is shown by people from social groups with a personal link, where respondents know the others well (family members, colleagues and to a certain extent also neighbours). These people enjoy a very high and considerable rate of trust from most respondents.

4. Differences between the examined regions

Further, we will concentrate mainly on the differences between the compared regions. The factor analysis carried out for each regional set separately shows a rather different structure of dimensions. The dimensions of *political institutions and non-anonymous individuals* are identified in the same way (the same indicators relate to them). The index of trust in *political institutions is* 3,15 for Mostecko and 3,18 for Táborsko. The index of trust in *non-anonymous individuals* is 1,4 for the region of Mostecko and 1,74 for the region of Táborsko. The difference is caused by the fact that in the region of Táborsko also the item „trust in colleagues“ was included, while in the region of Mostecko there was only the item of „family members“. The structure and level of the *„social institutions“* is also almost the same in both regions (Mostecko 2,51, Táborsko 2,43).

The structure of other dimensions is internally different, which signals different levels and contents of trust in both regions. The dimension *entrepreneurs* is structured in a different way, the indication of trust in local institutions was added in the region of Mostecko, while in the region of Táborsko it was the trust in groups of anonymous individuals. A comparison of indices shows that this dimension enjoys higher trust in the region of Táborsko (index 2,27) than in Mostecko (index 2,62). We can infer from this, that in the region of Mostecko the critical view of entrepreneurs is the same as that of officials, while in the region of Táborsko the respondents have approximately the same level of trust in entrepreneurs as in anonymous groups (e.g. foreigners). Further details concerning the trust in particular objects are summarised in **fig. 1**.

Fig. 1 Average evaluation of trust in examined objects (see the list below) in the public space of Mostecko and Táborsko (the higher the average, the lower the trust) (source: author)

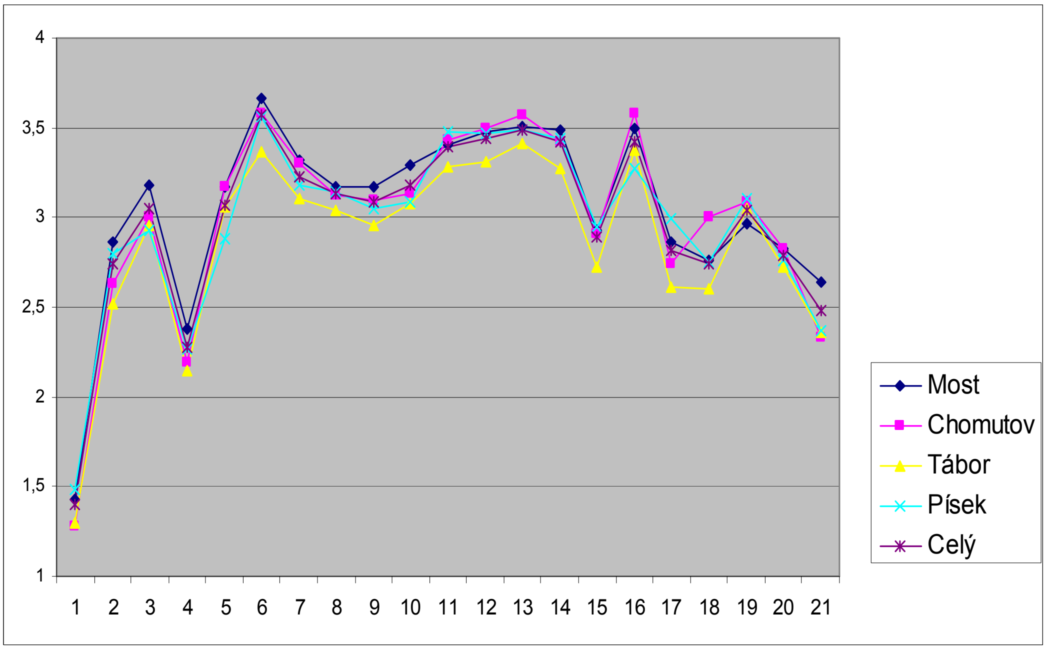


Note: Examined objects (groups and institutions): 1. Family members, 2. Neighbours, 3. People in the community or town, 4. Colleagues, co-workers, 5. Citizens of the CR, 6. Foreigners living in your town (community), 7. Elected officials from the local authority (the Mayor, councillors), 8. Clerks in public institutions (local authority, job center, tax authority etc.), 9. Local Czech entrepreneurs, 10. Foreign entrepreneurs and firms in your place of residence, 11. The Senate of the CR, 12. The Parliament of the CR, 13. Political parties in the CR, 14. The current government, 15. The European Union, 16. Churches, 17. Courts of justice, 18. The media, 19. Trade Unions, 20. Police in your place of residence, 21. Health care in your place of residence.

Obviously the curves of the graphs evaluating particular items are almost the same, nevertheless, as the links between the trends show, there are noticeable differences in the evaluation of trust in the examined objects. The set of respondents from Táborsko is generally less critical in almost all items.

There are also certain differences within the examined regions of Mostecko and Táborsko. The differences in particular items between the districts of Most and Chomutov are small. On the contrary, the situation in the region of Tábor is different. While the district of Písek does not differ much from the districts in Northern Bohemia, the level of trust in the public arena in the district of Tábor is generally higher.These differences are marked in the graph of average evaluation of trust of particular indicators.

Fig 2 Average evaluation of trust in the examined objects of public arena (see the above list) in particular districts. (source: author)



Note: Most, Chomutov, Tábor, Písek (study areas), Celý (whole area).

5. Conclusions

From this analysis of data obtained through a survey of the inhabitants of the districts in both compared regions, it follows that collective social capital (trust) varies. The findings rather verify the initial hypothesis of our research, that social capital (as well as other kinds of „non-economic“ capital) in the old industrial regions, affected in this case also by the postwar exchange of population and high migration, is lower in comparison with that in „traditional“ regions. This is represented by the lower level of universal trust in both anonymously delimitated social groups and public institutions. Particularly, there are different levels of trust in neighbours, people in the towns, foreigners, elected local officials, but also in some institutions, e.g. health care, police and churches. In this regard, the level of trust in the regions of Táborsko and Písecko is significantly higher.

The level of collective social capital corresponds with other indicators of the state of social capital, e.g. divorce rate, crime rate, stability of population. The situation in the region of Táborsko is also more favourable in this regard. Similarly, we have noticed differences in the area of civic commitment, participation in elections and a different pattern of voting for political parties in the regional elections in 2008.

To sum up, we can assume that the local community of towns and municipalities in the examined regions has a different level of not only social capital, but also of other kinds of capital, especially cultural and human. We assume that in both regions there is also different social potential with respect to the ability of the population to apply these kinds of capital in solving current and conceptual problems of an individual and of a common nature. We can also take into consideration different ways of thinking when solving social problems. Here further questions arise: What consequences can be drawn from the presence of low collective social capital for the further development of the North Bohemian region? Does this economically strong region really not offer many more opportunities for both the solving of social problems and the development of personal fulfillment? Is the current state caused by a lack of human and cultural capital? The very issue of examining and activating social capital in both regions is the subject of our further studies.

In connection with these conclusions we should remember that this is the first stage of the solution of a three-year project. The key objective of this stage was the assessment of possibilities for measuring social capital by means of a survey and the finding of appropriate indicators which differentiate according to the level and actual content of the capital. The verified indicators will be applied in a more extensive representative research project. The methodological conclusion refers to the question as to whether the indications used for measuring trust are sufficient to determine the content of the social capital of the population in the respective regions. Prior research showed that the concept of collective social cupital, such as trust, is applicable to empirical research and that the majority of applied indicators facilitate the differentiation of the level and content of the social capital of the inhabitants.

Acknowledgements

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The Politics of Landscape on Regional and Local Levels

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Abstract

Landscape concept includes its both physical and cultural content, juxtaposes its material and mental attributes. Landscape means something different than region emphasizing nature/humans interaction and distinguishes between environmental and ecological social construction of landscape. The fabric of relatively compact parts named ESPECT consisting of economy, society, politics, ecology, culture and technology is intended for searching mechanisms of their spatial temporality under the baton of politics in their heterotopic pattern. From this point of view outlines options and limits of landscape sustainability on the regional and local spatial dimensions in the politics of targets, measures, activities in regional development programs.

Keywords: landscape; politics; sustainability; security; regional development

1. Introduction: Framework and framing

As we mentioned (Hynek, Hynek 2005) our activity in landscape study was a part of policymaking and we were looking for active politicians, professional, activists, citizens holding their perspectives to join in our environmental discourse on the Czech regional strategies and programs. The basis of our approach consisted in the use of the ESPECTS framework. This framework has been developed as a set of lenses which represent and show some prevailing categories and tendencies in the classification of things, events, phenomena etc. The framework is a priori designed and aims to be in this a priori phase as much non-biased and neutral as it can be. It means that it attempts to avoid the pitfalls of perspectivism (some a priori-chosen particular combination of lenses proportions) that would precede an analysis itself. All possible perspectives are taken as legitimate, though, not all of them would be in the later phases of the same normative value.

Fig. 1 ESPECT (source: Hynek, Hynek, orig.)

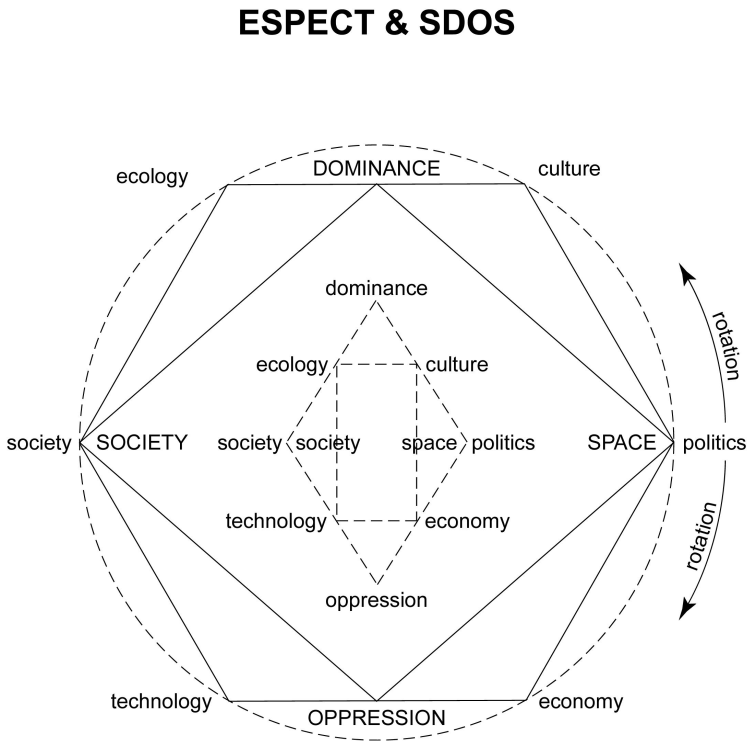
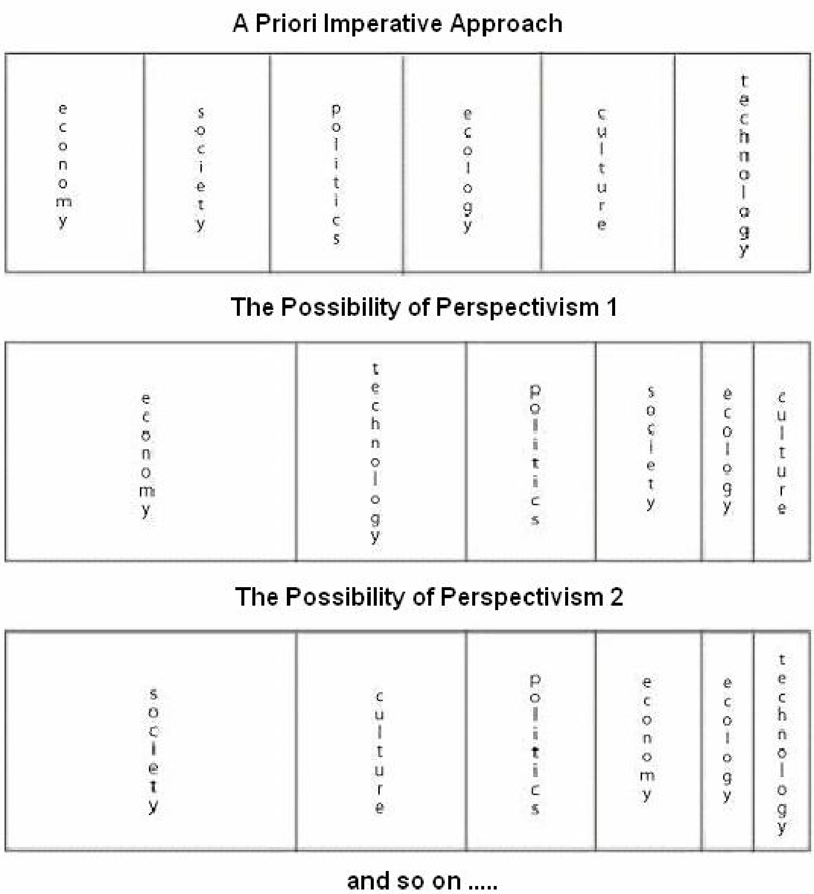


Fig. 2 ESPECT (source: Hynek, Hynek 2005)



The ESPECTS framework has been specifically developed for the scientific practice purposes and as such it gives the observer a wide choice of points of view. As far as the field of science is concerned, the objective is to keep all lenses clustered in the ESPECTS in equilibrium. Therefore, the same attention ought to be paid to all parts of this framework. The domain of practical policy-making and politics, however, work differently. Science and politics can be conceived as two different fields of human activity, featuring different criteria, structures, mechanisms of socialization and actors too. As our practical experience shows, these social fields overlap to lesser or greater extent and we can often witness the process in which politicians turn to experts to ask for advice or expertise (esp. in non-precedent situations).

In case this process becomes more solid and engenders somewhat regular interactions over a particular issue, the scientific mechanisms change. For instance, if the scientist is to be asked to supply the regional stakeholder forum with his/her expertise and recommendation, the issue requires active political framing(s) for a subsequent political debate. In other words the scientist needs to create different frames of the issue for different occasions. He/she needs to take into account things like the composition of stakeholders present in the negotiation and/or bargaining process, the prevailing patterns of the institutions where these negotiations take place, the "history" of similar negotiations etc. According to M. Hajer (2003: 58), the public domain is 'spaces in which people of various origins deliberate on their future as well as their mutual interrelationships and their relationships to the government' (here a regional one).

It was the nature of our scientific domain (its wide and in some sense an overarching scope) which played an important role in the expectations of stakeholders as far as our contribution was to be concerned. Thus, in order to meet their demands, we could not be in an "only-expert" role. We had to introduce and present some political solutions as well. Practically, we refused Peter M. Haas's notion of politically neutral experts who would withdraw from the political debate when the first political contest occurs. Since our role was to provide the forum of policy-makers (gatekeepers) and various stakeholders with scientific expertise, we did exactly that. However, our role was not exhausted by this: we were also representatives of a private regional research agency that had been granted this contract. Therefore our final position/stance reflected both of these attributes. Consequently, we opted for James K. Sebenius's strategy in which scientist are an active link in a political chain and the task was to transform the scientific facts into a politically feasible "winning strategy."

This process of transformation needs to be understood as an attempt to persuade or convince the other involved actors about the strengths of our proposal. And again, for such a process, one cannot rely on a rather naïve notion of neutral science. There is nothing as a neutral science, it is always the level of scientist involvement and the nature of the issue that influence (though not determine) the style and strategy of the issue presentation. As the above case shows, once the scientist gets into the political field and is expected to be not just an active participant in the political debate but also a "solution provider," the creation of various political (not just scientific) strategies and frames is being a crucial part of his/her contribution.

2. Spatiality

Spatiality has been recognized by D.Gregory in human geography in four main senses connoting the human and social implications of space:

a) Upon existentialist and phenomenological tradition (Pickles 1985) as understanding places and spaces in our immediate experiences, constellations of relations and meaning which we encounter in our everyday activities. It reveals the human significance of contextuality and cannot be understood independently of the beings that organize it with the character of ‘ situating’;

b) Upon structural Marxism spatiality identifies the connections and correspondences between social structures (modes of production or social formations) and spatial structures. Lipietz (1977) claims that the concept of spatial structure is dependent on and so must be derived from a concept of spatial structure. Spatiality consists of a correspondence between ‘ presence – absence’ in space and ‘ participation – exclusion’ in the particular system of social practices contained within each level with its own topology;

c) Soja (1985) develops H. Lefebvre’s vision of spatiality specifically to socially produced space, the created forms and relations of a broadly defined human geography: ‘All space is not socially produced, but all spatiality is’. Spatiality is both the medium and the outcome of situated human agency and systems of social practices broadly consonant with structuration theory. A. Giddens (1984) also rejected the idea that ‘ space has its own intrinsic nature’ and asserted:… ‘in human geography spatial forms are always social forms…and spatial configurations of social life – spatialities – are just as much as a matter of basic importance to social theory as are the dimensions of temporality’;

d) Upon post-structuralism, especially after Deleuze and Foucault spatiality is indicated as the ways in which constellations of power-knowledge are inscribed in space and through which particular subject-positions are constituted and particular identities fabricated.

E. Relph (1981) distinguishes 4 different sorts of space, or knowledge about space, produced by different relationships to places:

a) pragmatic space – organized by our bodily situation;

b) perceptual space – observing through intentions;

c) existential space – by cultural structures as much as our perceptions (full of social meanings), relationship to some human existence or task;

d) cognitive space – how we abstractly model spatial relationships.

Spatiality in this sense explains how space and social relations are made through each other.

Another understanding the space comes from K. Hübner (1990):

a) space is not simply composed of a continuum of a multiplicity of points but is rather,made up of discrete elements, the so called témene with through their alignment constitute the spatial dimension;

b) sacred and profane spaces;

c) there is no single place.

And also postmodern geography in accordance with M. Dear (2001) identifies three topical areas concerning our contribution:

a) cultural landscapes and place-making, with an increasing emphasis on the urban;

b) economic landscapes of post-Fordism and flexible specialization, with particular interest in global-local connections and the spatial division of labour;

c) continuing philosophical and theoretical disputes, especially those relating to space and the problems of language.

According to D. Harvey (1996) spaces and times (or rather space-times) are not external coordinates but are contained within – or ‘ implicated in’ – different processes that effectively ‘ produce’ their own forms of space and time. H. Lefebvre (1991, in Gregory D., 2000) proposed spatiality as a concept of socially produced space – both mental space and material one.

3. Landscape spatiality

Landscape as the common word is also a geographical term used very broadly in various intersecting individual, formal or generic meanings, from our point of view juxtaposed, not contradict:

- Representing scenery;

- Observed territory in a single view;

- 'Way of seeing' rather than as an image or an object (Cosgrove 1998);

- Human environment, human ecology (e.g. H. Barrows 1923, P. Haggett 1983), the link of people and land;

- Pattern of landscape ecosystems at choric/regional level, in the sense of C. Troll (1939, 1970): the complex of causal and reciprocal connections between biological communities and their environment in a particular section of landscape, a unifying approach to the natural science with social geography;

- Spatial product of socio-economic production, reproduction and consumption - complex metabolism between nature and society;

- Territorial infrastructure is constructed as a vital organizational landscape to facilitate social production and reproduction. Relationship between economic production, social reproduction and political governance are reconstructed - deindustrialization, urban sprawl, role of the cities (from welfare to workforce), cities (Taylor 1996) are replacing states in the construction of social identities, social production rather than reproduction;

- Distinct association of forms, both physical and cultural (Sauer 1925): landscapes are products of cultures and also reproducing them through time, cultural region includes its matching landscape;

- Iconography, text (Cosgrove, Daniels 1988; Duncan, Duncan 1988), double encoding of landscapes – wrapped in another representation (Crang 2001). Literary landscapes, multiply mediated environments. Landscape as property (Cosgrove, Daniels 1988), owned by those beholding it; capturing and controlling the land through representation of it as landscape in maps and in paintings – and through fashioning landscapes on the ground using design and architecture. The landscape then, far from being neutral and inert, has social and cultural meanings, a symbolism – an 'iconography'.The similar method of ' thick description' of anthropologist C. Geertz provides the same role in landscape studies;

- Simulacra (Baudrillard 1988; Clarke, Doel 1994);

- Theatre, dramaturgy (Cosgrove, Daniels 1993; Cresswell 1996);

- Land management framed by state and shaped by economy (Blaikie 1985);

- How politics as policy of resource management, control over the environment is discursively constructed (e.g. Moore 1995; Leach, Mearns 1996 eds.);

- Implies a collective shaping of the earth over time, reflect a society's – a culture's – beliefs, practices and technologies (Crang 2001), shape and shaping the people living there, landscape is a bank of cultural memories;

- Regional personality or a genre de vie expressed in landscape (Vidal de la Blache 1921; Annales School);

- A palimpsest – landscape is the record of change, as cultural values change so new forms is required (Crang 2001), includes past practices and knowledges, series of layers – abiotic, biotized, biotic, anthropized, anthropic, noospheric;

- Cultural landscapes as other spaces/places, e.g. regions, in the sense of J. Allen, D. Massey and A. Cochrane (et al. 1998: 8), are constructed both materially and discursively, and each construction affects the other;

- We cannot omit Foucault's contention: the operation of power or the constitution of subjectivity with seeing how power, space and subjectivity entail production of space;

- 'Spatializations' (Latour 1993) are not just physical arrangements of things, but spatial patterns of social action and embodied routine,as well as historical conceptions of space and world.Landscapes are concrete instances of spatialization.

4. The condition of sustainability

Current concept of sustainability is a favourite bone of contention between its defenders and opponents. In defiance of the latters it is still living theme. We try to deepen performance of sustainability by several ideas [1] and practical illustrations [2].

[1] How many pillars for sustainability?

Continuing form of spatial formation of ' power-knowledge' is situated knowledge (SK) in the sense of D. J. Haraway (1991) - a doctrine of embodied objectivity that accommodates paradoxical and critical feminist science projects. SK replaces the traditional conception of scientific practice as the pursuit of a disembodied, inviolable and neutral objectivity with an alternative formulation that stresses embodied physicality, social construction, and cultural politics, view from nowhere, scientific fetishism… Embodiment means vision of particular kinds of human bodies, embodiment is also technological (machines, GIS / biases, hidden assumption, aporias) collective nature of inquiry involving interaction, difference, and debates over meaning and responsibilities. Situated knowledge is embodied in the physicality of specific human bodies and their artifacts, the possibility of critical engagement.All situated knowledge is partial, including the SK we have of our own knowledge about ourselves.

N.J. Thrift (in Johnson, Gregory, Pratt, Watts 2000: 4-6) comments actor-network (A/N) theory of B. Latour, M. Serres and other authors:

- all the usual boundaries…between humans and things, nature and culture, tradition and modernity, inside and outside / must be put aside;

- the world is a series of acts of ' heterogenous engineering': Latour's actant are hesitant, A/N theory is also known as actant-rhizome theory;

- the existence of A/N depends so heavily on circulation… immutable mobiles = devices, types of people,animals, money…;

- the stress laid on mediaries and intermediaries… messengers.

It problematizes the act of representation as it becomes a kaleidoscope of different representational modes. However it offers geography better understanding interactions between nature and technology, provides a means of understanding space as an order of partial connection and in doing so suggests new means of understanding space and place.

Cultural turn as an intellectual shift has been also blurring the artificial distinction between the 'economic', the 'cultural', and the 'political'. Profound role played by systems of signification, including discourses, language, texts and representations of all kinds – to forge a nonrepresentational theory of action that stresses performative embodied knowledge.

C. Katz (2001: 93-94) interprets M.Foucault's heterotopia (Foucault 1984: 252, 1986) as reworkings of space by the forces of globalization and the effects of high technology. Lived space is heteregenous, heterotopias are 'real' spaces within "social spaces whose functions are different or even the opposite of others in landscape of power. They juxtapose several spaces or sites that are 'incompatible', and so 'function' either to create a space of illusion that exposes the partitioned spaces of everyday life as illusory, or to 'create a space that is other' as ordered as our everyday spaces are ' jumbled', the latter is the heterotopia of ' compensation.

New concept of ' thirdspace' coined E. Soja (1996, in Latham 2004: 272) is the notion of a trialectics of being – the insight that the ontology of being can only be interpreted by examining the interlocking of spatiality, historicality and sociality. But let's give E. Soja (1996: 56-57, in Hubbard, Kitchin, Valentine 2004 eds.: 272) his word: "everything comes together in Thirdspace: subjectivity and objectivity, the abstract and the concrete, the real and the imagined, the knowable and the unimaginable, the repetitive and differential, structure and agency, mind and body, consciousness and unconsciousness, the disciplined and the transdisciplinary, everyday life and unending history".

5. Spatial environmental/cultural landscape ecosystems at the regional level

For the purposes of providing the basis for a subsequent discourse on environmental issues in the area of the Czech NUTS II/South-East – The Highlands and South Moravia, we have constructed a thematic map which represented our knowledge base. The starting point of this map is a presentation of spatial pattern of land cover of the South-East region (SER) from various sources of data including remote sensing data, air photos etc. Landscape ecology generally portrays landscape ecosystems. In the particular case of cultural landscape it examines how humans use natural resources, whereby creating cultural landscape ecosystems (CLE). A CLE spatial identification depends on the map scale; in this case it is mainly 1:100 000 where they are presents as clusters.

Their recognition enables us to gather, process, store and use data on CLEs. We can utilize the information concerning their physical components (landforms on rocks, regolith and slope sediments, soils, climate and hydrocycle, potential and real biocenoses), human activities (agriculture, forestry, mining, fishing, manufacture, transportation, housing, recreation, tourism, nature/landscape protection, etc.), and their spatially pronounced interactions which influence both inputs and outputs in a two-way fashion. Any CLE belongs to the chain of production, reproduction and consumption with its general, specific, and unique position and focus. CLEs are from an anthropocentric position a part of human environment.

Discourse on environmental issues of the SER included various individuals and social groups, politicians, experts, professionals, enterprisers, industrialists, businessmen, workers, public servants/officials, juniors and seniors, males and females, citizens of different social origins and experience. Their environmental experience with the SER is first of all local, linked with their residence, service places, job place, recreation/tourist places. We can hardly meet somebody with full spatial knowledge of the entire SER's CLE. However we must not forget to take into account the role of specialists in agriculture, forestry, transport, health services etc., who know their field of expertise around the SER. On the other hand, our position was previously based on our own regional survey. All these stakeholders contributed by their own perspectives to the rich ongoing discourse and gave us a good sample of the local interests.

The practical procedures included practices of regional coordinating group, consultants, knowledge base, frames and their SWOT analysis, strategies, critical points, objectives, priorities, strategy of development, actors, regional conference and implementation, policies, principles, financing, EU programmes, framing, SME, etc.

The importance of local/regional environmental experience, evaluation, problems and perspective was taken into account during the agenda/setting and the process of policy-making. These activities resulted in the creation of the final product, the strategies for both The Highland and South Moravia regions. As an example of environmental targets and measures for South Moravian Program of Regional Development - 2007 (Hynek, Hynek, in press) are stated the contents in following table **(tab. 1)**:

Tab. 1 Environmental targets and activities/measures for South Moravian Program of Regional Development, 2007 (source: Hynek, Hynek, in press)

SPECIFIC TARGETS (SP)

Restoration of small and medium watercourses, taking precautionary measures against floods
Activities:
A1. Revitalization of water ecosystems and multiple use of watercourses
To support processing projects which concern revitalization of water ecosystems: riverbeds, riversides, floodplains with wetlands, in conformity with money funds of the State Environmental Fund, the Ministry of Agriculture and water catchment managements in subsidy titles for the years 2007-11. To comprehend issues of watercourses and reservoirs as part of wider topic – wetlands in the sense of the internationally accepted Ramsar Agreement. To emphasize the use of recreational potentials of watercourses in towns/cities. To arrive to expectations of the South Moravian Program of Advancement in ducts and sewerage by supporting long-distance ducts as The Vir Reservoir Regional Duct and local prime quality water resources.

A2 Restriction of activities in flooded areas and sensitive measures taken against floods
To respect principles of a newly commissioned plan of anti-flood measures that is based on the restriction of constructing new buildings in flooded areas and on increased protection of settlements against floods. Deliberated introduction and operationalisation of crisis management in the case of exposure to floods linked with other natural hazards and risks caused by the land-use systems. To accept water reservoir systems limits and to reduce the risks of their flood conditions and the potential impact on residents.

Enlargement of ecological stability area systems
Activities:
A1 Institutional promotion of area protection of constituent elements in European Ecological Network (EECONET)
Trustworthy support of introducing protection/conservation referring to all constituent elements in physical ecosystems biodiversity and landscape values. Specific focus on area systems of ecological stability, large-area and even small-area nature protection, Natura 2000 system tracts, natural parks and outstanding landscape constituents in cooperation with the Czech Agency for Nature and Landscape Protection and with administrations of landscape protected areas and national parks. To participate in efforts to extend the forested areas in South Moravia through the implementation of the South Moravian Forest Management Plan concerning the reduction in wind soil erosion. The cornerstone of measures consists in maintenance and renovation of natural balance in landscape, in the protection of life forms diversity, in the preservation of natural values and beauties, as well as in considered steps in natural resources management. Specific attention paid to economic, social, and cultural needs of residents on both regional and local levels.

A2. Strengthening the development of settlement sustainability
South Moravian settlement sustainability is to be reinforced by the endeavor to eliminate hazardous concentration of air pollution. It is necessary to prevent the devastation of urban environment by harmful building interventions. Urban sprawl should be under public administration control for preventing destruction of (semi)natural landscape ecosystems. Emphasis on the subsidy of public transport and on upgrade communication maintenance.

A3 Sustainability projects processing and assistance in their multi-sources and multi-level implementation
Sustainability is a long-term effort that can essentially be approached as a conceptual mode in all sectors. Since environment/landscape ecosystems and the socioeconomic sphere are in close interlocking, it is impossible to achieve sustainability in one sector without achieving it in others. There is upcoming practicable management plan for protection and further development of all values of the Lednice/Valtice area in the Czechia/Austria transborder area.

Implementation of comprehensive programme in the Svratka-river basin above the Brno reservoir and in the Dyje-river basin above the Vranov reservoir, including the renovation of their recreational purpose
Activities:
A1 Water quality restoration in the Svratka-river
To develop a project 'Clear Svratka River' based on following contemporary directives concerning the water quality in water bodies. Submit a proposal on sewage water treatment plants in municipalities having at least 1,000 'population equivalent'. To adjust the quality of drinking water from the Vír Regional Duct (The upper Svratka-river basin). In view of the planned survey covering the Svratka-river basin, an analysis of sources, of nutrient flows, and of anti-erodible measures reducing floating debris into the Brno reservoir is intended for the construction of small retaining reservoirs above it. More effective cooperation with the neighbour administrative region – The Highland – is proposed (that is the region where the upper Svratka-river source is located).

A2 A preliminary programme for restoration of water quality in the Dyje-river
To appraise initial experience with the programme for restoration of water quality in the Dyje-river concurrent also for the Dyje-river basin above the Vranov reservoir. The support of cooperation among the regions of South Moravia, The Highland and South Bohemia.

A3 Environmental purification of water catchments in South Moravia
To assist in preventive decrease of loading from the sources of pollution in agriculture (agrochemicals, animal waste) and pollution from settlement, industries, services, traffic and housing. To carry out in stages construction of sewage water treatment plants (SWTP) in municipalities with more than 1,000 'population equivalent' and to renovate outdated SWTP. To precede accelerated anthropogenous soil erosion causing, among others, silting up water bodies with sediments (reservoirs and ponds are covered too). To evaluate data on water quality in reservoirs and encouragement of gradually implementation of measures contained in the incoming Plan for Main Basins (2009) that covers irrigation, sewerage, SWTP, floods protection in compliance with the existing Water Act.

Fixing impacts of human activities upon the environment
Activities:
A1. Management of old ecological burdens
To monitor the state of remedy concerning old ecological burdens and to prevent the emergence of new ones by the utilization of GIS technologies (e.g. registration of waste dumps in South Moravia). To take part in converting closed old ecological burdens into nature landscape ecosystems. To avoid the neglect of alternative methods for identification of ecological burdens and to carry out related proposals.

A2. Decreasing noise level
The recognition that new ecological burdens also consist of an increase in noise level around frequented traffic lines (railways, roads). It is particularly important to search for ways that reduce noisiness in settlements. That is the reason for introducing noise protection, such as noise barriers, bypasses as well as the enforcement of speed limits on roads.

A3 Industrial pollution reduction
In the case of industry it is necessary to ensure that agreed/approved norms of environmental pollution respect environmental pollution limits and to encourage companies to pay attention to International Standards of Quality ISO. Also user-specific operating regulations EMAS (The Eco-Management and Audit Scheme (EMAS), i.e. the EU voluntary instrument aimed at the improvement of environmental performance on a continuous basis, is embraced. To support projects and measures ensuring the reduction of industrial pollution and of industrial impacts upon the environment in compliance with legislation in force.

A4. Waste management programs implementation
To respect the principles of environmental policy of South Moravia in waste management as declared in the Waste Management Plan for the years 2004-2013. To support waste minimization and recycling. To insist on the prevention of waste generation and on its conversion into material resource whenever possible. To train population to separate waste. Scrapyards should be successively found in municipalities above 2,000 inhabitants.

Saving energy projects implementation
Activities:
A1 Subsidies for renewable energy sources use, initiation and implementation of energy saving projects
To subsidy energy saving projects, raise energy from renewable and alternative sources and to complete their 8% share in energy consumption in line with national environmental policy targets.

A2. To strive to achieve regional energy independence
To take advantage of European and national funds for the reduction of energy consumption with a target of reaching gradual regional energetic independence on external sources by supporting public transport, savings in building heating, preferring local goods and services production, and minimizing waste of energy. The support for agriculture and forestry production that provide renewable sources of energy, especially biomass.
Improving quality of environmental education, training and enlightenment
Activities:
A1 Implementation of environmental education, training and the notion of enlightenment
To strengthen and coordinate activities in environmental education, training and enlightenment. To endorse centers spreading sustainability education according to the European strategy (Vilnius, 2005) in administrative districts of municipalities with extended political powers. To interconnect these centers with NGOs (non-governmental organisations) and to forge networks of primary and secondary schools. To encourage these schols to carry out common

strategies, programs and to follow the Aarhus Convention, the European Convention on Landscape, the European Charter of Sustainable Tourism in Protected Areas, the Charter of Sustainable Cities as well as future international and national documents. To develop environmentally sound education, to nurture debates between and among various actors, communities, institutions and experts, including universities and research institutes. To see through an active engagement with tangible results, projects, plans, programs, all with active public participation.

A2. Promoting birth of the Local Agenda 21 system (LA 21)
To spread LA 21 to seats with reasonable terms of effective implementation in public hearing of master plans, strategies, programs and projects of regional/local development. To ensure effective dialogue between public administration, non-governmental organizations, experts, firms engaged in environmental management, This ought to be in accordance with the Lisbon and Göteborg strategies as well as with environmental indicators published by the Czech Ministry of the Environment. To reinforce public participation in public hearing, decision-making and implementation of projects improving the quality of the environment and landscape ecosystems.

6. Klentnice-Drasenhofen: General Landscape Spatiality and Early Temporality

The transborder region investigated is delimited by the physical landscape between two rivers - the Danube and the Dyje/Thaya, and two basins, i.e. the Wiener Becken (Vienna basin) and the Brno basin (the Dyje-Sratka rivers Vale) .The region is known in Austria as Nieder Österreich – Mährische Inselbergschwelle and in the Czechlands as the Lower Austria-South Moravia Carpathians. Its other name is geological: The Waschberg Zone situated north of the Danube river which is essentially an external (leasing edge) Alpine-Carpathian orogenetic unit consisting of strongly deformed older Tertiary Molasse beds and limestone klippen sheared off from the Mesozoic-Paleogene Molasse base.

The Klentnice-Drasenhofen area is a part of the Pavlov Hills. This name does, however, portray generic rather than specific terrain features. The landforms of three surface levels include the highest oblique limestone ridge of nappe overthrusts: rocky klippen chain of crests/scarps between the Dyje and Danube rivers reaching up to 550 m a.s.l. (Děvín in the Pálava Crest). Děvín stands out in the middle of undulating surface of claystones/sandstones hills covered with loess deposits and lower valley floor with alluvial floodplains and higher terraces. Physical landscape called the Pálava consists of main crest/scarp and its piedmont is composed of two step-like levels as mentioned above. The climate is warm and dry and can be classified as Pannonian. The former vegetation of Pannonian oak forests changed into cultural forest-steppes with rich soils known as mollisols.

Contemporary cultural landscape forms spatially a palimpsest with relics of former phases starting with the Liechtenstein family’s (13th-16th century) effort to meliorate swampy track into a system of ponds and meadows between Mikulov and Drasenhofen. Subsequently rulling Dietrichstein family was active in late mannerism of renaissance and introduced baroque park cultural landscape of fields, vineyards, orchards, gardens, game preserves, pheasantries, follies, mills, ponds, columns of crucifixion, calvary statues, manors, chapels, altars etc. In the centre of such composed landscape was the town of Mikulov, serving the function of an urbanized segment with suburban fringe encircled by rural landscape.

In the 19th century when the corvée (1848) was abolished, the farmers got hold of strips of fields and the landscape changed into ´stripped landscape´. While the look of the landscape remained the same in the Drasenhofen area, it was completely changed in the Klentnice area during the 1950s and 1960s. There were two main political and social events that changed the cultural landscape here. These were the end of the Second World War (WW2) with ensuing transfer of ethnic Germans from then Czechoslovakia according to the Potsdam Agreement (1945) and also the fall of the Iron Curtain.

There was a new concept of sustainability introduced in the 1970s, resulting in the declaration of the Pálava Protected Landscape Area (est. 1976) on the Czech side.

Ten years later, it became the third place in the today's Czech Republic to be listed as a UNESCO biosphere reserve. It became known as the Pálava Biosphere Reserve, being the part of the Man and Biosphere Programme. Subsequently it has also been included into a Special Protected Area category based on the Birds Directive within Natura 2000. Between July 8–11, 2003, the Committee of the International Coordination Council of UNESCO's "Man and Biosphere" program in Paris approved the extension of the Pálava Biosphere Reserve to include the Lednice-Valtice Cultural Landscape and associated floodplain forests at the confluence of the Morava and Dyje rivers. The newly designated area was renamed to the Lower Moravia Biosphere Reserve (BR).

After initial characteristics have been spelled out, the team's research focus will be dealt with in the following lines. The field of interest in this contribution is specifically the spatiality of the Pálava landscape in the sense of an examination of landscape-ecosystem patterns used culturally and also of a continuing ribbon between the villages of Klentnice and Drasenhofen. Interestingly, while the approach of the Czech side is enforced in a bottom-up fashion, the Austrian approach is quite the opposite, with grassroots approach in place. Our understanding of spatiality follows Cloke, Crang and Goodwin (2005: 611), i.e. spatiality as fundamentally being about socially produced space. That, from a human geography point of view means that space is socially experienced rather than being an innate backdrop to the social life. Spatiality thus ought to be used in plural as spatialities, in order to stress the many different ways in which space can be constructed and experienced.

7. Detailed landscape survey in the Czech/Austrian cross-border area of Klentnice-Drasenhofen

Dismantling the Iron Curtain in 1989 and the Development after the Velvet Revolution: Dismantling the structure of the Iron Curtain in 1989 brought with it as a result millions of tourists from central-eastern Europe border-crossing the bottleneck between Mikulov and Drasenhofen in their trips to previously unreachable Austria. Also, the Austrians were curious neighbours and began to explore the other side of the border. Curiosity was thus a driving force of tourist exchange and the Austrians had many advantages over Czechs in the promotion of their part of the region, starting with their hard currency, social and economic experiences, images, media, etc. Emergent economic transition in Czechoslovakia/the Czechlands after 1989 looked rather meagre when compared with rich Austria between 1990-1996. This difference has been, however, narrowed as Austria entered the phase of stagflation in 1996 and has remained din it up to date.

When the Austrian side of the border is examined in this period, significant marginality of the area is found out. One such example has been the termination of a duty-free-shopping zone literally. On the Czech side, one can witness an uncontrolled rise in sex clubs and brothels: These are not so much for Czech clientele, but rather for Austrians. Interestingly, visitors are coming from the stronghold region of Austrian Christian-democratic Party (ÖVP). The Czech village of Klentnice is traditionally conservative in poll too, with its community preferring a conservative mayor instead of a candidate calling for public changes. Similarly, South Moravia is the bulwark of Christian Democratic Party in the Czechlands (KDU-ČSL), though at the local level of Klentnice, independent deputies are in power.

As for agricultural production with high added value, both sides strive to achieve natural organic quality of wine production by the use of bio-control and the introduction of resistant sorts of viticulture. Moravian wines are produced in private/cooperative sectors for a change of former strong state farms. The Czech Wine Act was accepted in the 1990s and was appreciated by producers and consumers. This has been one of a few successful examples of Czech governance. The village of Klentnice is a part of the self-governed microregion of the Mikulov-town, in which the latter comprises 17 municipalities and its form is primarily intended to reach EU funds (e.g. LEADER project etc.). Both Klentnice and Drasenhofen have been turned after 1989 into more residential, wine-producing and recreational villages with new buildings.

The Pálava landscape used to be a tourist hot spot also in socialist Czechoslovakia. It is still, with more foreign tourists visiting the area. They prefer the use of personal cars without much hiking and biking, just preferring to have meals and drinks there. Local residents offer them various services such as hotels, guest houses, private accommodation, tourist lodging accommodation, meals-preparation, beer, wine, fruits and entertainment in ´pony ranch´ or nature trails diverging into several directions. They learned quickly to do business using some experience from near Austria. The majority of residents are said to be satisfied here.

8. Divergent Course of Events in then Czechoslovakia and Austria in 1948-1989

While then Czechoslovakia became in 1948 a part of the Soviet Bloc, Austria, though until 1955 under the Soviet administration and going through a difficult period of denazification and economic reconstruction, emerged eventually as one the Western democracies. This political divergence produced very different effects on both sides of the common border.

Fassmann (quoted in Lichtenberger 2000: 340-352) recognizes the following periods of economic development in Austria:

1945-1952: Reconstruction according to the Marshall Plan, industry as the engine of growth;

The 1950s: The Austrian economic miracle;

The 1960s: integration into the world economy, improved technical infrastructure;

1970-83: ´Austro-Keynesianism´;

After 1983: More monetarist policies.

Austrian agricultural policies, as Lichtenberger (2000) summarizes, were included in national strategies based on protectionist measures and dirigiste administration lying in high subsidization of farmers. This strategy supported productivity increase from self-sufficiency to surplus production and an increase in commercial farming. Austrian post-WW2 welfare state led to de-agrarization in the sense of numerical reduction of agricultural labour from full-time to part-time farming, mechanization, heightened application of agrochemicals and crop selection. It was also for those reasons that more significant rural-urban migration took place and the number of second homes created increased. This in turn led to the letting of private rooms, vacation homes and tourist farms. The village of Drasenhofen, for instance, rebranded itself as the Viennese second home region. This trend petered out when the Iron Curtain fell in 1989. Finally, transferred German families from the South Moravia which re-settled in Austria and Germany have met every year in a memorial place of the crest of Schweinbarther Berg – Südmährerkreuz (337 m a.s.l.), not far from Drasenhofen.

Drawing on Fassmann´s criteria, one can distinguish between the following periods with respect of the Czechoslovak side:

- 1947-1948: General reconstruction and the Sovietization of economy and society;

- 1949-1953: The Creation of heavy industry including weapon production, the collectivization of agriculture and installation of politically authoritative regime – (´dictatorship of proletariat´, Marxist-Leninist ideology);

- The 1960s: integration only within the Soviet bloc, extensive development, economically loosing compared with Austria; the Prague Spring and Soviet/Warsaw pact Armies invasion;

- The 1970s-80s: Extensive command and the retardation of economy, politico-social ´normalization´ and the dullness of life.

For the structure of Znojmo-Retz Environmental Security Project questionnaires see the appendix.

9. Conclusion

Landscape ecology is transdisciplinary construct of cultural landscape developed also by geographers with their main contribution concerning landscape spatiality with respect to sustainability and security. The Czech problem is in landscape definition by human (social?) geographers not recognizing landscape ecosystems. Another problem consists in specific interpretation of landscape in the sense of economic, political, religious, home, childhood/youth, film, arts landscapes in cultural geography (Duncan et al. 2004). This wide interpretative variety of landscape constructions is a reason for new discourse in geography connecting both physical and human geographers. However, The Millennium Ecosystems Assessment as up to date interdisciplinary program focusing on ecosystems as capital represents the common not for tragedy but for benefits in searching sustainability and security in contemporary turbulent world. Our team experience in regional and local studies, especially in transborder ones makes this point clearly enough.

Appendix

A) Znojmo-Retz Environmental Security Project:

Semi-structured questionnaire (A. Hynek; May 2006)

1. Introduction, Znojmo-Retz area location, environmental security
2. Znojmo-Retz area divisioning, community studies
2.1. Znojmo
2.1.1. urban and suburban
2.1.2. northern vicinity
2.1.3. the Dyje/river gorge
2.2. National park Podyji/Thayatal
2.3. southern parks edge
2.4. the Daniz-stream
2.5. Retz urban and suburban
2.6. Fugnitz and Pulkau streams
3. Physical and cultural landscapes ecosystems, services provision
4. Population/settlement – mental maps and imagination
5. Technical, social, environmental infrastructure
6. Public administration, environmental programmes and projects
7. Environmental quality – SWOT analysis, actors/actants, placeholders and stakeholders
8. Environmental hazards, risks
9. Environmental security systems, crisis management, shareholders and stakeholders, an option to connect South Moravian and Low Austrian security systems
10. Measures strengthening common environmental security
11. Conclusion

Questionnaire

The state of the environment before the fall of Iron Curtain

1. Environmental changes after 1989
2. Environmental SWOT analysis
3. Who is active/initiative in environmental issues?
4. Who are the actors of environmental damages? Residents, visitors, larger municipalities? Czechs/Austrians, casual/intentional marauders, individuals, groups, gangs
5. Are the inhabitants able to improve their environment?
6. Who threatens environmental quality?
7. Who helps to improve environmental quality?
8. Are the national parks - Dyje/Thaya rivers positive/negative/barrier/controversial/neutral part of your environment?

9.	Whom do you trust to help you with environmental quality? Experts, technicians, scientists, politicians, local authority, entrepreneurs/businessmen, non-governmental organizations (NGOs), strong/powerful individuals, church, physicians, lawyer, they/themselves
10.	Is there any environmental course, public education in your municipality?
11.	Are there any records in your chronicle on natural hazards?
12.	Which natural hazards are you anticipating?
12.1.	heavy rains
12.2.	heavy snowing and thawing
12.3.	floods on bigger rivers
12.4.	local flooding
12.5.	sheet wash, soil sheet
12.6.	ravines, gullies
12.7.	extreme drought
12.8.	disappeared water resources
12.9.	wind storms, local tornados
12.10.	fogs
12.11.	black ice
12.12.	wind fallen trees
12.13.	outbreak, plant/animals invasion
12.14.	grass burning
12.15.	forest wildfire
12.16.	plants/animals extinction
12.17.	disease dissemination by plants/animals
12.18.	disease dissemination by air, water
12.19.	landslides, rock falling
12.20.	biodiversity reduction
12.21.	growing temperature and moisture extremes (global warming?)
12.22.	plants and animal invasion from the south (growing warming?)
12.23.	featureless landscape? deteriorated? monotonous?
12.24.	sudden/violent changes in temperature/moisture
12.25.	local/regional concurrence of natural hazards
13.	The origins of natural hazards:
13.1.	transport- emissions, noise, crashes
13.2.	combustion - coal, oil, plastic, chemicals
13.3.	sewage
13.4.	domestic waste
13.5.	toxic waste
13.6.	to waste disposal site
13.7.	unsorted waste
13.8.	channelized water courses, piping, concrete the water courses
13.9.	river bank plants removal (trees, shrubs)
13.10.	ill-considered ploughing
13.11.	agrochemicals
13.12.	erodible crops (e.g. maize, potatoes)
13.13.	industry
13.14.	sand/gravel quarries
13.15.	stone pits
13.16.	cattle/poultry production
13.17.	tourism
13.18.	human immunity/resistance lowering by loosing the contact with nature
13.19.	human immunity/resistance lowering by growing chemicals application
13.20.	careless built-up area
13.21.	immoderate natural resources consumption
13.22.	non-respecting nature in the environment
13.23.	non-cultural humans/nature interaction harming gene pool, resilience
13.24.	inappropriate technologies of natural resources use
13.25.	non- premeditated intervention into nature and undervalued responses
13.26.	speedy forgetting the natural hazards and doing-nothing for prevention
14.	What is necessary to do for improving environmental quality?ecosystems?
14.1.	dykes

14.2.	leaving the flooded areas, no building permits there
14.3.	channeling
14.4.	to improve water discharge control
14.5.	to construct new reservoirs
14.6.	to improve old and build new sewage water treatment plants
14.7.	to stop burning coal
14.8.	not to burn plastic and flammable chemicals
14.9.	more information on environment, to ask questions
14.10.	support saving the energy
14.11.	using energy from biomass, wind, water, geothermal
14.12.	supporting nuclear fuel
14.13.	improving waste disposal
14.14.	burning the waste
14.15.	sorting the waste (are you sorting it?)
14.16.	to save or change the landscape character?
14.17.	to establish biocorridors, biocentres, interactive items in landscape
14.18.	biofarming

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Some possibilities for identification of spatial economical-sectoral structures in the national sectors of river catchment areas

(example of of the upper Ob river and Russian part of the upper and middle Amur river)

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Abstract

In the paper, the approach to the identification of the sectoral industrial structures within large catchments located in one or several natural zones of Russia is considered. A "binding" of enterprises of the particular sector to the natural zone is important and means often that the extraction of individual kinds of matter and energy of natural origin from the territory surrounding the enterprise is performed without intermediaries (including neighboring enterprises of other sectors, "directly" and, as a rule, without taking into account a reducibility of natural environment. In our case, the forest and forest-steppe zones can "provide" a supply to the enterprises of sectors of water for technological needs, individual species of floristic and faunistic resources. In addition, such an enterprise "withdraws" (from agricultural or forest use) a territory for its expansion or storage and processing (outside the enterprise) of manufacturing waste. Other kinds of communication (between enterprises of one and/or different sectors) are fixed in the monetary and physical terms. This circumstance allows us to assume that they are taken into account in the intersectoral structures of regions in the country.

The identified spatial economic-sectoral structures within the catchments surveyed can be compared between each other and the prospective directions of the future safe development can be planned both in individual enterprises and in the whole natural-production combination.

Based on dynamics of producing the separate kinds of raw materials, the relatively independent line of analysis of relations in such natural-production combinations is proposed. It should be preliminarily noted that the technogenic press on the nature of the tundra or semi-arid natural zones should be lower (to avoid initiation of degradation processes of wildlife) than in the forest zone. However, such conclusion should be in perspective confirmed by calculations.

Keywords: economical-sectoral structure; river catchment; administrative-territorial division; natural-production; monetary-production

1. Introduction

In the modern period of the world economy development, the sectoral structure of economy of countries (= national economy) becomes more and more accessible both for the "internal" analysis and interstate comparisons, especially this concerns the sectoral structures of industry. While, in case of steady rising of standardizing of the statistical information of them, the sufficient specificity of displaying their structure components (by internal filling of sectors) and its completeness (in order to provide the "closeness" for the outer observer) remains. In particular, the possibilities to analyze the intersectoral structure of economy in the river catchments "containing" in whole or in part the territories of small states with relatively unitized content of the "productive" statistical accounting are expanded.

As the expressive example, the countries of the Danube River basin can serve when data of the production-sectoral structure of their national economy at the level of basic units of administrative-territorial division allow, according to our preliminary estimation, to determine accurate to 90% and more the cumulative production-sectoral structure for the whole catchment. (However, the above "accuracy" is a relative value in our case. As a certain "standard", we take conditionally such a case in the Russian territorial-production combination when the boundaries of any surveyed catchment coincide fully with the external borders of one or several subjects of the Federation being the integral administrative-territorial, economical and statistical units).

As the other, more complex examples, the basins of Parana, Mekong and Amur rivers can be when the territories of countries are much more than their "national sectors" within these catchments and, without data of the sectoral structure of economics at the level of their local administrative-territorial division, the error in the calculations of such type can increase from 15 to 60%. In this case, a problem of analyzing the sectoral structure of production in the "framework" of the integral river catchment of the interstate use can be complicated by the incomparability of statistical information in the adjacent countries both by years and scales (including details) of survey. In this connection, we tried to simplify, to some extent, its solution and the Russian parts of two transboundary catchments were selected. Therefore, we will consider further the specificity of the national economical and information space in greater detail.

Since 1990s, when a number of countries switched from the planned to market economy with introduction of the "national accounts" into the "production" statistical accountability of the international system, the regional (subject: Krais, Oblasts, autonomous oblast, republics, autonomous okrugs and two biggest cities) level of the sectoral structure of the industrial production becomes accessible to analysis in Russia. Prior to the USSR collapse, the union republics corresponded to such a level and this situation reduced by order of magnitude the possibility of detailing of the "sectoral constructions". In our case, it is possible to "superimpose" this new structure on the appropriate level of structural hierarchy of river catchments and acquire materials to analyze the relations for more complex – not only economical but also natural-economical combinations.

We will show such possibilities of identification of the aggregate sectoral structures and comparison characteristic by the example of the upper Ob River and Russian part of the upper and middle Amur River.

2. Case Studies

If Kolpashevo town (Tomsk Oblast) is considered as the "extreme low limit" of the upper Ob River region), then, identifying its catchment on the teaching outline map of the West Siberian on 1:12500000 scale using a template, we can determine in percent a share of each of 7 RF subjects, its "components" as well as a share of area of each of these subjects falling on the catchement under consideration. The similar calculations were carried out by us for the Russian part (6 subjects) of the Upper (to

Blagoveshchensk inclusive) and Middle (including the Russian territory adjacent to Ussuri River and Khabarovsk city) reaches of Amur river. The preliminary results are shown below:

- in the upper reaches of Ob River, these territories are Republic of Altai (19.46% and 99% respectively) (1), Republic of Khakass (3.64% and 26.7%) (2), Altai Krai (24.15 and 67.9) (3), Krasnoyarsk Krai (6.57 and 1.31%) (4), Novosibirsk (10.11% and 27.1)(5), Kemerovo (20.07% and 100%) (6) and Tomsk (15.99% and 24.2%) (7) Oblasts;

- in the Priamurye part under study Chita Oblast (20.11% and 45.1%) (9), Aginsky Buryat Autonomous Okrug (1.97% and 100%) (10), Amur Oblast (33.52% and 89%) (11), Jewish Autonomous Region (3.73% and 100%) (12), Khabarovsk (31.22% and 38.9%) (13) and Primorsk (9.45% and 55%) (14) Krais.

The sectoral volumes of the industrial production (by value of finished products) in 2002 for all listed regions were calculated by us and are given in **tab. 1**.

Tab. 1 Cost of production made in the sectors of industry by regions adjacent to the Upper reaches of Ob River and Priamurye in 2002 (in mil/ rubles) (source: author, based on statistics)

Sectoral structure/ Name of region	PI	FI	FM	NM	C&PC	ME& MW	T W& PPI	BMI	LI	FI	OS
1. Republic of Altai	5,6	-	-	1446	27,8	234	411	1329	222	156	300
2. Republic of Khakass	3824	1793	677	8362	36,6	549	220	293	494	1683	366
3. Altai Krai	8434	-	456	136,8	4513	9391	729	1504	501	10303	5516
4. Krasnoyarsk Krai	18558	6573	773	2232	3093	11213	7733	2513	386	8313	1933
5. Novosibirsk Oblast	9847	848,9	1415	6056	2321	13187	5584	4131	1924	12621	2660
6. Kemerov Oblast	20632	45508	49751	4683	8048	7024	585	2634	732	5853	878
7. Tomsk Oblast	3983	14421	83,9	6665	5366	15995	922	1174	84	2221	1006
% of sum for lines 1 - 7	16,9	18,0	13,8	7,7	6,1	14,9	4,2	3,5	1,13	10,7	3,3
9. Chita Oblast	4736	1006	27,9	5561	41,9	503	363	224	70	1160	279
10.Aginsky Buryat auton.okrug	219,8	9,52	-	7,3	-	7,6	1,4	4,9	0,3	12,2	8,9
11. Amur Oblast	5110	813,3	61,4	3729	15,4	783	1657	1197	61	1381	568
12. Jewish Auton. Region	269,8	35,2	25,1	50,3	3,4	243	260	513	174	86	17
13. Khabarovsk Krai	9838	4381	2613	7533	846	33128	8532	1537	154	7379	922
14. Primorsk Krai	13677	1996	-	1752	1217	5695	4089	1704	876	15965	1703
15. % of sum for lines 9 - 14	26,6	6,5	2,14	14,6	1,67	19,8	11,7	4,07	1,05	9,12	2,8
16. Total, billion rubles.	99134	77385	55883	48213	25529	82852	31086	18758	5678	52764	16157
17. % of sum for lines 1–7 and 9 - 14	22,6	17,6	12,7	11,0	5,8	18,9	7,1	4,3	1,3	12,0	3,7

Note: ordinal number is designated by Latin numerals in the first column while region is designated by Roman numerals. Abbreviations are as follows: PI – power industry; FI–fuel industry; FM-ferrous metallurgy; NM- nonferrous metallurgy; C&PC-chemistry and petrochemistry; ME&MW-mechanical engineering & metal-working; T,WW& PPI-timber, woodworking and pulp-and-paper industry; BMI-building materials industry; LI-light industry; FI-food industry; OS-other sectors.

In the columns of **tab. 1**, data of production value in each of 11 "typical" sectors of industry are presented while in the lines, Siberian (1 – 7 lines) and Far-Eastern (9 – 14 lines) regions belonging in whole or in part to the catchments under consideration are shown. In the sixteenth, last but one, line of this **tab. 1**, the total indicators for two these catchments are presented in money terms while in the eighth, fifteenth and seventeenth lines - the aggregate (Ob and Amur basins and "total" for them) sectoral structure of industrial (in %) respectively.

At the next stage, the expert judgment (taking into account the specialization of each of separate industrial centers = cities with known industrial specialization belonging to the catchments under study) allows us to determine which share of the monetary indicator of any industrial sector of the region only in part belonging to the catchment surveyed should be included into its "composition" **(see tab. 2)**.

Tab. 2 Expert judgment of a share of the "regional sectors" adjacent to the Upper reaches of Ob River and Priamurye in the sectoral monetary volumes of industrial production of appropriate regions in 2002, in % of each monetary indicator from Tab. 1. (source: author, based on statistics)

Sectoral structure/ Name of region	PI	FI	FM	NM	C&PC	ME& MW	T W& PPI	BMI	LI	FI	OS
1. Republic of Altai	100	-	-	100	100	100	100	100	100	100	100
2. Republic of Khakass	0,1	0,1	-	-	-	-	10	-	0,1	0,2	0,1
3. Altai Krai	97	-	100	100	67	95	99	98	97	89	99
4. Krasnoyarsk Krai	10	40	0,1	30	30,1	5	2	23	1	6	0,1
5. Novosibirsk Oblast	87	100	100	100	97	78	90	85	87	65	93
6. Kemerov Oblast	100	100	100	100	100	100	100	100	100	100	100
7. Tomsk Oblast	96	1	100	100	98	100	78	98	100	99	100
9. Chita Oblast	95	99	1,0	94	100	97	90	97	99	98	100
10.Aginsky Buryat auton.okrug	100	100	-	100	-	100	100	100	100,	100	100
11. Amur Oblast	100	100	100	100	100	100	100	100	100	100	100
12. Jewish Auton. Region	71	100	1	100	100	100	100	100	100	100	100
13. Khabarovsk Krai	73	78	0,5	9	65	17	37	67	87	55	92
14. Primorsk Krai	83,1	99	-	16	2	7	34	43	1,5	2,5	0,2
Total, billion rubles.	99,1	77,39	55,9	48,21	25,5	82,85	31,1	18,76	5,68	52,76	16,2
% % of sum for lines 1 – 7 and 9 - 14	22,6	17,6	12,7	11,0	5,8	18,9	7,1	4,3	1,3	12,0	3,7

Note: the same as in **tab. 1**.

These are only preliminary estimates which should be substantially made more exact (for example, using the sectoral structure of industry of the local administrative districts for each of regions or data of particular enterprises but it is extremely difficult to do the latter). However, such "corrected" data are only available for Primorsk Krai and only for preceding and subsequent years or information of particular enterprises (Ignatov et al. 2003). But we "legalized" them for the purpose of demonstrating the further probable sequence of actions.

Then, multiplying each indicator of **tab. 1** by the percent coefficient (divided into 100) in the appropriate "cell" of **tab. 2**, we obtain the volumes of production in money terms fabricated by the industrial enterprises of each region located in the catchments surveyed. Based on results obtained, we make the recalculation (in percents) of the sectoral structure for each of regional sectors of two catchments **(see tab. 3)**. The sums by columns (i.e., by sectors) in the "resultant" lines will represent the sectoral structure of the industry in the Upper reaches of Ob River (line 8) and Russian part (without the Lower) of Priamurye (line 15).

Tab. 3 Sectoral structure of industry of areas adjacent to the Upper reaches of Ob River (from SUM to1-7) and Priamurye (from SUM to :9-14), 2002 , in percents. (source: author, based on statistics)

Sectoral structure/ Name of region	PI	FI	FM	NM	C&PC	ME& MW	T W& PPI	BMI	LI	FI	OS
1. Republic of Altai	0.002	-	-	0.50	0.01	0.08	0.14	0.46	0.08	0.05	0.10
2. Republic of Khakass	0.001	0.0	-	-	-	-	0.001	-	0.0	0.0	0.0
3. Altai Krai	2.81	-	0.15	0.47	1.04	3.06	0.25	0.51	0.17	0.05	1.88
4. Krasnoyarsk Krai	0.64	0.90	0.0	0.23	0.32	0.19	0.05	0.19	0.0	0.17	0.0
5. Novosibirsk Oblast	2.94	0.29	0.49	2.08	0.77	3.53	1.73	1.23	0.58	2.82	0.85
6. Kemerov Oblast	7.09	15.63	17.09	1.61	2.64	2.41	0.20	0.91	0.25	2.01	0.30
7. Tomsk Oblast	1.31	0.05	0.03	2.29	1.81	5.15	0.25	0.39	0.03	0.76	0.35
% of sum for lines 1 - 7	14.79	16.87	17.76	7.17	6.71	14.78	4.69	3.69	1.10	8.96	3.48
9. Chita Oblast	6.11	1.35	0.0	7.10	0.06	0.67	0.44	0.29	0.09	1.58	0.38
10.Aginsky Buryat auton.okrug	0.26	0.01	-	0.01	-	0.01	0.0	0.01	0.0	0.02	0.01
11. Amur Oblast	6.93	1.10	0.08	5.06	0.02	1.06	2.25	1.63	0.08	1.88	0.77
12. Jewish Auton. Region	0.35	0.05	0.0	0.07	0.0	0.33	0.35	0.70	0.24	0.12	0.02
13. Khabarovsk Krai	9.75	4.64	0.02	0.92	0.75	7.64	4.29	1.41	0.18	5.51	1.15
14. Primorsk Krai	15.43	2.68	-	0.38	0.03	0.54	1.79	1.01	0.02	0.54	0.01
15. % of sum for lines 9 -14	38.78	9.84	0.10	13.54	0.86	10.25	9.13	5.02	0.48	9.64	2.34
16. Total, billion rubles.	62.1	56.4	51.8	30.9	20.2	50.6	20.4	1.,5	3.6	33.2	11.9
17. % of sum for lines 1–7 and 9 - 14	19.63	15.45	14.19	8.73	5.53	13.86	5.58	3.96	0.97	9.09	3.25

Note: the same as in **tab. 1**.

Thus, we "obtained" two territorial natural-industrial combinations (NIC) the latter of which has area two times larger than the first but as to the cost of production, the ratio is inverse (with fourfold excess) and, in whole, the first NIC prevails over the second one (in the regions with predomination of resource specialization, this means almost the same excess in the physical volumes, i.e. not only in money terms but also in tons). The ratio is in favor of the second NIC but only as to "other" sectors whereas, in the power industry, nonferrous metallurgy, "timber, woodworking and pulp-and-paper" industries, the price of the first NIC production is two times higher than that of the second NIC, this ratio is triple in “chemistry and petrochemistry”, six-fold in fuel and engineering industry. As for the remaining “components” of the sectoral structure, this ratio is much more. (True, it means sometimes only work of enterprises in backward sectors outside the catchments under study rather than a poor development of economy in the eastern regions. Thud concerns the ferrous metallurgy in Khabarovsk Krai and food industry in Primorsk Krai). The larger are not only monetary but, first of all, physical volumes of products of the resource sectors, the higher is the probability of loading growth on local water bodies including the technogenic pollution of transit watercourses and water supply sources. But our attempts of the conjugate analysis of the statistics concerning the sectoral structure of production and sectoral structure of discharges of used contaminated waters (Shchekota, Ignatov 2005) did not result in the satisfactory results due to a poor comparability of such structures though these results considered individually are important (in part, to specify the processes of the natural-economical interaction in the catchments surveyed). At the next stages of the above line of works, it seems to be possible to concretize appreciably the conditions of functioning of economical sectors for each of sectors (parts of region) within the catchments considered through the short-term dynamics of nature management in these catchments. Now, we will attempt to do so by one example.

3. Conclusions

By determining the specializations of the catchment sectors **(see tab. 3)** for each of regions included into it based on data of physical volumes of separate kinds of production, it is possible to suggest the extraction volumes of natural matter and energy with somewhat more reliable territorial referencing than the All-Russian statistics for regions can provide. So, in the above statistical yearbook (Regions of Russia 2003), data of 5-10-year dynamics of production of coal, petroleum, natural gas, industrial wood, building brick, precast constructions, fish catches etc. are given and this information characterizes directly or indirectly the “pressure of economy on the natural environment of the region” – this “press” can result in deterioration of natural environment or it was already expressed in the soil subsidence due to expansion of mines in the areas of coal output, in poorly reclaimed soils in case of strip mining of minerals, in untimely restoration of the quantitative and qualitative composition of forests etc. However, these are preliminary conclusions. Statistical data for regions of the country do not allow us to get the correct conclusions concerning the extent of natural environment disturbance in the areas of intense development of resources of natural origin.

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Regionalisation of Climate Change Impacts in Germany for the Usage in Spatial Planning

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Abstract

Climate change is expected to become one of the major drivers of landscape change in the decades and centuries to come. Understanding the impacts of climate change (e.g. increasing temperature, storm events, changes of intensity, variability and amount of rainfall) on ecosystems, landscapes and land uses is essential as basis for adaptation and mitigation strategies and decisions in politics and spatial planning. There is a major lack of knowledge especially about the indirect effects of climate change on the landscape e.g. on landscape functions and ecosystems services and about indicators usable to describe regional impacts (e.g. the effects on land use changes for the production of alternative energy resources).

Spatial planning needs spatial explicit information about the impacts of climate change on a detailed scale level as basis for the development and implementation of mitigation and adaptation strategies. A method for an assessment of climate change impacts in Germany on a regional scale level has been developed. Aim is the description of relevant changes for the usage in spatial planning. Using the data from the hydrostatic regional climate model REMO assessments of the major regional impacts of climate change (e.g. the flood risks, soil erosion risk, risks of heat waves, risks of forest fires) has been conducted. By inclusion of socio-economic statistical data the results have been differentiated to regions suitable for regional planning (Regionalplanungsregionen) and to natural regions by GIS. A high spatial differentiation of impacts in Germany could be stated.

Keywords: climate change; regionalisation; impact assessment; vulnerability; spatial planning

1. Introduction

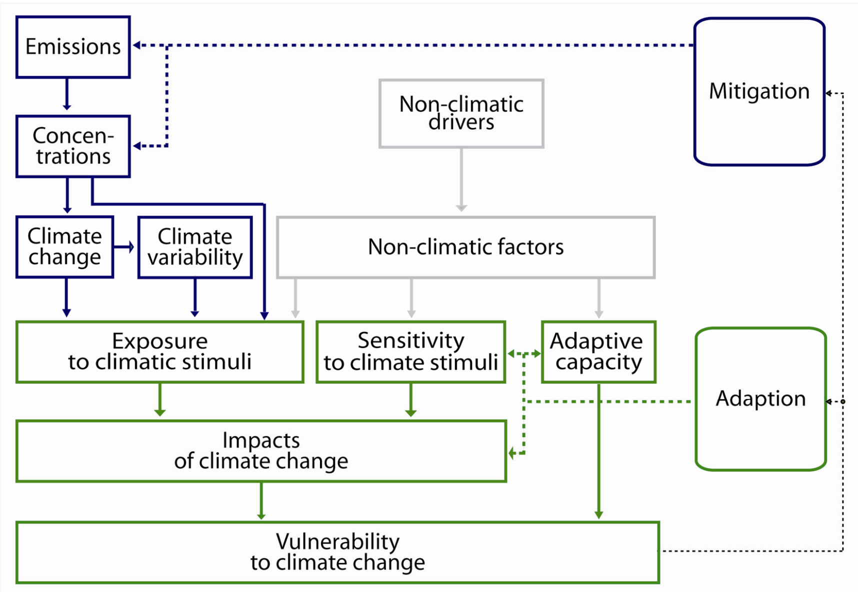
There is a growing consensus that spatial and land use planning have an important role in addressing climate change and its effects (e.g. Stern 2007; Greiving, Schmidt-Thomé 2008; Greiving, Fleischhauer 2008; Fleischhauer, Bornefeld 2006; Ritter 2007; Vries 2006; Wilson 2006). However, in the German planning system climate change is not sufficiently taken into account and progress on adaptation is still at an early stage. To foster the reflection of climate change in spatial planning more information about regional and local impacts of climate change is needed. To provide this information as basis for spatial planning is one of the main goals of climate change impact regionalisation in Germany.

To specify the systematic context for this regionalisation of impacts of climate change main definitions shall be given by following the IPCC results. "Climate Change (CC) refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/ or the variability of its properties that persist for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forgings or to persistent anthropogenic changes in the composition of the atmosphere or in land use" (IPCC 2007). Adaptation refers to "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. *anticipatory* and *reactive*, *private* and *public*, as well as *autonomous* and *planned*. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc" (IPCC 2007). "Sensitivity is the degree to which a system is affected, either adversely or beneficially, by *climate variability* or *climate change*. The effect may be *direct* (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or *indirect* (e.g., damages caused by an increase in the frequency of coastal flooding due to *sea level rise*). This concept of sensitivity is not to be confused with *climate sensitivity*" (IPCC 2007).

Vulnerability describes "the degree to which a *system* is susceptible to, and unable to cope with, adverse effects of *climate change*, including *climate variability* and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its *sensitivity*, and its *adaptive capacity*" (IPCC 2007).

A detailed discussion of the progress of the vulnerability concept can be found by Füssel and Klein (2006).

Fig. 1 Conceptual framework for an assessment of vulnerability to climate change impacts. (source: Füssel, Klein 2006)



The conceptual framework for a vulnerability assessment to impacts of climate change (Füssel, Klein 2006) gives an integrative overview about the aspects to be solved. Another prerequisite developed by the IPCC (2001) is the scenario formulation as basis of the global change prognosis. We follow the three main common future scenarios of IPCC B1 (global sustainability), A1B (balanced usage of energy) and A2 (local adaptations and heterogeneity) for our regional investigations in Germany.

Several studies already have focused on the impacts of climate change in Germany (e.g. Zebisch et al. 2005). Regional studies have been developed for different parts of Germany (e.g. Bavaria, Baden-Wurttemberg, Hesse, Saxony or Brandenburg) and a number of ongoing projects and studies are focusing on catchment development, coastal protection or on integrative management of climate change. Sectoral studies assess impacts of climate change on German agriculture (e.g. Schaller and Weigel 2008; Stock et al. 2007), nature conservation (e.g. Leuschner, Schipka 2004; Pompe et al. 2008), forestry (e.g. Kölling, Zimmermann 2007; Jenssen et al. 2007), water management (e.g. Kämpf et al. 2008), tourism (e.g. DB-Research 2008) and many more.

The spatial character of most impacts of climate change (e.g. floods, heat islands in cities) is obvious. However, not every spatially relevant impact is relevant for spatial planning, because its lacks of an cross-sectoral character and is in focus of sectoral planning divisions. Spatial planning should help regional and local authorities to "adapt" to climate change by proposing and coordinating adaptation measures, which touch a variety of interests and responsibilities. Planning activities like for instance the protection of flood plains will potentially conflict with other aspects, e.g. of nature conservation, agriculture or recreation. Spatial planning can provide tools to mediate and coordinate these cross-sectoral conflicts.

The impacts of climate change show a wide range of variation on a regional scale. The spatial distribution of impacts is related to the sensitivity of the macro chores and to the spatial differentiation of the exposure to changes in climate variables (temperature, wind, precipitation). Consequentially, the effects of natural hazards interrelated to climate change (e.g. floods, water shortage, heat waves, landslides) are not evenly distributed. The adaptation of the main land uses/land users (e.g. for agriculture, forestry, energy production, tourism or mobility) needs to reflect this and must differ regionally.

Based on this theoretical framework the paper discusses the following issues for Germany:

a) The formulation of the main spatial indicators for extreme and slow events;

b) the regional differentiation of impacts of climate change;

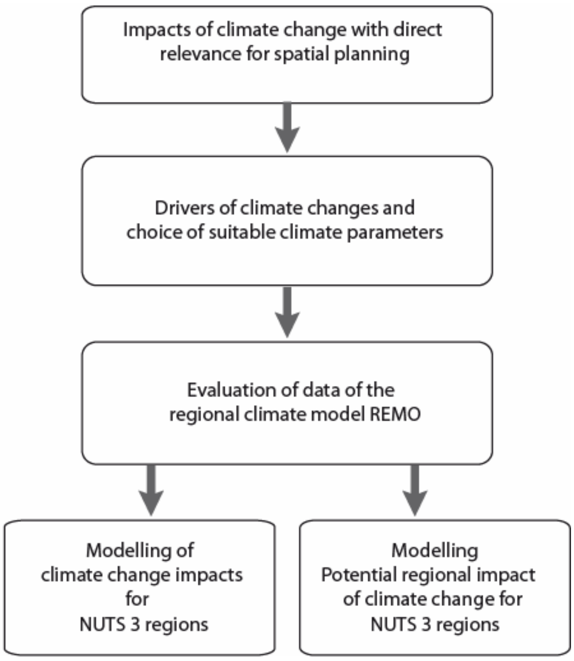
c) the spatial differentiation of the indicators;

d) the regional sensitivity to climate change stimuli.

2. Results

The study demonstrates the steps described below **(see fig. 2)**. Different data sets have been used for spatial differentiation of the climate change impacts on a regional level. The emphasis of analysis and assessment was to fix indicators suitable for spatial planning. Different spatial and statistical data of public origin are combined with applications of GIS methods.

Fig. 2 Framework to regionalise climate change impacts for the usage in spatial planning in Germany. (source: authors)



2.1 Impacts of climate change with direct relevance for spatial planning

Starting point of the investigation was the identification of potential climate change impacts that can be influenced by spatial planning. Out of a large number of potential climate change impacts the following impacts have been extracted. They can be classified into impacts caused by regional extreme events or fast changes and impacts caused by slow changes:

Impacts caused by extreme events:

a) occurrence of longer and more intensive heat waves;

b) increasing frequency of heavy rains and flash floods;

c) increasing frequency of large river flood events;

d) increasing frequency and intensity of storm surges;

e) increasing frequency of mass movements (landslides etc.);

f) increasing frequency of forest fires;

g) more frequent destruction of infrastructure.

Impacts caused by slow changes:

a) increased loss of soil by water erosion;

b) increased loss of species and biodiversity;

c) more pronounced fluctuations of the ground water level;

d) increasing fluctuations in the availability of water for industrial use.

Based on this list, indicators for every impact were chosen. Methods, data and assessment thresholds have been selected to assess the spatial distribution of the indicators.

2.3 Spatial differentiation of climate change impacts

As shown in **fig. 1** potential impacts of climate change can be regarded as a product of exposure to climate stimuli on the on hand and regional sensitivity to these stimuli on the other hand. Hence, to assess regional impacts of climate change in Germany both factors (exposure and sensitivity) had to be analysed.

The models applied for the analysis and the assessment of the regional exposure and sensitivity to climate stimuli are rule based. For each of the climate change impacts relevant for spatial planning a simple conceptual model based on indicators for exposure and sensitivity to climate stimuli has been developed. The results are qualitatively differentiated in assessment classes to mark the regions with the need of protective activity. In this paper the impact “longer and more intensive heat waves” is used to exemplify the methodology.

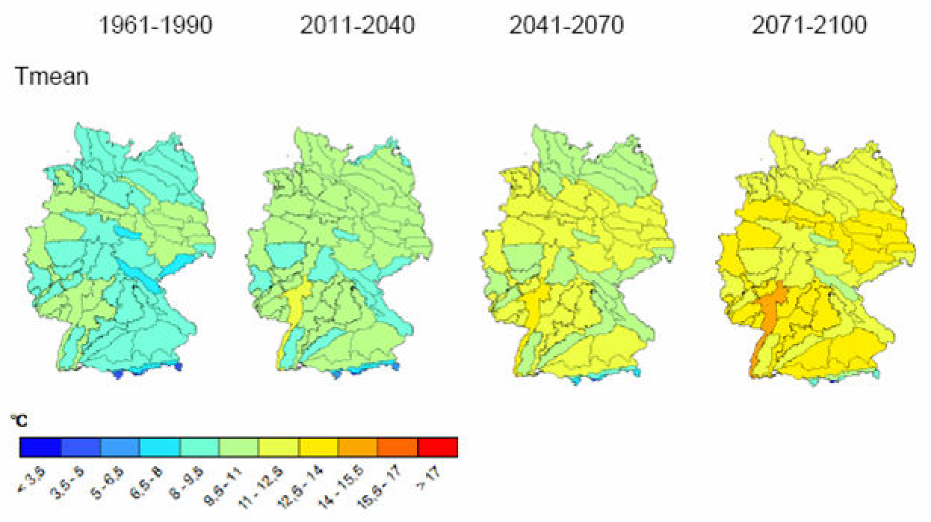
2.3.1 Differentiation of the exposure to changes in regional climate

The exposure to climate stimuli is a description of relevant changes in regional climate. The regional differentiation of regional climate changes is based on data provided by the regional climate model REMO (Jacob et al. 2001, 2008). REMO is a hydrostatic model developed by the Max-Planck-Institute for

Meteorology in Hamburg. The data originating from REMO model runs based on a rotated spherical grid of 0,088° (10 x 10 km) have been provided by the World Data Center for Climate, Hamburg. The data were downloaded and processed for this study by the “spatial systems unit” of the Austrian Research Centers in Vienna/Austria (Loibl et al. 2008). The data include information on temperature (Tmax, Tmin, Tmean), mean precipitation, the number of summer or tropic days, the number of frost days and the number of days with precipitation higher than 30 and 50 mm, respectively. The results for the scenario A1B, A2 und B1 were aggregated into 30-year mean for the consecutive time periods 1961-1990, 2011-2040, 2041-2070 and 2071-2100, showing monthly and yearly mean.

The spatial differentiation of climate prognosis for Germany on the basis of REMO calculation has been worked out by Jacob et al. (2008). The main methodological problem in the study presented by the authors was the differentiation of indicators for potential climate change impacts on the scale of spatial and regional planning in Germany. In a first step the information of the 10*10 km pixel of the REMO data basis has been aggregated on the level of natural regions of Germany.

Fig. 3 Example of REMO results for scenario A1B, aggregated as 30-year mean of annual temperatures for the natural regions of Germany (source: Loibl et al. 2008)



In **fig. 3** the potential of GIS-based aggregation methods is demonstrated. The regional differentiation of temperature changes is aggregated to the main natural regions. Well-defined are the North German plains, the Rhine valley, the Alps and the Harz Mountains or the Low Mountain Ranges. All climatic data described above have been available for the further operations.

2.3.2 Regional sensitivity to climate stimuli

The sensitivity to climate stimuli is determined by endogenous factors and main regional characteristics. The interdependencies (or the interplay) of these bio-physical, social, political factors and processes are influencing the degree of sensitivity (see also Dietz 2006). Hence, indicators for the main structural factors are needed to model the sensitivity. In this study types of sensitivity regions have been classified based on several public available data. As statistical basis for the indicators the level 3 of the “Nomenclature des unités territoriales statistiques” (NUTS*)* was chosen as spatial reference for the sensitivity assessment. In Germany the NUTS level 3 consists of 313 rural districts (Landkreise) and 116 urban districts

(Kreisfreie Städte / Stadtkreise). In **tab. 1** the indicators for the assessment of the regional sensitivity against longer and more intensive heat waves is explained.

The indicators were assessed following the rules demonstrated in **tab. 2**. The sensitivity indicators have been combined and aggregated by using the matrix given in **tab. 3**.

Fig. 4 gives the visualised example of the GIS application of the assessment. The result shows a high sensitivity against longer and more intensive heat waves in the South-Eastern part of Germany, in urban districts and cities, and in several regions in the central and central western parts of Germany.

Tab. 1 Impact, structural factors for the modelling of sensitivity and factors applied. (source: own investigation)

Potential impact of climate change relevant for spatial planning	**Structural factors to model the sensitivity**	**Indicators (factors)**	**Data source**
higher number of heat periods or heat waves	housing density	Areas of settlements, business, trade and transport infrastructure	INKAR2007
	Health sensitivity of parts of the population	habitants older than 65 years	INKAR2007

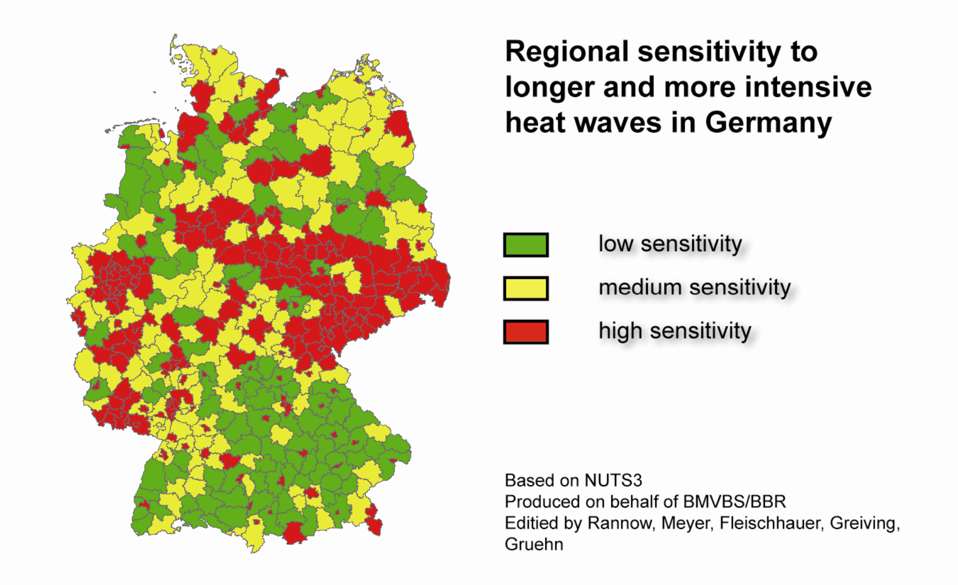
Tab. 2: Assessment of the sensitivity indicators (source: own investigation)

Sensitivity Indicator	**Assessment**	
housing density in %	<= 14,9 %	low (1)
	15 - 29,9 %	medium (2)
	>= 30 %	high (3)
Proportion of habitants older than 65 years in %	<= 12,9 %	low (1)
	19 - 20,9 %	medium (2)
	>=21 %	high (3)

Tab. 3 Assessment matrix for integration of two sensitivity indicators. (source: own investigation)

	Sensitivity Indicator I			
Sensitivity Indicator II		low	medium	high
	low	low (1)	medium (2)	high (3)
	medium	medium (2)	high (3)	high (3)
	high	high (3)	high (3)	high (3)

Fig. 4 Regional sensitivity against impacts of climate change in Germany (example: longer and more intensive heat waves). (source: own investigation)



2.3.3. Assessment of the potential regional impacts of climate change

The assessment of the potential regional impacts of climate change was applied by using comparable GIS-based methods. Main aspect of this step of GIS analysis was the disaggregation of the REMO data from the level of natural regions to the NUTS level 3. The assessment of the potential increase of the number of hot (or tropic) days was applied following the assessment rules in **tab. 4**.

Tab. 4 Assessment of the regional potential impact of climate change (example: longer and more intensive heat waves). (source: own investigation)

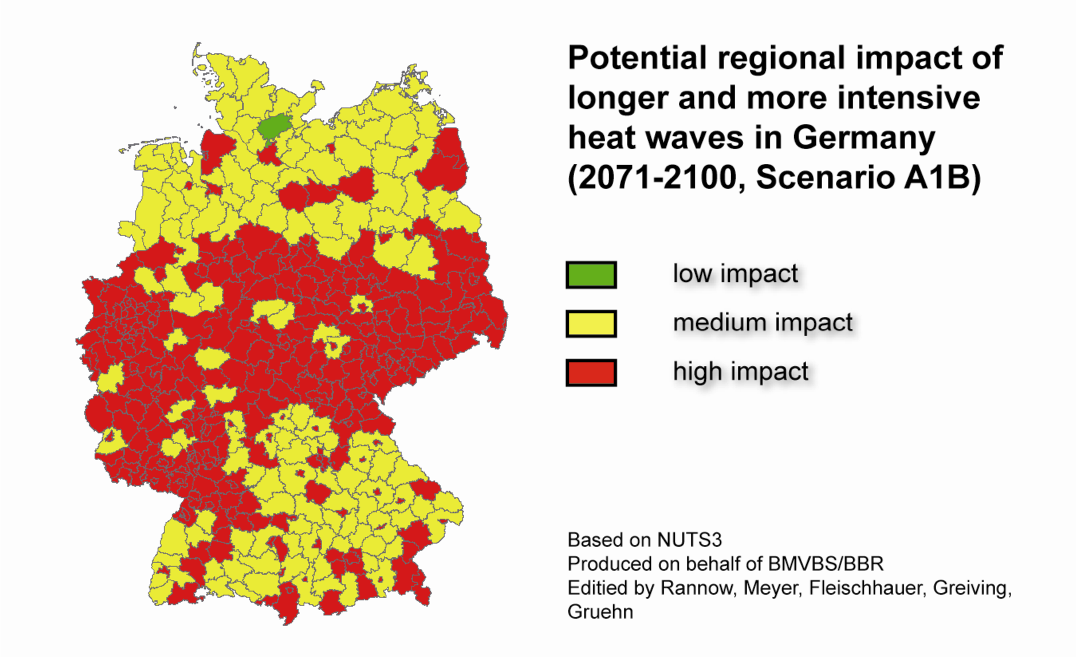
Climate change indicator	Assessment	
Increase of the number of hot (or tropic) days	<= 4	low (1)
	4 - 8	medium (2)
	> 8	high (3)

Tab. 5 Assessment matrix for integration of the exposure to regional climate change impact and the regional sensitivity to assess the potential regional impact of climate change. (source: own investigation)

	Exposure to regional climate change impact			
Sensitivity		low	medium	high
	low	low (1)	medium (2)	medium (2)
	medium	medium (2)	medium (2)	high (3)
	high	medium (2)	high (3)	high (3)

Fig. 5 shows the map of the potential regional impact of longer and more intensive heat waves in Germany for scenario A1B in the period 2071-2100. Larger parts of Germany will be affected by problems related to heat waves especially Central and South-Eastern Germany and the urban regions are endangered. The **fig. 5** was produced by the combination of the exposure of regional climate change impacts and the regional sensitivity by using the assessment rules given in **tab. 5**.

Fig. 5 Potential regional impact of climate change (example: longer and more intensive heat waves). (own investigation)



3. Discussion and Conclusions

Increasing mean temperatures will affect most countries and result in a higher number of weather extremes with intensive heat stress (IPCC 2007). The occurrence of extreme heat waves in Central Europe, comparable to the summer of the year 2003, will become a normal climatic situation in the second part of the 2100 century (MPI 2006). Heat periods or heat waves are consecutive days above 30° C (heat days) including some extremely hot days with a temperature higher than 35 °C. For example, in August 2003, a prolonged period of 12 days with temperatures above 35°C was documented for the weather station of Karlsruhe (Schönwiese et al. 2003).

The assessment of impacts of climate change discussed in this paper is a first step towards detailed investigations of impacts of climate as basis for spatial planning and decision making on the regional scale. The aggregation of results from regional climate models like REMO on larger "integrative" spatial units, like natural regions and planning regions, is a methodological way to generate information useful for policy and planning. The combination of the data set gives impression of the variety of potential impacts of climate change in Germany compared to existing regional studies available for Germany.

A new view on the wide range of different potential impacts of climate change as basis for strategies in spatial planning can be gained by using GIS methods when different data sets are combined. Using a simple rule based assessment approach valuable information on the spatial distribution of different potential impacts of climate changes could be provided. On the same methodological basis the regional sensitivity against potential impacts of climate change can be calculated. Thus, regions more sensitive compared to other regions can be identified. Based on this information spatial planning, i. e. on a regional level can be used to target adaptation measures to the regions primarily affected by climate change. Depending from the respective national planning system, the focus could be on more mandatory measures, or where regional planning lacks of binding effects, on more informal, discourse-based approaches (Gruehn 2006).

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Renewal of the landscape under the Krušné hory (Ore Mts.) after termination of coal mining

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Abstract

The countryside in northern Bohemia, particularly in Podkrušnohoří, is an area that was affected by intensive mining and industrial activities throughout the 20th century. With the development of mining and power engineering the burden on the landscape gradually increased, until the end of the eighties. In the second half of last century Podkrušnohoří was sacrificed to the interests of increasing brown coal mining. Coal burning has become the primary energy source for Czech economy with high material and energy requirements. Podkrušnohoří was the area which was afflicted by anthropogenic activity at the most in the Czech Republic. The mining has to be followed by landscape restoration, in the first phase it is the landscape recultivation, which reached a good level, comparable with neighboring countries. The recultivation is followed up with the revitalization of the area. The Faculty for the Environment UJEP in Ústí nad Labem has been operating for 19 years in this area already and cooperating with enterprises, mining organizations and authorities in the region on the issues of landscape renewal after mining and on the issues of recultivation. Since the ninties it has been involved in verifying the process of revitalization of the territory. Currently, within the MMR project "The Model Solution of the revitalization of industrial regions and territories after termination of coal mining at the example of Podkrušnohoří (the area under the Ore Mountains range)", it deals with such theoretical aspects that are aimed not only at the revitalization, but also at the resocialization of the area, at the return of people to the landscape, where they had lived before.

Keywords: coal mining; anthropogenic infliction of landscape; recultivation; revitalization; resocialization

1. Introduction

The anthropogenic afflicted landscape in Podkrušnohoří is gradually changing, it is partially returning to the state prior to mining. The recultivation is in progress, the largest part of the territory has been converted to forest ecosystems, the agroecosystems are renewed, particularly the permanent grassland. The hydric form of recultivation has an important place in the program of recovery of the basin area. As a part of the reconstruction there are and will be - especially in the future projects - other recultivations, which foresee the creation of new recreational areas, sports grounds and other sites of interest for population activities.

The staff of the Faculty of Environment participated in the solution of the problems of strongly anthropogenically affected areas in different forms, from consultations of technical projects, development projects, experiments, work covered in collaboration with students to studies and research projects. It involved for example the work on the research concept of Ministry of Education No.13520001 "Research of the anthropogenic load in the Northbohemian region," on projects of the Ministry of the Environment, the Ministry of Social Affairs and, in the current period, on the project of the Ministry for Regional Development WD-44 - 07-1 " The Model Solution of the revitalization of industrial regions and territories after termination of coal mining at the example of Podkrušnohoří (the area under the Ore Mountains range)" which has been solved since 2007. This interdisciplinary project focuses on geographical, environmental and social indicators characterizing the model areas in the districts Chomutov, Most, Teplice and Ústi nad Labem. On the basis of analysis of disparities and their causes the main effort is now to contribute to concepts how to revitalize and resocialize the coal-basin districts effectively and how to return humans to the renewed landscape. The acquired knowledge should contribute to the processing of proposals how to reduce the environmental and socio-economic inequalities, which are currently facing the entire region.

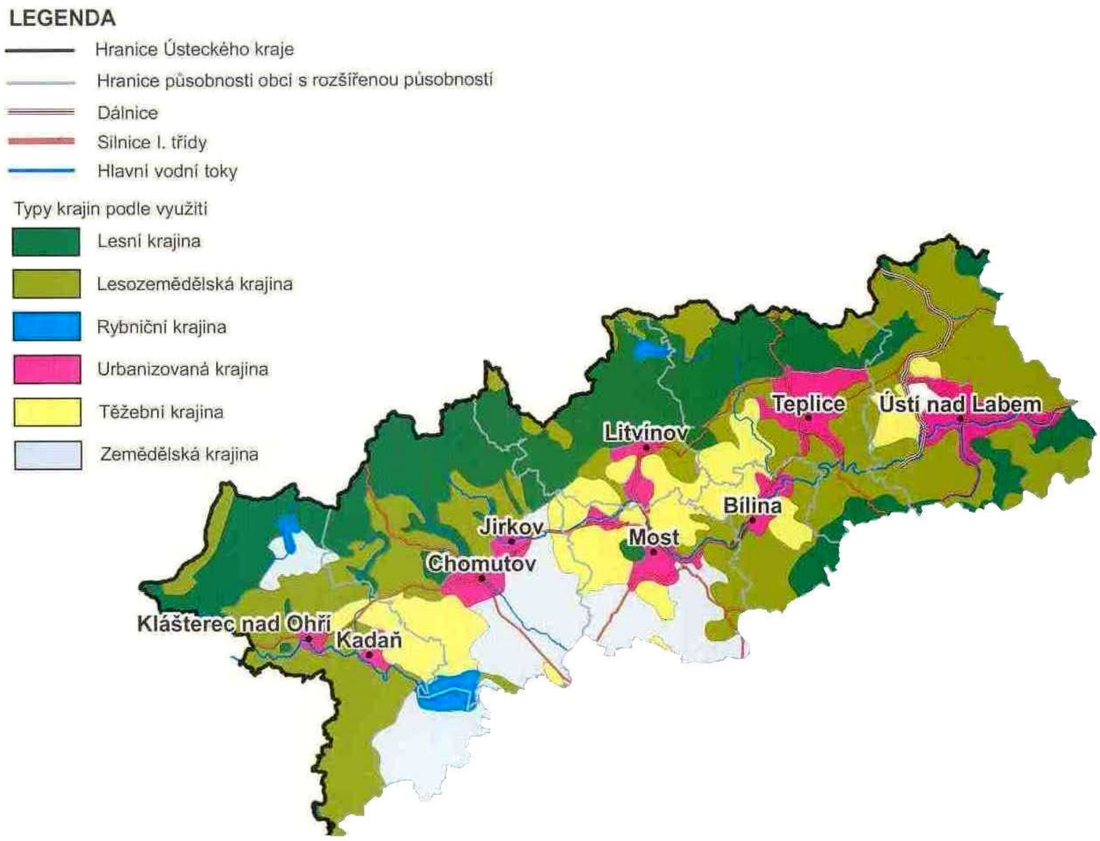
2. Study area

The object of work at the contemporary project is the most anthropogenically afflicted area in the Czech Republic – the area between Chomutov and Ústí nad Labem. It consists of 4 districts: Chomutov, Most, Teplice and Usti nad Labem. This model area spreads out over 227 605 hectares and is inhabited by 488 953 inhabitants. It is an area with relatively high population density of 215 inhabitants per 1 square kilometer .The model area was divided into urban areas, which are located on 68 205 hectares and are populated by 417 768 inhabitants, with a density of 613 inhabitants per square kilometer. There is the highest population density in the municipality with extended powers (the ORP) Chomutov – 1 527 people per square kilometer and ORP Usti n.L. - 852 people per square kilometer. In contrast, the rural area represents 70 % of the territory, but the population here is only 71 191 inhabitants, it is only 14,6 % of the population of the area of interest with the average of 44 people per square kilometer. The lowest population density has the ORP Kadaň with 23 inhabitants per square kilometer (Dejmal 2008).

The geological structure of the area of interest is very diverse, with rich deposits of mineral resources in the basin under the Ore Mountains. According to the weather conditions the area is divided (according to E. Quitt) into 3 regions – the cold area (ridges of the Ore Mountains, Milešovka Mountain), the slightly warm area (the slopes of the Ore Mountains, Doupov mountains, part of the Czech Central Highlands) and the hot zone (Elbe valley, the basin of Most and part of the Czech Central Highlands).

The area has an atypical structure of land resources in comparison with the whole Ústí region and with the territory of the Czech Republic. Agricultural land represents only 38 % of the territory (in the Czech Republic it is 54 %). In contrast, the share of other areas there is 22,5 % which is 2.6 times higher in the area of interest than the average of the Czech Republic. In the period 1960-2006 the area of agricultural land was significantly reduced by 24 878 hectares, which was 28,6 % of the state in the year 2007. The most significant reduction of agricultural land occurred in the district of Most at a rate of 35,5 %. The atypical structure of land resources is a consequence of the largest anthropogenic burden on the area – the brown coal mining. (Statistical Yearbook of the Czech Republic 2007; Environmental Yearbook, Charles University Prague 2007). The area of interest is shown in **fig. 1**.

Fig. 1 The area of interest and its diversification according to its utilization (source: The environmental yearbook of the Region Ústí 2007, modified by FŽP)



Note: green – forest land, brown-green – forest/agricultural landscape, blue – water surface (pond landscape), violet – urban landscape, yellow – mining landscape, grey – agricultural landscape.

3. Materials and methods

As a basis for the work on the project there were both statistical data on the selected districts, data from the environmental yearbooks of the Ústí Region and before all obtaining data on the basis of our own investigation within mining companies and our survey on selected locations.

The acquired data were analyzed and on the strength of it a part of Natural and socio-economic characteristics of disparities of an industrial landscape (Vráblíková et al. 2008a) and a part of another publication Revitalization of an anthropogenically afflicted landscape in Podkrušnohoří - The theoretical basis for the possibility of its revitalization (Vráblíková et al. 2008b) were prepared and published and from which several documents have been selected for this contribution.

On the basis of various analyses less conventional approaches were proposed and the method of controlled succession was verified in field.

Further on, new, less traditional ways of land utilization were proposed in the frame of other reclamations.

4. Results

4.1 Anthropogennic loads in the landscape under the Ore Mts.

Northern Bohemia, particularly Podkrušnohoří, became in the second half of the 20th century the largest and most burdened area with the worst quality of environment in Central Europe. In the area of northern Bohemia the high anthropogenic stress was due to industrializing the landscape, to the construction of buildings of all types, to the increasing population and population density, to the urbanization processes and particularly because of the extraction of mineral resources, because of industrial development and other economic activities. After 1945 ninety nine settlements were destroyed as a result of economic activities, of which 80 % were due to mining and construction of dumps. The whole town of Most (34 thousand inhabitants) was wiped off. As a result of coal mining in the north Bohemian basin area there was a significant disturbance of an area of approximately 260 square kilometers.

Since the 70's the air pollution burden has had significantly detrimental effects on ecosystems and the health of the population of northern Bohemia. The leading emitters in the area of interest are 6 coal-fired power plants built in the basin area with a total capacity of 5 010 MW. These plants do not only emit SO2, NOox and dust, but also wastes - fly ash, which is floated and stored in the vicinity of the power plants. The availability of energy gave the prerequisites for the development of other industrial complexes (like CHEMOPETROL Litvinov).

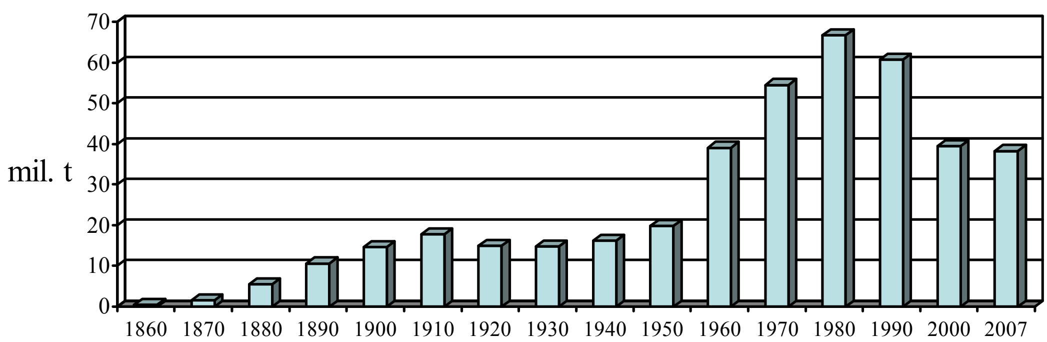
The negative situation in the field of environment was the reason that the area was included in the so-called Black Triangle, which was formed by three areas - Podkrušnohoří, Saxony and Silesia.

4.2 Coal mining – the root cause of selected disparities in Podkrušnohoří area

North Bohemian brown-coal basin is the most important lignite basin in the Czech Republic. The stretch of the basin area is approximately 1 400 square kilometers.

It is reported that in the North Bohemian Coal Basin more than 3,5 billion tons of coal have been extracted, of which 2,6 billion in large opencasts. More than 7 billion square meters of overlying soil were moved to external and internal dumps. The historical development of mining in the period 1860 - 2007 is given on the basis of analysis in the **fig. 2**.

Fig. 2 The historical development of coal mining in Podkrušnohoří in the period 1860-2007. (sources: the history of mining, materials of SHR, MUS and SD)



Currently two joint-stock companies operate in the North Bohemian lignite basin, which came into being in the early 90´s of the last century on the basis of privatization of former state-owned enterprises. In the western part of the basin there is the Libouš opencast, in the eastern part the Bilina opencast. These opencasts are parts of a joint-stock company

North Bohemian Mines Chomutov (SDCH). In the central part of the basin the opencasts “Czechoslovak Army (CSA)” and “Vršany – Šverma” are operating. These opencasts are parts of a joint-stock company Mostecká uhelná (MU). In the next section **(see tab. 1)** there are cross-sectional data of mining in the period 1945-2007.

Tab. 1 Development of coal mining in the North Bohemian brown coal basin after 1945 - in five years sections. (source: Kašpar 2007)

Development of coal mining in the years 1946- 2007													
Year	1946	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2007
Tons (in milions)	13,4	19,8	27,9	39,6	48,9	55,0	60,7	67,5	72,8	62,1	47,1	40,3	38,3

The development of brown coal mining underlines the importance of the North Bohemian brown coal basin for the needs of energetics. But, at the same time, it is accompanied by the burden, which affects the environment and landscape. For a long time the mining is involved in the dynamic changes in the landscape, particularly the opencast mining, which varies from small opencasts in the 60´s to large opencasts that have a negative impact due to the occupation of large land holdings, to the scale of the opencasts themselves and to the scale of external dumps. The coal mining has been the heaviest incidence into the landscape of Northern Bohemia. The mining affects landscape features, creates an entirely new landscape, which is linked with the whole complex of changes - relief, landscape structure, microclimate, negative impacts on the biota. Coalmining significantly affects the landscape, generates new landscape figures – dumps and residual pits, it changes the geomorphology, disturbs the hydrological situation, degrades and destructs the pedosphere, affects the atmosphere and the microclimate and distorts the biosphere in the subsystems of phytocoenosis, zoocoenosis and microbial coenosis.

4.3 Redevopment of damages and renewal of the landscape

The renewal of an area and the coal mining hang together according to legislation. The development of areas involved in the rehabilitation since 1950 to the present is given in **tab. 2**.

Tab. 2 Information of the development of rehabilitation works in the basin (1950-2007 in ha). (source: data from SD, MU a PKÚ, Vráblíková et al. 2008a)

Year	1950	1960	1970	1980	1990	2000	2005	2006	2007
Completed recultivation works	0	350	1 100	3 000	6 400	7346	9558	10337	10759
Recultivations in process	20	595	2 465	4 139	2 809	5368	5288	5221	5430
Total	20	945	4510	7139	9209	12714	14846	15558	16189

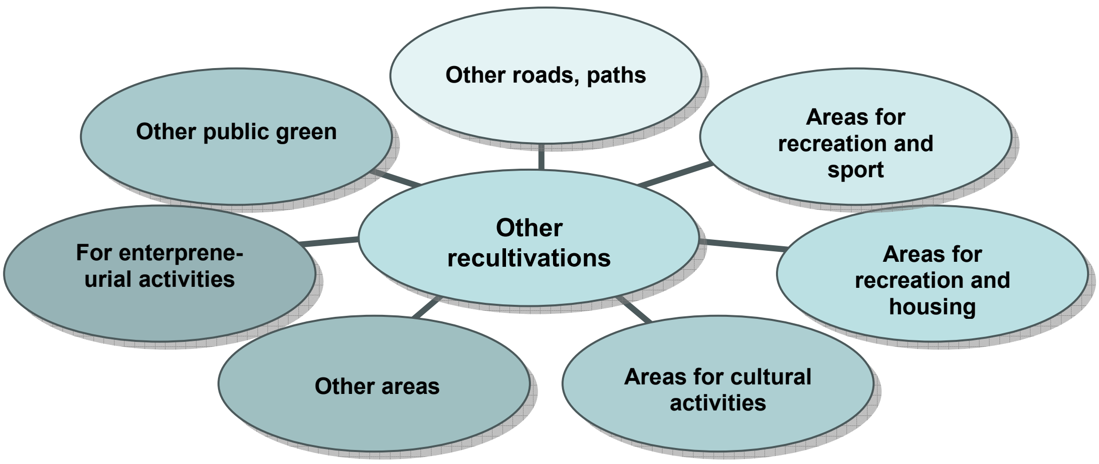
This survey shows that significant progress in the rehabilitation of the land has been achieved since 2000. The volume of completed rehabilitations reached 10 759 hectares in the year 2007, further 5 430 hectares were in process. An overview of the structure of completed rehabilitation is given in **tab. 3**.

Tab. 3 Overview on the structure of rehabilitation completed during the period 1960 – 2007 in hectares. (source: data from SD, MU a PKÚ)

Sort of recultivation / Company	agricultural	forestal	hydric	Other rekultivations incl. parks	Total
SDCH	1450	1637	136	333	3556
MUS	1522	3012	138	1641	6313
PKÚ	349	303	8	230	890
Total in basin in hectares	3321	4952	282	2204	10759
%	30,9	46,0	2,6	20,5	100%

The forest recultivations take up the largest share of recultivations, fully 46 %, agricultural recultivation occupies a significant proportion, too, it covers almost one third of the renewed territory. The volume of water reclamation increases as well, which consists of minor water works (such as ditches, retention tanks or water basins for suburban recreation, such as flooding of residual holes - Lake Most, Chabařovice). Since 1998, the proportion of other reclamations has significantly increased. Their aim is to create functional and recreational green spaces, to integrate recreational and sports areas into the landscape and to build basic infrastructure and to prepare areas for commercial use. In the frame of the project specific proposals for the possible applications of the so-called other reclamations are drawn up and, at the same time, methodological approaches are proposed how to deal with them **(see fig. 3)** (Vráblíková et al. 2008b).

Fig. 3 Methodological approaches to reclamation. (source: Vráblíková et al. 2008 et al.)



4.4 Characteristics of a renewed landscape

On the basis of evaluation of the monitored sites a landscape after reclamation can be characterized as:

- ecologically balanced, allowing sufficient space for the development of environmentally stable terrestrial, semiterrestrial and acquatic ecosystems,

- healthy and hygienically unobjectionable (necessary for any use)
- efficient and potentially productive (economically efficient – an appropriate choice of economic utilization),
- aesthetic and recreationally impressive (appropriate modeling of the relief, inclusion of water bodies, scattered green, bio-corridors etc.).

The reclamation is seen as a regulated process of the recovery of the landscape affected by mining. Its aim is to restore the natural balance of the landscape. It includes works not only of technical nature (landscaping, stabilization measures, hydrotechnic measures etc.), but also of biological nature (creation of agroecosystems, agricultural usage, forest planting, growing care, etc.). It should lead up to the concept of a diversified landscape structure (i.e. the concept of appropriate distribution of agricultural, forestal, water utilization and recreational areas). The mere reclamation is not enough in the third Millennium. It is necessary to promote it by further revitalization and resocialization.

4.5 Revitalization of a landscape

The concept of revitalization has ranked among the terms often frequented in last the period. In addition to its links to biology (return to life), in the second half of the 20th century the concept of revitalization has been related to landscape. In this meaning there is a wide range of interpretations, for example that the revitalization is understood as a functional integration into the landscape, or as a final layout of devastated territory that ensures the creation of an aesthetic landscape phenomenon and restoring natural ecosystem functions, while allowing full use of the territory in accordance with the ground plane.

One of the less conventional forms of renewal is the possibility of the controlled succession in practice, which was verified in the research in the opencast Most, in its part called "Pařidelský lalok". The work consisted in the organization of small sites, where spontaneous growth of trees, grass ecosystems and the creation of small wetlands came about during the remediation. These sites were planed to be involved in the classic forms of reclamation process in subsequent periods. These natural ecosystems have been left in the territories and human edited. Oaks were planted and grass mixtures were sewn there. This method of area recovery by a controlled succession was supplemented by traditional forms of recultivation. An environmental and economic evaluation was done after tracking these ecosystems for a period of four years. It was, however, only a small area in the range of several hundreds square meters. This unusual form of recultivation facilitated the genesis of a heterogeneous, environmentally stable area, linked up to the classic forms of agricultural and forestry reclamation, and created an aesthetically more impressive area and proved the usefulness of this method of rehabilitation in practice **(see fig. 4)**.

Fig. 4 Managed succession at „Pařidelský lalok" site. (source: authors)

Since the nineties the aim of workers involved in the revitalization of the North Bohemian coal basin has been to restore the territory, to diversify the different types of ecosystems, to restore their natural functions. A detailed assessment of the revitalization is part of the work of the Faculty of the Environment on the basis of microbiological analyses of particular sites. Revitalization can be seen as a superstructure over the reclamation of the land. In a broader sense the term revitalization is used for renewal of environmental and economic and social functions of the landscape so as to achieve the basic principle of revitalization - the return of life into the landscape. The aim is to create conditions for human life in the newly created landscape units, conditions for the next phase of recovery - resocialization. To that end, coordination with local planning practice is appropriate.

5. Discussion

The project is focused not only at traditional forms of reclamation of the area (see Štýs) but in particular at the verification of new forms of evaluation of revitalization with the help of biological methods (micro-organisms, biomonitoring, Lumbricidae). These new forms will be part of the proposed methodology. Non-traditional crops are also tested on reclaimed soils (energy sorrel – Rumex, see fig. 5)

Fig. 5 Production of energetic crops. (source: authors)

6. Conclusions

Currently the area between Chomutov and Ústí is classified as a structurally affected region, where there are a number of disparities. It is necessary to find ways that could lead to their reduction from social, economic and environmental points of view. In Podkrušnohoří there live more than 400,000 people, 613 people per square kilometer on average. It is necessary to restore the area by means that improve the landscape in the environmental, economic and social contexts. High quality recovery of the area after termination of mining, followed up by the revitalization and resocialization, will return life to the landscape, will create conditions for the comeback of man into the area, for his housing, food production and recreation.

Acknowledgements

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Proposal for Improvement of the Scenic Roads

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Abstract

As enhancing the quality of life and desire for a pleasant environment, people are growing more and more interested in the field of landscape. This issue has been applied to road users, when they're on the roads. It is very important to promote the scenic roads for their desires. The objective is to improve the scenic roads. For this, a study was carried out to a series of on-site investigations over the past few months in Korea and other countries. Similar projects that had been done before in Korea and abroad were examined. This proposal will contribute toward a future pleasant road environment.

Keywords: scenic road; landscape; environment; road user

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1. Introduction

As the quality of life has improved, many of road users tend to use their own cars or rental cars as a means of transportation and their needs are growing. The way of enjoying tourism has been changing from rushing to see famous sights to enjoying a leisurely trip. People just want to enjoy the scenery along the roads.

So it is important to improve the attractions of each region that would give a good amenity. Recently, the numbers of projects, relative to scenic roads, have been increasing in Korea as well as other countries.

For instance, USA has operated the National Scenic Byways Program that is a grass-roots collaborative effort established to help recognize, preserve, and enhance selected roads throughout the United States since 1992. Also Korea and other countries have promoted scenic roads for better environment.

Thus, some countries have planed and constructed a variety of scenic roads for aesthetic pursuits. So it is necessary to promote scenic roads, which suit the desires of road users, for pleasant natural environments.

A thorough study on three (Korea, USA and Japan) national cases about scenic road projects was carried out. This study indicated the key to the future direction and success of the project.

2. Definition of Scenic road

Definition of scenic road is an interaction that happens between the on-looker and the object on the road. However, this relationship has to bring a positive affects to the road users. Scenic road can be divided into categories as seen in **fig. 1**.

Fig. 1 Classifications of Scenic Roads – Diagram. (source: authors)

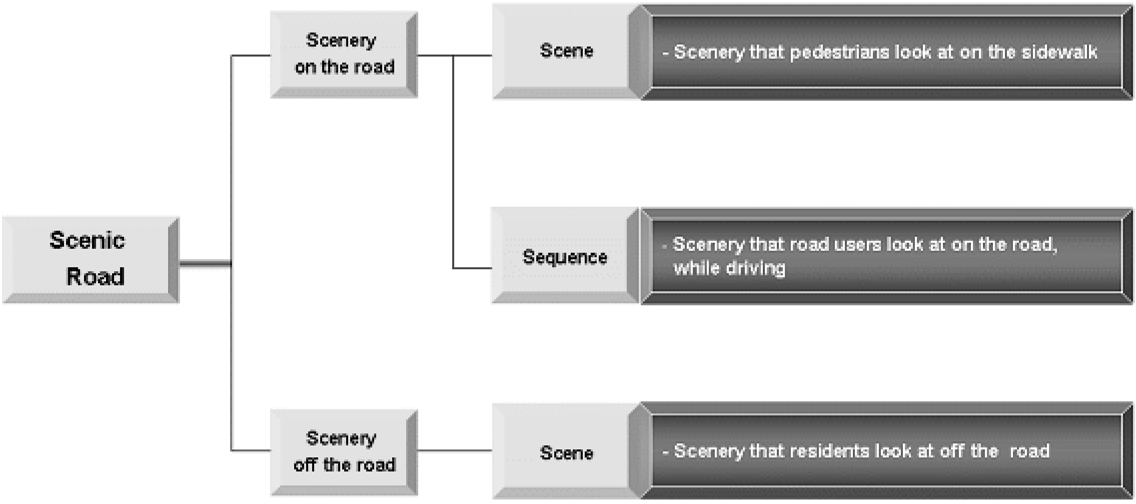
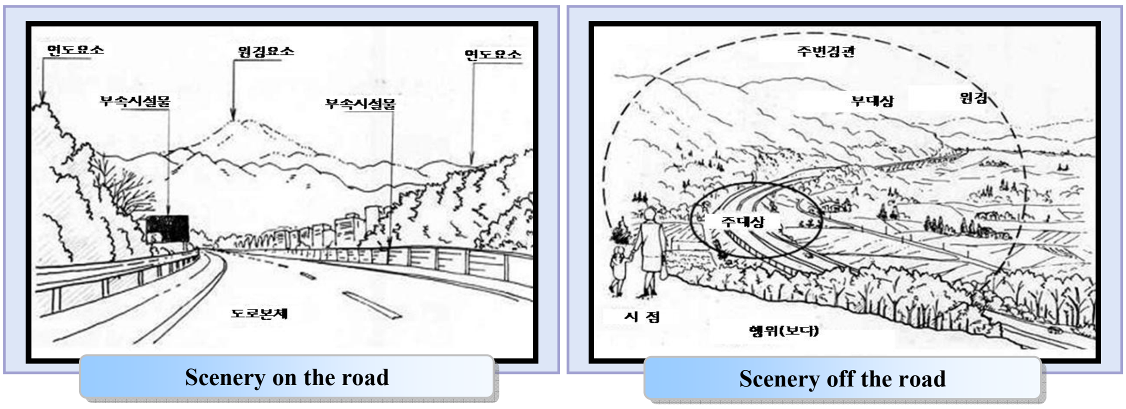


Fig. 2 Classifications of Scenic Roads – Examples. (source: authors)



3. Field investigation

3.1 USA

National Scenic Byway is a road recognized by the *United States Department of Transportation* for its archeological, cultural, historic, natural, recreational, and/or scenic qualities. The program was established by Congress in 1991 to preserve and protect the nation's scenic. Characteristics for scenic roads are as follows.

Archaeological Quality involves those characteristics of the scenic byways corridor that are physical evidence of historic or prehistoric human life, such as identified through ruins, artifacts, structural remains, and other physical evidence.

Cultural Quality is evidence and expressions of the customs or traditions of a distinct group of people. This includes crafts, music, dance, rituals, festivals, speech, food, special events, and architecture.

Historic Quality encompasses legacies of the past that are distinctly associated with physical elements of the landscape, whether natural or manmade, that are of such historic significance, such as buildings, settlement patterns, and other examples of human activity.

Natural Quality includes geological formations, fossils, landform, water bodies, vegetation, and wildlife.

Recreational Quality involves outdoor recreational activities directly associated with and dependent upon the natural and cultural elements of the corridors landscape. They include downhill skiing, rafting, boating, fishing, and hiking.

Scenic Quality is the heightened visual experience derived from the view of natural and manmade elements of the visual environment of the scenic byway corridor. All elements of the landscape landform, water, vegetation, and manmade development contribute to the quality of the corridors visual environment.

Field investigation is as follows.

a) Maryland State

- Maryland state department has designated three scenic roads which include Historic National Road, Catoctin Mountain and Chesapeake Country.

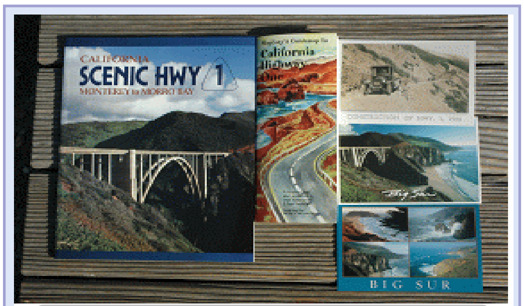
- Varieties of advertising and promotional materials are offered for road users.

b) *California State route 1*

- State route 1 is a state highway that runs along a large length of the Pacific coast of the U.S. state of California. It is famous for running by some of the most beautiful coastline in the world, leading to its designation of scenic road.

Fig. 3 Examples of USA Scenic Roads. (source: authors)

Catoctin Mt. Hwy (Maryland)



Promotional Material

Scenic Route (Lake Tahoe-Nevada) State)

BIXBY BRIDGE of BIG SUR (1932)

3.2 Japan

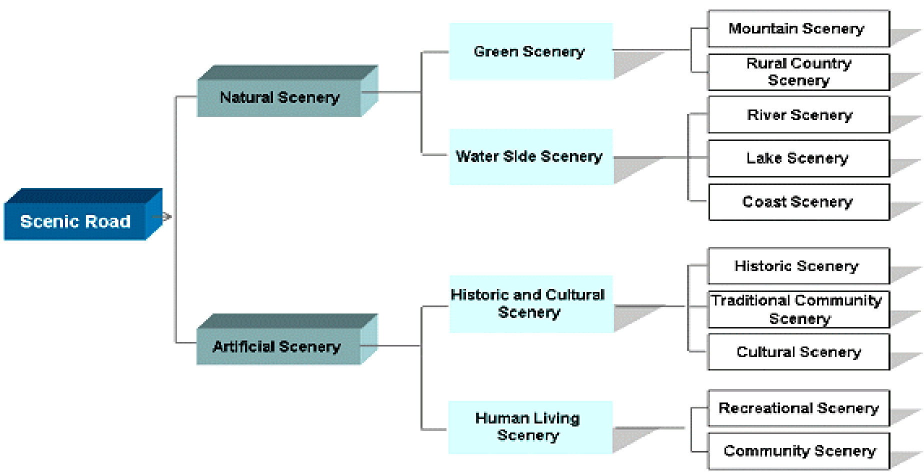
Scenic Byway Japan is a program that aims at the development of beautiful landscapes and tourism activity menus. It seeks to acquaint visitors who want to enjoy and come in close touch with communities. It is mainly implemented by the cooperative work of people who live in Japan. It makes good use of various natural resources such as mountains, lakes, fields, snow, foods and hot springs. As a result, various activities and events have been opened. The image of a wonderful trip is now being broadcast from the "byway" connecting local communities to the world.

Fig. 4 Examples of Japan Scenic Roads. (source: authors)

3.3 Korea

The Korean government (Ministry of Land, Transport and Maritime Affairs) designated 100 of Korea’s beautiful routes for advertising Korea’s aesthetic roads in 2006.

Fig. 5 Types of Korea Scenic Roads. (source: authors)



For this opportunity, local governments have promoted the scenic projects (Happy Road 2010, Green Road, etc) more actively.

The index of assessment for scenic roads has been developed since early 2008. This project is to know if the construction for scenic roads would be a worthy investment or not, after developing the master plan for the scenic roads.

Korea scenic roads have different types of features. For example, road users see the sights of fields and gardens. This s is called a Rural Country Scenery as seen in fig. 5. Brief explanations about the concepts of scenic roads are as follows:

- Green Scenery features an area that has the colors of grass or the leaves of most plants and trees, such as mountains and forests along the road.

- Water Side Scenery features an area beside or near to the sea such as ocean, lakes and rivers alone the road.

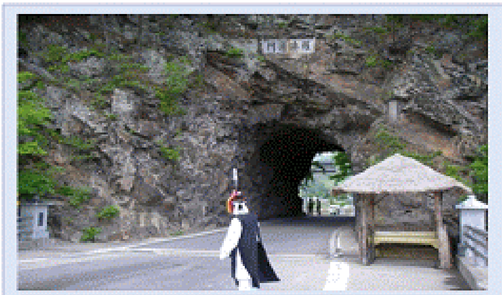
- Historic and Cultural Scenery features an area that has historic building, scenes, and monuments, also has customs, to particular civilization and social groups.

- Human Living Scenery features an area that involves outdoor activities directly associated with people, such as recreational and community activities.

Fig. 6 Examples of Korea Scenic Roads. (source: authors)

Green Scenery

Water Edge Scenery



Historic and Culture Scenery

Human Living Scenery

4. Discussion

Scenic roads are not only to preserve nature, but also to give road user a good amenity. Some countries like Korea, USA, and Japan have promoted the project about scenic roads for pleasant environment. However, there aren't many guidelines about scenic roads, even though each country has its own resources for choosing the scenic roads. Therefore, it is necessary to promote scenic roads that suit the desires of road users for pleasant natural environments using these guidelines. It is very important to make the best use of the resources that each country has. The issue of environmental disruption due to road construction has to be considered very prudently. That means it is needed to have a plan to coexist among the roads, the road users, and nature. But, the most important thing is to make residents lead in active discussions for better understanding about scenic roads. Also, the government has to have a positive support for the project.

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Land use dynamics of the South Moravian region during last 170 years

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Abstract

Quantitative analysis of the dynamics of the Czech landscape development is an integral part of a research project MSM 6293359101. The dynamics is researched from the perspective of land use and is based on the analysis of old topographic maps in a medium to large scale from five periods, namely 1830s, 1880s, 1950s, 1990s and 2000s. These maps were manually vectorized with the smallest distinguished area of 0.8 ha. There have been distinguished nine land use categories. The analysis includes among others changes in the area of these categories and delimitation of stable and unstable areas from the perspective of land use. First results concern a map sheet M-33-XXIX from the topographic maps in the scale 1:200000 covering part of South Moravia. This region is typical agricultural landscape with prevailing arable land that covers more than 55 % of the total area and that has not significantly changed during the researched period. Second biggest and also stable area is represented by forest with more 21 % of the total area. A significant drop was identified with the permanent grassland with more than 10 % from 1830s to 1950s. On the other hand the development of settlements (i.e. built up area) is well apparent. The area of vineyards remained more or less the same but the area of orchards has increased. An increase was also noted for water area (reestablishment of dried ponds or creation of new water areas), other area and recreational area (this started to occur since 1950s). Mostly stable areas are those of arable land and large forest complexes in the north, northwest and also floodplain forests in the south. Also settlements cores remained stable during the researched period. The most dynamic areas are connected with floodplains of the Svratka, Svitava and Dyje rivers.

Keywords: land use; old maps; changes; South Moravia

1. Introduction

Land use changes have recently become one of key issues in landscape ecology. They reflect mainly different phases of political and socio-economical development as well as environmental changes and often are a valuable source for both its future management/land use planning and restoration ecology (Bičík et al. 2001; Bürgi et al. 2004; Egan, Howell 2001).

There are two types of sources for studying land use changes. The first source is represented by statistical data related to a municipality (cadastre, region, state); the second one is represented by data derived from satellite images or aerial photographs and old maps. Unlike statistical data, data from images, photographs and maps show spatial pattern of the land use and are not bound to administrative units. On the other hand they are often modified by interpretation of these spatial information resources and by their scale and thus can be different from statistical data.

The advantage of using old maps (sometimes they are called historical maps), with the contrast to satellite images and aerial photographs, lays in their age – they show landscape structure in older periods than the other resources. Old maps with a good quality that record landscape structure in 18th and 19th Century can be found in the former Austrian-Hungarian Empire (maps of 1st, 2nd and 3rd Austrian Military Survey, maps of Stabile Cadastre) as well as in former Prussia or Italy (see e.g. Agnoletti 2007; Haase et al. 2007; Jordan et al. 2005; Lipský 2002; Olah 2000; Petek, Urbanc 2004; Skokanová 2008; Stránská, Havlíček 2007).

Research project MSM 6293359101 Research into sources and indicators of biodiversity in cultural landscape in the context of its fragmentation dynamics, especially its part Quantitative analysis of the dynamic of the Czech landscape development, which is undertaken at Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Pub. Res. Inst., focuses on evaluating general trends in the dynamics and development of the main land use categories of the Czech cultural landscape. This evaluation is based on the creation of land use maps for the respective map periods, and analytical maps of landscape changes within the whole country. Results from the analyses and land use maps are aimed at the regional to national level and that is why the partial results will be published for map sheets in the scale 1:200 000.

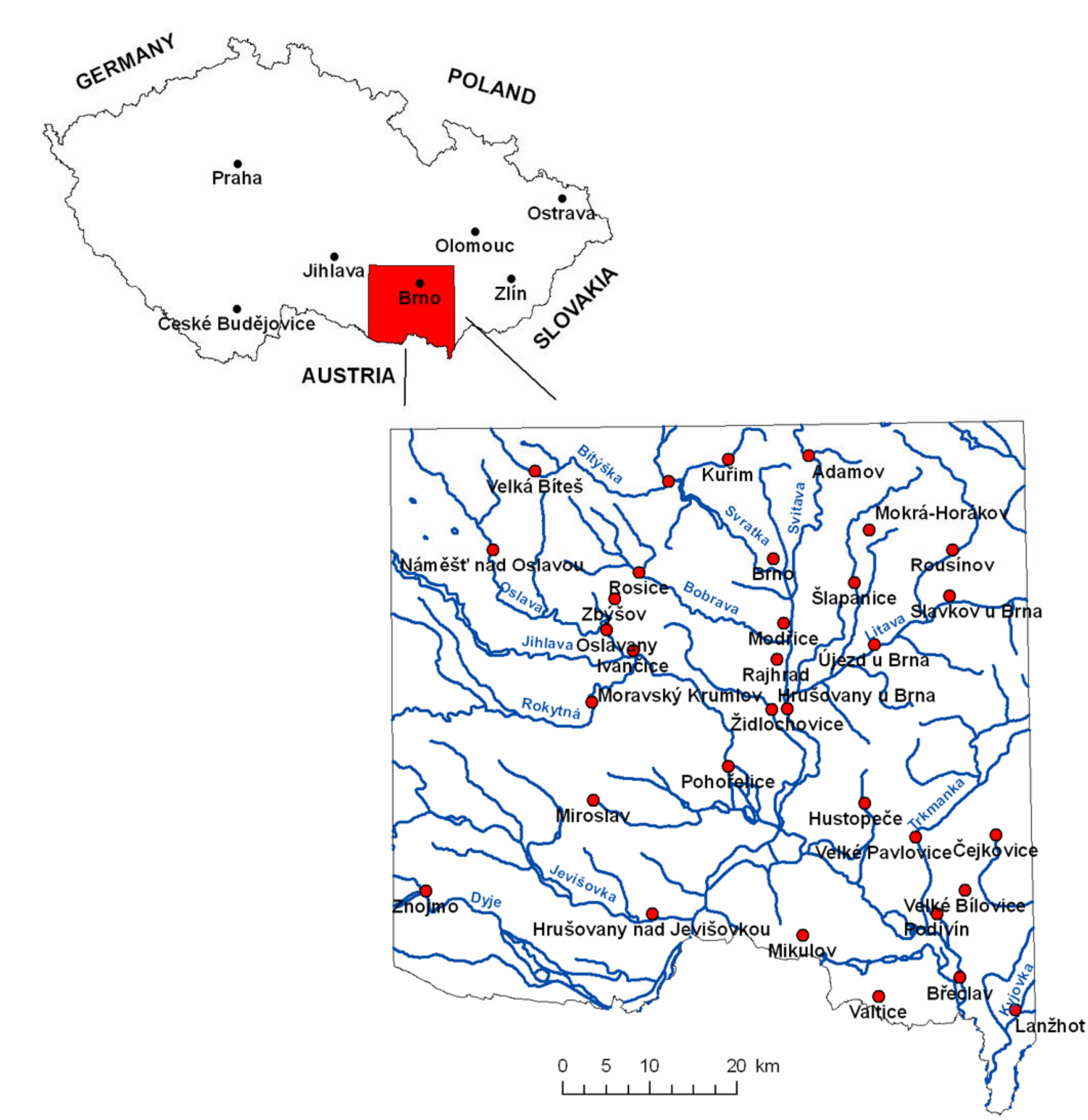
This article presents first results of the research project concerning map sheets M-33-XXIX (Brno) and M-33-XXXV (Wien).

2. Regional settings

The map sheets M-33-XXIX and M-33-XXXV cover 4794,4 km^2 and are situated in South Moravia at border with Slovakia in the east and Austria in the south **(fig 1)**.

South Moravian landscape represents a typical agricultural region with very favourable natural conditions for this sector: the major relief forms are wide floodplains of the lower parts of the Dyje, Svratka, Svitava and Morava rivers, surrounded by hilly areas of geomorphological regions Křižanovská vrchovina, Bobravská vrchovina and Drahanská vrchovina highlands in the north, Jevišovická pahorkatina hilly land in the west, Ždánický les forest, Litenčická pahorkatina and Kyjovská pahorkatina hilly lands in the east and Mikulovská vrchovina highland in the south (Demek, Mackovčin 2006). Despite the relatively flat to hilly relief and thick geological substrate, the soils are much differentiated (Mackovčin et al. 2007). The soils in the floodplains are very fertile with predominant chernozems and fluvisols. Luvisols and cambisols are typical for hilly areas. From the climatic point of view, the region belongs to the warmest areas of the Czech Republic with high temperatures in the summer, mild winters and low precipitation (Quitt 1970). The northern parts are characterized by lower temperatures and more precipitation. The relief together with land cover influence climate significantly on a meso-scale. Main rivers that drain the study area are the Jihlava, Svratka, Svitava, Dyje and Morava with their tributaries the Bobrava and Bítýška (both left tributaries of the Svratka), Oslava (left tributary of the Jihlava), Rokytná (right tributary of the Jihlava), Jevišovka (right tributary of the Dyje), Litava (left tributary of the Svratka), Trkmanka and Kyjovka (both right tributaries of the Dyje). Thanks to these natural conditions, South Moravia has been cultivated since Neolithic agricultural revolution.

Fig. 1 Delimitation of the study area. (source: authors)



The main focus of the agriculture is on growing crops, vegetable, fruits and wine.

Despite intensive agriculture, there are many unique biotopes with many protected species. Many of these biotopes are protected by Czech legislation – there are 215 small specially protected areas with the mean size of 0,35 km^2 that cover 75,1 km^2 and parts of 3 large specially protected areas (protected landscape areas Pálava and Moravský kras and national park Podyjí) that cover 151,1 km^2, which is about 4,7 % of the study area.

The main political and economical centre is Brno in the north with the population of 366 680. Other big cities are Břeclav and Znojmo, which are situated in the south.

From the economical point of view, the region can be divided into two parts – the north with the concentration of industry, especially in Brno and its surroundings, and the south with the concentration of agriculture. The main industrial branches used to be machinery, textile, rubber and food industry. Commerce was also an important part of the economy. Nowadays, the significant industrial branches are machinery and electronic industry. Other main economical sectors are commerce and tourism.

3. Materials and methods

Maps, which were the sources for the analyses, were following: maps from 2nd Austrian military survey in the scale 1:28 000 from the period 1836-1852, maps from 3rd Austrian military survey in the scale 1:25 000 from the period 1876-1880, Czechoslovak military topographic maps in the scale 1:25 000 from 1950s and 1990s, and Czech topographic base maps in the scale 1:10 000 from 2002-2006.

These maps were georeferenced and manually vectorized in ArcGIS program. Nine land use categories were distinguished according to the methodology created at the author's workplace (unpublished): 1 – arable land, 2 – permanent grassland, 3 – orchard, 4 – vineyard and hop-field, 5 – forest, 6 – water area, 7 – built-up area, 8 – recreational area, 0 – other. These categories were based on the legends of the processed maps. Only areas larger than 0.8 ha were vectorized with regard to the output scale of the project (1:200 000). Digital processing of the maps provided information about the spatial distribution of individual land use categories and about comparison of changes in their proportion in the given period.

The analysis of land use changes lies in overlaying vectorized maps and in calculating the number of land use changes for the whole researched period. Scale of the changes ranges from 0 (no change) up to 4 (maximum possible change). Assessment of land use changes can be processed both between individual periods and for the whole researched period. This analysis shows landscape dynamics or landscape stability in terms of land use. It also delimitates land use stable cores, i.e. areas where no changes occurred, which is important for future landscape development.

4. Results

The mid-19th century is characterized by large complexes of permanent grassland along the southern parts of the rivers Dyje, Jevišovka, Jihlava, Trkmanka and Svratka. Big forest complexes are situated in the north – in the Drahanská and Bobravská vrchovina highlands, east (Ždánický les forest) and south (Milovický les forest in the Mikulovská vrchovina higland and Boří les forest and floodplain forests at the confluence of the Dyje and Morava rivers). Floodplain forests can be traced along the Svratka River up to the village of Modřice. The matrix (according to the concept of Forman, Godron 1993) is represented by arable land – more than 58 % of the total area are ploughed. Vineyards are a typical feature of the south Moravian region. They concentrate in the south around city of Znojmo, towns of Hustopeče, Velké Pavlovice, Velké Bílovice, Mikulov and Valtice, northwest of the village of Podivín and west of the village Čejkovice. However, they can be also found as north as the city of Brno. Map from this period also shows large Kobylské and Čejčské jezero lakes north of Čejkovice and

Žatčanský rybník pond south of Újezd u Brna village. Settlement (i.e. built-up area) is distributed more or less regularly as this region belongs to the old residential regions of the Czech Republic. Small patches of permanent grassland, forest, water area and orchards create a landscape mosaic that is typical for the hilly areas in the northwest, north and east.

The situation at the end of the 19th century is similar to the situation 40 years ago: forest complexes, vineyards and built-up area remain more or less the same. On the other hand, categories of arable land, permanent grassland and also water area were influenced by agricultural revolution and its transition into a technological and scientific revolution in agriculture. Agricultural revolution, which was characterized by extensive expansion of cultivated land, especially of arable land to the detriment of permanent grassland, reached its maximum in the 1860s and 1870s. From the 1880s, it began to concentrate on intensive tillage of better soils (Bičík et al. 2001). Because of the favourable natural conditions of the study area this process is typical for this region: permanent grassland starts to be ploughed along the rivers Svratka, Jihlava and Trkmanka; both Kobylí and Čejčské jezero lakes and Žatčanský rybník pond has been turned to arable land. Ploughing of the permanent grassland in floodplains was also enabled by river engineering works that restricted annual floods. The landscape mosaic is still typical for the hilly areas.

The land use in the 1950s was influenced by several events. The most significant event was change in political system in 1948 that caused among others so-called socialist industrialization. This concerns founding unified agricultural cooperatives and state-own farms, or in other words collectivisation. One of main features of the collectivisation was farm consolidation, which resulted in vast fields (Skokanová, Havlíček 2007). The landscape mosaic was significantly suppressed and remained only in the northwest along the upper parts of the rivers Oslava and Bítýška. Increased pressure on the quality soils resulted not only in ploughing permanent grassland along the rivers but also in cutting down floodplain forests in the Svratka valley between Rajhrad and Hrušovany u Brna villages. Another significant event that influenced land use categories, in this case vineyards, was spread of Phyloxera and other wine diseases, which occurred at the turn of the 20th century not only in the Moravia but also in Austria and Hungary (Jordan et al. 2005). Both world wars, especially WWI, also accelerated the decline in viniculture (Kraus et al. 2005). Bigger concentrations of vineyards remained west and north of Mikulov, north of Velké Pavlovice, north of Velké Bílovice and northwest of Podivín. Vineyards around other above mentioned localities (i.e. Znojmo, Čejkovice, Hustopeče and Valtice) did not disappear but their area was significantly reduced. Larger complexes of orchards can be noted east and west of Hrušovany nad Jevišovkou, around Brno, north of Slavkov u Brna and along the Jihlava river north of Pohořelice. They are a result of a boom in fruit growing in the first half of the 20th century. The three main cities (Brno, Břeclav and Znojmo) spread their areas and also induce introduction of a new phenomenon – development of recreational areas. New water areas are created – Brněnská přehrada lake northwest of Brno, Jaroslavický rybník pond in the southwest and Pohořelické rybníky ponds south of Pohořelice (these ponds were re-established).

Further growth of the built-up area in the 1990s is very clear especially in the case of Brno. The growth was caused by increase in number of population. It was also influenced by administrative reforms in the 1960s when Brno together with Břeclav and Znojmo were established as centres of new regional districts. The situation from the beginning of the 1990s reflects full impact of collectivization on landscape – almost all floodplains were ploughed, with the exception of permanent grassland at the confluence of the rivers Dyje and Morava; big agricultural complexes (cow- and pig-houses, granary etc.) at the vicinity of villages and towns or even in the open countryside were developed (Mackovčin et al. 2007). After the decline in viniculture the vineyards were re-established in the traditional wine districts but also in new localities, such as around willage of Miroslav, town of Židlochovice and southeast of village of Ivančice. Also orchards spread mainly around Velké Pavlovice, Velké Bílovice and west of the confluence of the rivers Svratka and Jihlava, but also around Židlochovice, Hustopeče and northeast of Znojmo. A new water area was created at the confluence of the rivers Svratka and Jihlava, so called Nové Mlýny water body. It attracted establishment of recreational areas; further expansion of this category can also be seen around Brno.

Finally, the beginning of the 21st century represents the period of economical and political transformation. The most significant features of this period, which are expressed in the landscape, are suburbanization – typical especially around Brno, seizure of agricultural land for building commercial and industrial centres, but also grassing or afforestation of less used localities.

If we consider proportion and development of individual land use categories, we can say that the prevailing category is arable land, which exceeds 55 % of the total area throughout the whole researched period. It peaks in the 1950s and has the lowest area at the beginning of the 21st century.

The second most wide spread category is forest with the average proportion of 22 %. The proportion of this category was smaller in the first two periods and then it increased and remained more or less stable.

The biggest changes occurred in the category of permanent grassland. A significant drop in the area was noted for the first half of the research period, i.e. 1840-1950, with the decrease for more than 10%. From the 1950s to the 1990s the drop continued but was not so remarkable because almost all permanent grassland was already destroyed. A slight increase in 2002-2006 was a result of land abandonment.

As it was already mentioned in the previous text, the proportion of vineyards decreased in the 1950s as a consequence of wine diseases and economic situation and increased again in the 1990s, which was a result of systematic management of both cooperative farms and few private farmers.

Quite a steep increase in the proportion of built-up area in the second half of the 20th century reflects mainly economic development, i.e. construction of industrial plants, residential housing etc. While in the 1950s the increase in this category was at the expanse of permanent grassland, in the 1990s it was at the expanse of arable land.

There is a steady increase in the proportion of orchard and other area, as can be seen in tab 1.

Tab. 1 Area of the land use categories (km²) in the period 1840-2006. (source: authors)

category	1840	1880	1950	1990	2006
arable land	2794.6	3078.1	3135.6	2856.9	2771.1
permanent grassland	671.7	443.5	186.7	121.0	157.8
orchard	19.0	16.5	50.5	78.0	87.1
vineyard and hop-field	141.7	126.5	72.6	142.5	126.8
forest	1045.3	1006.1	1104.0	1128.7	1162.0
water area	23.3	10.6	21.0	66.8	65.8
built-up area	98.6	110.8	217.4	361.8	377.5
recreational area			3.7	30.6	36.0
other	0.1	2.2	2.9	8.0	10.2

The recreational area occurs since the 1950s and its proportion increases since then.

A decrease in the proportion of water area at the end of the 19th century was caused by draining several lakes and ponds. Increase in the second half of the 20th century was a result of re-establishment of several ponds, namely Pohořelické rybníky and Jaroslavický ponds, and building new water bodies of Brněnská přehrada lake and Nové Mlýny water body, as it was mentioned before.

From the perspective of land use changes, more than 65 % of the study region is stable. The stable areas are bound to large forest complexes in the north as well as in the south and to vast blocks of arable land in the lowlands. The most dynamic areas are those of river floodplains, especially the lower parts of the Dyje, Jihlava and Svratka; areas around Znojmo and Brno and also areas of vineyards north and west of Mikulov and Hustopeče, Velké Pavlovice, Velké Bílovice and Čejkovice. The most common change was from permanent grassland to arable land, from arable land to built-up area and from permanent grassland to forest.

5. Discussion

We can say that the traditional character of the Czech agricultural landscape can be characterized as a small-scale mosaic of fields and thick web of country roads lined with fruit trees (Lipský 1995). This character was widely spread up to the second half of the 20th century but was destroyed by socialist agriculture that led towards significant simplification of the landscape. The only area in the study region where it was preserved to some extent is the area north and west Náměšť nad Oslavou and Velká Bíteš.

Development of land use categories in the study region differs for individual categories. If we compare trend for the arable land with the trend in the whole Czech Republic as was researched by Bičík et al. (Bičík et al. 2001), we see a slight shift in the peak of the proportion of this category (the whole Czech Republic experienced it at the end of the 19th century, while the study region in the 1950s). The shift can be caused by the fact that the study region is a typical agricultural one. The trend of forest development as well as development of the built-up area in the study region corresponds with the trend of the whole Czech Republic. The same findings were recorded for the category of permanent grassland but the differences between the beginning and the end of the researched period are not so big in case of the whole territory. Trends in other categories are rather difficult to compare as the definitions of categories on both scales differ due to the different methodology.

6. Conclusions

This research article represented first preliminary results concerning a part of a research project, which is undertaken at the Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Pub. Res. Inst. The results were processed for the area of south Moravian region, map sheets M-33-XXIX and M-33-XXXV, to deliver trend in land use development for the last 170 years on the basis of old topographic maps. These trends were roughly compared with the general trends derived from the statistical land use data of the whole Czech Republic and were found to correspond with these general trends.

The advantage of using old topographic maps for derivation of land use data and trends in land use development lays in their spatial information and their independency on administrative units. On the other hand, these data are dependent on the quality of the map sources and their interpretation. It is therefore favourable to combine both types of the data.

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Long-term land use changes and the quality of agricultural land in Czechia

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Abstract

This article evaluates the correlations between land use changes and the quality of agricultural land in Czechia. The first part of the study is based on using the LUCC Prague database containing land use data from 1845, 1948, 1990 and 2000. The official price of agricultural land of each cadastre of Czechia was incorporated into the LUCC Prague database and the data was used for monitoring the correlation between land use changes and the quality of agricultural land. In principal, the official price represents relative differences among the individual cadastres from the point of view of natural fertility. For the purposes of verification of the results sought in the whole territory of Czechia, an example of a case study in Sedlčansko is included. This methodology investigates the correlation between land use changes mapped during field investigations and the quality of soil determined by quality soil ecological units (QSEU).

Keywords: land use; land use changes; Czechia; agricultural land

1. Introduction

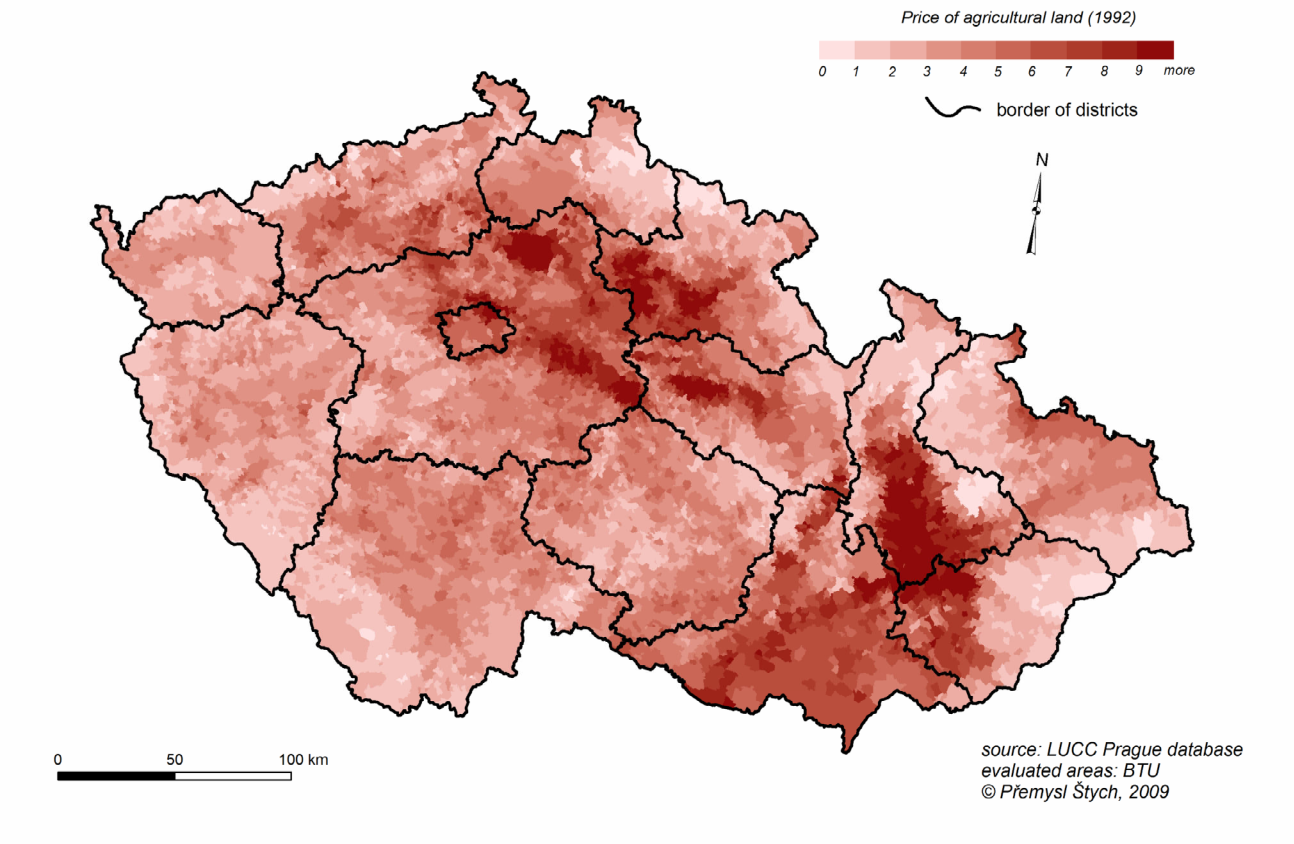
The research team of the Faculty of Science has created an original database over the last few years about the land use development of Czechia in the years 1845, 1948, 1990, and 2000. The territory of Czechia was divided into almost 10 000 basic territorial units (average size 7 km2), which are contained in the database and are comparable with all the time horizons mentioned above. The database is divided into three summarized categories: agricultural land (arable, permanent cultures, permanent grassland), forested areas and the rest (built up areas, water areas, other areas). Information about the database and methodology has been published earlier, e.g. Bičík (1998). At present, this database is used to search for correlations between land use changes and other characteristics of the set of basic territorial units (BTUs). One of these is pedological characteristics. This article evaluates the correlations between land use changes and the official price of agricultural land for the whole area of Czechia. The price was derived from results of detailed pedological mapping (1:5 000) carried out in the 1960´s and 1970´s. The official price of agricultural land expresses the natural productivity of this land. Detailed pedological maps (1:5 000) were used for the sake of a comprehensive analysis in the case study, Sedlčansko, where land use changes in the period 1993 – 2003 were investigated. The overlay of these two digitalized layers in GIS determined land use changes according to the individual pedological type of soil.

2. Aims and Methodology

The main goal of the study was to identify the dependency of land use changes on pedological characteristics. This article reviews and develops the results of previous investigations, e.g. Bičík, Kupková (2002) or Kabrda, Bičík and Šefrna (2006). The first part of the study is based on using the LUCC Prague database containing data from 1845, 1948, 1990 and 2000. Only categories of agricultural land were analysed. The official price of agricultural land of each cadastre of Czechia was incorporated into the LUCC Prague database in 1992 and the data was used for monitoring the correlation between land use changes and the quality of agricultural land. According to Bičík and Kupková (2002), the officially fixed price is based on detailed pedological mapping done in the 1960´s and 1970´s, on a scale of 1:5 000. The results of this mapping helped to determine quality soil ecological units (QSEU). With a coded number, the QSEUs express the soil type as well as the inclination, aspect and agrarian-climatic conditions. Relatively homogeneous soil units in the agricultural landscape were created by a combination of these parameters. The differentiation of the quality of the QSEU is expressed by values from 0 to 100, 100 representing the highest quality QSEU. As several QSEUs can occur in one cadastre, the weighted average is calculated according to their percentile representation. In principal, the official price represents relative differences among the individual cadastres from the point of view of natural fertility and oscillates, pursuant to the decree of the Ministry of Agriculture, in individual cadastres from CZK 0,50 to CZK 15. The calculation of the official price of agricultural land, which was used in analyses, was done at the beginning of the transformation period in 1992. Today the structure of agricultural production is naturally different. In spite of this, the official price enables a defining of the differentiation of territory in relation to the pedological character. The regional distribution of the official price of agricultural land in Czechia in the year 1992 is shown in **fig. 1**. The BTUs were divided into 10 categories, according to the official price. A weighted part of the given land use category in the total area in the individual price categories was calculated in the years 1845, 1948, 1990 and 2000.

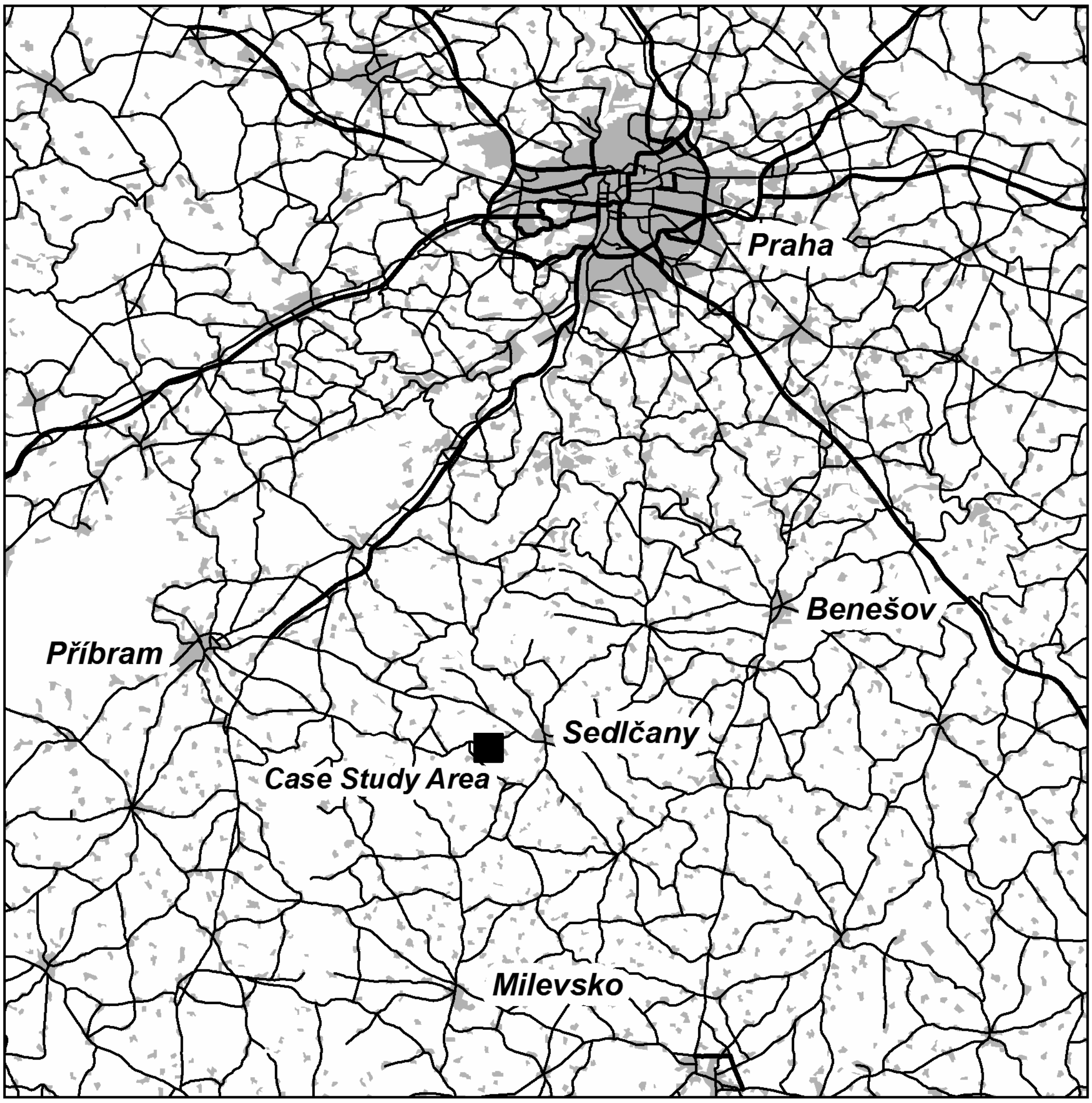
For the purposes of verification of the results sought in the whole territory of Czechia, an example of a case study in Sedlčansko is included. This section examines the correlation between land use changes mapped during field investigations and the quality of soil determined by QSEU. The Sedlčany region is situated on the border of Central and South Bohemia **(fig. 2)**. This region can generally be described as an area with less favourable conditions for agricultural activities (LFA) and from the point of view of its socio-economic position, it belongs to areas called "inner peripheries" without important industrial development and without prime traffic connections to major centres. Concerning the natural conditions there is a disproportion between the south and the north. Relatively more favourable conditions are situated in the northern part of our case study.

Fig. 1 The regional distribution of the official price of agricultural land in Czechia in 1992.



Changes in land use were identified by comparing the map of field investigations carried out at the turn of the 20th and 21st Century (last updated in 2003), and the situation of land use was recorded in the state basic maps 1: 10 000 from 1993 onwards. In the areas administered by 6 cadastres (Břekova Lhota, Dublovice, Hrabří, Pořešice, Třebnice and Zvírotice), land use changes, which occurred during the period 1993 – 2003, were precisely recorded and subsequently processed in the GIS. The quality of soil was identified and located from digital maps of QSEU. In the territory of our model area, 54 units of QSEU were defined. According to their dispositions for farming, units were merged into six aggregate categories: shallow and immature soil, skeletic soil, extremely sloping soils, hydromorphous soils, semi hydromorphous soils and agronomically favourable soils. The first four categories of the classification are characterised by low quality soils; the sixth category, on the other hand, contains the best quality land suitable for intensive agricultural use in the case study. In the fifth category, medium-quality land, which is used for the arable procedures recommended only under certain conditions, is included (Dumbrovský et al. 1995). The overlay of both digital maps was processed in GIS and subsequently the proportion of individual soil types in the area of changes was calculated.

Fig. 2 Localisation of the case study Sedlčansko. (source: CEDA 150)



3. Results

Agricultural land, arable land and permanently grassed areas were selected for the purposes of this article. The results express the weighted part of the given land use category in the total area in the individual price categories in the years 1845, 1948, 1990 and 2000 (fig. 3 – 5). The results proved the significant loss of agricultural land in Czechia (in the years 1948 – 1990 by more than 20 %). However, the extent of the decrease was different in the categories of the lowest quality soil in comparison to development in the categories with higher soil quality. The weighted part of agricultural land was on average over 86 % in 1845 and 1948, in 2000 it was only about 78 % in the most fertile cadastres (land price over 8 CZK), the part of agricultural land resources in the lowest price category was almost 39 % in 1845; in 1948 it decreased to 32 % and in 2000 to 17 %. Arable land showed a similar trend, but the polarization of development was more substantial. During the first observed period, arable land increased in Czechia, but as fig. 4 shows, new arable land was concentrated into areas with higher soil quality. On the other hand, an intensive decrease is characteristic for the following period 1948-1990, with a huge decline of arable land in the territory of the lowest quality soil. This trend continued during the period 1990 – 2000. If changes of arable land are analysed in the whole period from 1845 to 2000, it is interesting to note that the area of arable land in regions with high quality soil was almost the same in the first year, 1845, as in the last observed year, 2000. On the contrary, the loss of arable land in the less favourable areas was very intensive.

The results express an interesting development of permanent grassland throughout the whole period 1845 – 2000. It documents considerable differentiation in the periods 1845 – 1990 and 1990 – 2000. The decrease of the area of permanent grassland was documented in all fertility categories of agricultural land resources in 1845 and 1990. However, what is very significant is the fact that in the years after 1990 the area of permanent grassland increased with a strong concentration in less favourable areas (mainly where the price was lower than 5 CZK). It was the first time in more than 160 years of monitoring land use changes that the area of permanent grassland increased. **(fig. 5)**.

Fig. 3 Percentage of agricultural land on total area in individual price intervals. (source: LUCC Prague database)

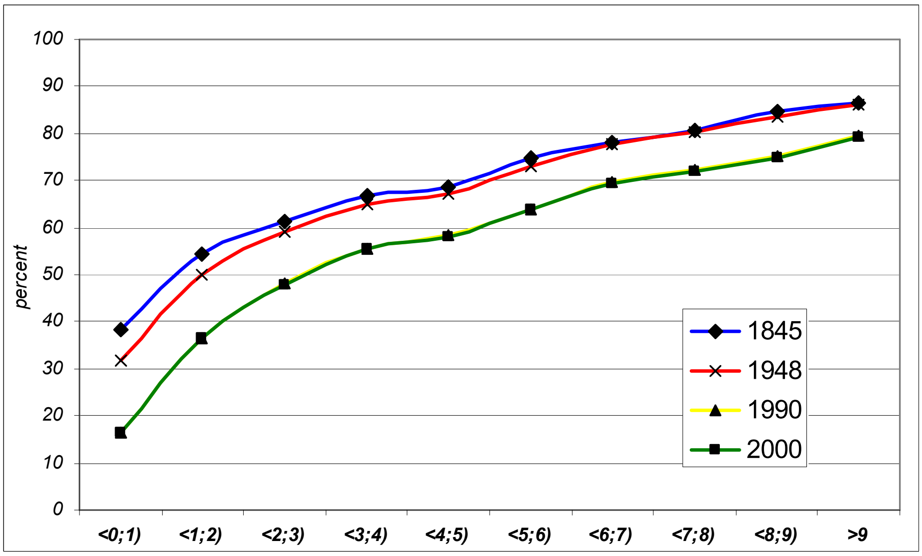


Fig. 4 Percentage of arable land on total area in individual price intervals. (source: LUCC Prague database)

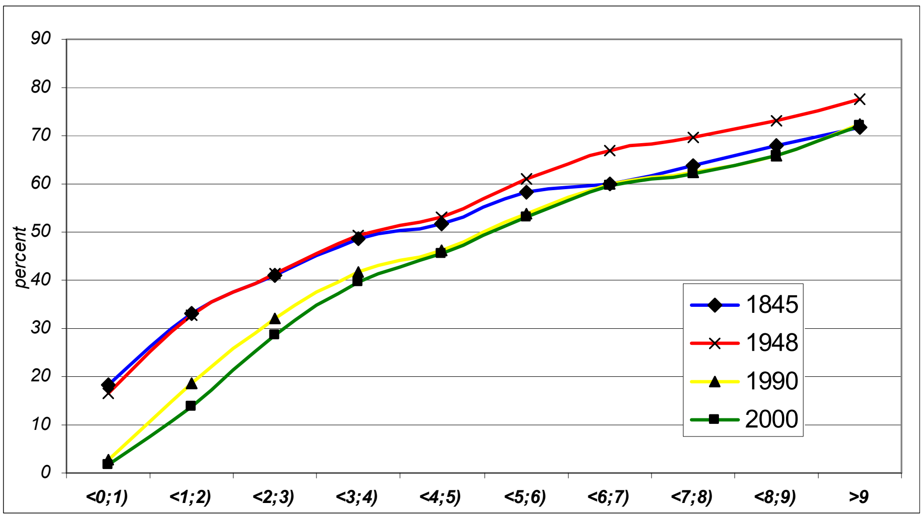
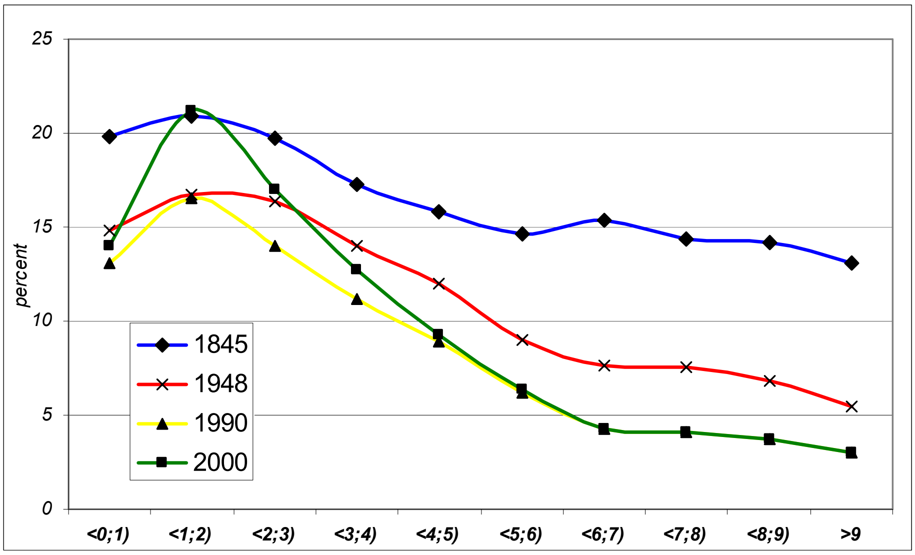


Fig. 4 Percentage of permanent grasslands on total area in individual price intervals. (source: LUCC Prague database)



Tab. 1 Land use changes in the case study Sedlčansko on individual categories of quality of soil 1993 – 2003. (source: field survey, map of quality soil ecological units (QSEU) 1: 5 000)

	grassing over		new arable land		fallow arable land	
	ha	%	ha	%	ha	%
hydromorphic soils	14,8	4,3	5,1	14,0	1,8	3,4
skeletic soils	137,5	40,0	11,8	32,5	22,4	42,1
extremely sloping soils	0,1	0,0	0,0	0,0	0,0	0,0
shallow soils	113,6	33,0	4,8	13,2	11,4	21,4
semi-hydromorphic soils	37,6	10,9	2,9	7,9	5,0	9,3
favourable soils for agriculture	29,4	8,6	10,5	28,8	12,5	23,5
change out of agricultural land	10,9	3,2	1,3	3,5	0,1	0,3
total	343,9	100,0	36,4	100,0	53,2	100,0

Tab. 1 illustrates changes in agricultural land in selected cadastres of Sedlčansko in the period 1993 - 2003. The results show that the most important process in the agricultural landscape was grassing over. Grassing was concentrated in the south of the area, where low-quality soils predominate. From the environmental and soil-protection point of view, it is a very positive trend because over 80 % of grassing was done in localities with low quality soils. The highest percentage of grassing was carried out on skeletic soils (40 %) and on shallow soils (33 %). During field research, fallow agricultural land was observed in the total area of 53,5 hectares. Around 88 % of the area of fallow land was located on agronomically unfavourable soils. New arable land was also detected in the model area during field research. These plots of arable land were mainly owned by farmers, who had had the agricultural land restituted and who cultivated only a small area of their available land. In view of the fact that new arable land was mostly created on non-fertile soils, farmers were not able to benefit from the conditions of the free market and it can be expected that now or in the next few years, most of the new arable land will be converted back into grass land.

4. Discussion and Conclusions

Partial results of the LUCC research that is currently being carried out at Charles University in Prague were presented in this paper. The research focused on two hierarchical scale levels that differ both in the sources of data and in the methodological approaches. From this point of view, research on a countrywidescale (based on the LUCC Prague database) enabled the main development trends of vaster areas to be defined, while studies of model areas on a more detailed scale (using detailed pedological maps and maps of field research) were used for the demonstration and verification of the results found out at the levels mentioned above. By studying both levels together and combining the results, the causes and consequences of the processes taking place in the landscape can be better understood.

The results indicate that there is a trend of deepening differentiation of regions based on their natural conditions. The results of this study proved the differentiation of development of selected land use categories of agricultural land based on the quality of soil. The quality of soil was derived from QSEU. Two antagonistic processes took place in the land use structure during the observed periods from 1845 to 2000. Fertile regions experienced agricultural intensification. These regions maintained their intensive use; the arable land consisted of an approximately similar area in 1845 as in 2000, but the percentage of permanent grassland decreased. On the other hand, infertile regions experienced extensification, accompanied by an intensive decline of arable land and grass planting during the last decades. Intensive human activities have been increasingly concentrated in favourable areas while more hostile peripheral areas have demonstrated the process of marginalisation. The decrease in agricultural and arable land is obvious in non-favourable regions. Market mechanisms determined by differential rents, changes in the system of agriculture and agricultural policy, polarisation of centre × periphery and the gradual integration of the Czech Republic into transnational groups are the main initiators of change. Comparison with similarly oriented studies of Czechia (e.g. Bičík and Kupková 2002 or Kabrda et al. 2006) or from foreign European countries (Krausmann 2001 or Gabrovec, Kladnik 1997) shows de facto identical trends. In the future, deeper polarization of land use changes will probably be caused by increasingly faster economic globalization and the absolute integration of the Czech agricultural market into the EU system. It is expected that a significant discussion about agricultural policy will take place in the EU.

Finally, there are a number of proposals for follow-up research such as widening the LUCC database by additional data (e.g. population data), which could enable a deeper analysis of the driving forces. Furthermore, interviews with the main local players (farmers, institutions etc) could produce interesting results and verify the case study research of land use changes.

Acknowledgements

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Implications of landscape heterogeneity on ecological values in selected types of agriculture landscapes

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Abstract

Agricultural intensification and abandonment of traditional farming are currently recognised as one of the major threats to biodiversity. Also in the case study area, the Biosphere reserve “Wienerwald”, a loss of landscape diversity and a decrease of species and biotopes can be noticed. In order to provide a basis for conservation management decisions we identified the spatial heterogeneity of selected types of agricultural landscapes and assessed their ecological functionality. We compared landscape sites according to their complexity. The main objectives were: (1) to assess landscape structure by ground truthing (matrix, patch origin and corridor inquiries) and to compare the results with previous landscape structure classifications, which were based on aerial orthophotos, (2) to complement the analyses of landscape structure with biotic data (habitat mapping and vegetation inventory) in order to assess the ecological value of landscape components, and (3) to compare different methods (landscape structure analysis, habitat mapping and vegetation inventory) for assessing ecological value. One important result of this study was that the rough classification of the interpretation of aerial orthophotos could be partly affirmed by ground truthing. A significant difference of landscape diversity was determined between the landscape sites of high and low complexity. Low complex sites were strongly influenced by humans and biotope diversity was low. The more complex landscape sites provided a higher density and diversity of ecologically valued biotopes, but these sites were commonly endangered due to the proceeding urbanisation. In order to identify ecologically valuable biotopes, which are of great interest to nature conservation, habitat mapping is indispensable.

Keywords: landscape complexity; landscape functionality; nature conservation; habitat mapping

1. Introduction

To a large extent biodiversity in Central Europe is depending upon landscapes created by human activities, leading to the dominance of agricultural landscapes (Piorr 2003). Agriculture has shaped and differentiated the landscape and its related biodiversity, giving rise to a unique seminatural environment. Areas defined by ecologists as 'seminatural' farmland, forest and grassland habitats are home to many of the continent's most valued species (Wrbka et al. 2005).

Both the abandonment of traditional farming and mainly the intensification of agriculture have led to substantial loss of biodiversity (Piorr 2003; Robinson, Sutherland 2002). In Europe over the last quarter of the 20th century, dramatic declines in both range and abundance of many species associated with farmland have been reported (Hole et al. 2004; Donald et al. 2001; Krebs et al. 1999; Preston et al. 2002). In response to this the European Union has committed its member states to stop the loss of biodiversity by 2010 (EEA 2007). Despite such efforts, intensification of agriculture – positively termed as improvements in crop management techniques - at the field and farm scale have been responsible for the loss of annual forbs and other species groups in agroecosystems (Firbank 1988; Albrecht 1995; McLaughlin, Mineau 1995; Sotherton 1998; Stoate et al. 2001; Benton et al. 2003). Furthermore, changes at the landscape scale have led to a decrease in spatial heterogeneity (Robinson, Sutherland 2002; Benton et al. 2003). As a positive correlation exists between landscape complexity and biodiversity (Moser at el. 2002; Schindler et al. 2007), a correlation between spatial heterogeneity and species diversity seems a promising approach to evaluating biodiversity in agricultural landscapes and capturing differences in agricultural systems. Therefore analyses of landscape structure can help in measuring progress/failure of agri-environmental policies.

Eastern Austria can be seen as a showcase for such developments, as the long history of human interference and different cultural influences have created a large variety of agricultural landscape types along the Danube river corridor. These are characterised by a high diversity of secondary habitats, which cannot be found in natural landscapes (Wrbka et al. 2005). Such biotopes with high ecological value contribute crucially to national biodiversity and are therefore of great concern for nature conservation. However, due to the abandonment of traditional farming and the intensification of agriculture, such biotopes are endangered (Schmitzberger et al. 2005; Zechmeister et al. 2002). Also in the case study area, the Biosphere reserve "Wienerwald", a loss of landscape diversity and a decrease of species and biotopes can be noticed (Hermann 2006). Thus, in order to induce appropriate conservation strategies, it is important to analyse distribution, configuration, status and endangerment of these biotopes and further information about the surrounding matrix.

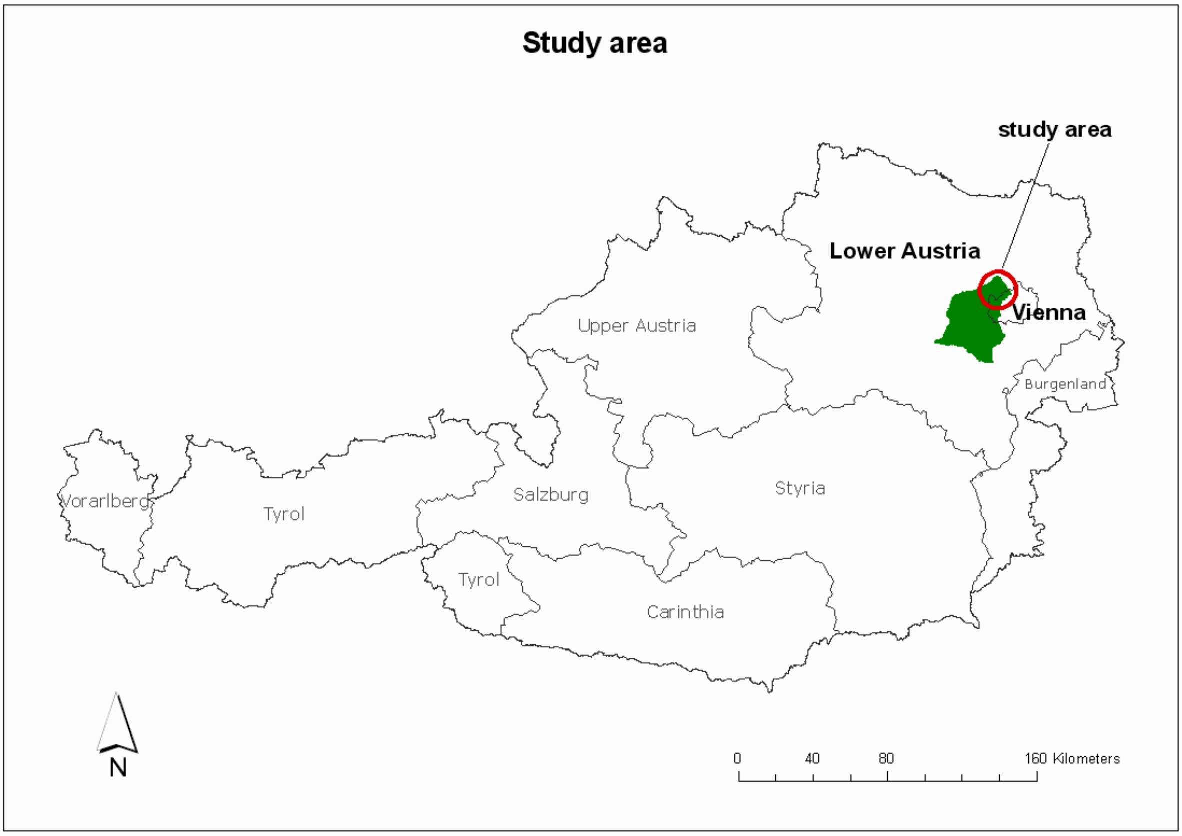
The aim of this study was to identify the spatial heterogeneity of selected types of agricultural landscapes (viticulture and orchards) and to assess their ecological functionality to provide a basis for conservation management decisions. We compared landscape sites close to the city of Vienna with rural areas in the county of Lower Austria. In the course of a previous project the landscape sites in the biosphere reserve Wienerwald have been classified according to their complexity based on an interpretation of aerial photographs (Arbeitsgemeinschaft AVL 2005). In this study the main objectives were: (1) to assess landscape structure by ground truthing (matrix, patch origin and corridor inquiries), (2) to compare the results with the classification based on aerial photographs, (3) to complement the analyses of landscape mapping with ecological data (habitat mapping and vegetation inventory) in order to assess the ecological value of landscape components, and (4) to compare different methods (landscape structure analysis, habitat mapping and vegetation inventory) for assessing ecological value.

2. Regional setting

The study was carried out in the suburb of Vienna (Döbling) and in Klosterneuburg in

Lower Austria, a more rural area **(fig. 1)**. All study sites are situated in the Biosphere reserve "Wienerwald". The "Wienerwald" consists of two geologic parts: the Flysch zone and the eastern ridge of the northern lime stone Alps (Götzinger et al. 1954). The north-west of the "Wienerwald" is characterised by wide Flysch-open valleys with sides flaring out. Fields and meadows are cultivated along these expanded valleys and on their slopes. Due to the sequence of warm and cold periods during the Quartenary, terrace landscapes have been developed along the Danube river, nowadays mainly used as vineyards (Plöchinger, Prey 1993). The study was conducted exclusively in the Flysch zone.

Fig. 1 Study area. (source: authors)



3. Material and methods

3.1 Study design

30 landscape sites (study sites) of 1 ha were selected in viticulture and in orchards by stratified random sampling. Out of the 30 sites, ten were of low (lcs), ten of medium (mcs) and ten of high (hcs) landscape complexity. Landscape complexity categories were based on the landscape structure assessment of the zoning plan of the Biosphere reserve "Wienerwald" for non-forested landscapes (Detailplanung zum Biosphärenpark Wienerwald; Bereich Offenland und Landwirtschaft" - Arbeitsgemeinschaft AVL, 2005). In the course of this project individual landscape units of the "Wienerwald" were classified according to their complexity (size range of landscape elements, edge effects, "ecological infrastructure"), based on an interpretation of aerial-orthofotos.

3.2 Field survey

To derive a sound dataset on the secondary landscape structure and its phyto-diversity, habitat mapping and point-sampling of vegetation were conducted. The field inventory was completed from May to July

2006. Data collection was based on the methodology of the projects "Landleben" (Wrbka et al. 2002) and "SINUS" (Wrbka et al. 2003) and comprised mainly landscape and vegetation ecological aspects.

3.2.1 Landscape mapping

All landscape elements in the study sites were mapped and plotted in Orthophotos. For each landscape element a land use type was identified and assessed regarding its patch origin (introduced, resource, disturbance, regeneration and remnant patch). The degree of the change of persistent landunits (totally changed CPL1, changed CPL2, moderately changed CPL3, unchanged CPL4), the degree of anthropogenic disturbance (episodic disturbance DIA1, mild and periodic disturbance DIA2, mild and periodic disturbance in short intervals DIA3, strong and periodic disturbance in short intervals DIA4), the actual and potential regeneration state (mild disturbance and long regeneration RGL1, strong disturbance and long regeneration RGL2, mild disturbance and short regeneration RGL3, strong disturbance and short regeneration RGL4) and the degree of adoptedness of specific species compositions to environmental resource patches (resource indicating species present according to dry and wet, nutrient rich and poor conditions RWD2, RWW2, RNR2, RNP2; resource indicating vegetation types present according to dry and wet conditions RWD3, RWW3;RNR3, RNP3) were valued.

Also the hemerobic value (Wrbka 1997) was recorded. Hemeroby is an integrated measure for anthropogenic influence on landscapes or habitats, taking into account the response of vegetation to human impact over time rather than the human impact per se. The concept was first introduced by Jalas (1955) and subsequently developed by several authors (Sukopp 1969; Kowarik 1988). The concept of hemerobic state has been widely used by scientists in the field of landscape ecology and forestry in Central Europe (Wrbka et al. 1999). An overview of categories of the hemerobic state and their attributes is given in Zechmeister and Moser (2001).

3.2.2 Habitat mapping

In the course of the habitat mapping only ecologically valuable biotopes were assessed and documented (Plachter 1991; Usher, Erz 1994; Kaule 1991). For each habitat we identified a biotope type according the Austrian valid biotope list (Essl et al. 2004), structural attributes, valuable defined attributes, and its actual and potential level of endangerment (Wrbka et al. 2002).

3.2.3 Vegetation census

In each study site the two ecologically most valuable biotopes were sampled. These samples included full species lists of vascular plants with abundance values using Braun-Blanquet (1964) method on a sampling plot. The sampling area was standardised for each vegetation type following general guidelines that are based on the minimum area concept (Westhoff, Van der Maarel 1973).

3.3 Data analyses and assessment

All mapped landscape elements were digitized in ArcGIS 9 (ESRI Inc., Redlands, CA) and annotated with the appropriated attributes. For the administration of the landscape and habitat mapping data we used Access 2000. The data of the plant inventory have been analysed using the software VEGI (Reiter 1997).

3.3.1. Land use type

For assessment of significant differences between the three complex classes according the land use types the Shannon index was calculated. Statistical analysis was done with a Student´s t-test

3.3.2. Biotope value

To each biotope a biotope value was assigned. This value was educed from reproducibility, rareness, complexity and diversity of the regarded biotope type (Wrbka et al. 2002). In order to adapt this value to the different biotopes, it was attuned to each biotope specific attributes (e.g. habitat area, networking function, species diversity, structural diversity) and was finally classified in an ordinal scale (Hermann 2006). The higher the biotope value the higher the ecological value of the regarded biotope. Thus the biotope value enabled an identification of ecologically important biotopes.

3.3.3 Plant communities

The vegetation data have been classified to the Austrian plant communities (Grabherr et al. 1993; Willner et al. 2007).

4. Results

4.1 Landscape structure analysis

4.1.1 Land use type

In total, 212 landscape elements have been mapped. The LCS contained 77 landscape elements, the MCS 76 and 59 belonged to the HCS. Although the LCS contained most landscape elements, their land use diversity was lower than in the other two classes **(tab. 1)**. A significant difference between the complexity classes existed only between LCS and HCS **(tab. 1)**.

Tab. 1 Shannon index and t-values of land use types, (p=0,05). (source: authors)

	low complex sites	medium complex sites	high complex sites
Shannon-Index of land use types	2,09	2,40	2,68
variance	0,02	0,03	0,01
	"low" - "medium"	"medium" - "high"	"low" - "high"
t-value	-1,42	-1,41	-3,12
degree of freedom	151,59	131,79	135,44

*4.1.2 Patch origin and persistence **(tab. 2)***

Whereas the lcs and mcs were identified to be dynamic regarding their farming intensity, the high complex sites were more conservative cultural landscapes (CPL 4 30 %). Approximately more than half of the area of the hcs were characterised by mild and periodic anthropogenic disturbance with long intervals. By contrast the lcs and mcs were dominated by mild and periodic disturbance in short intervals. The hcs contained all in all 34 % resource patches (in comparison: lcs: 10 %, mcs 15 %).

Tab. 2 Percentage of the total area of structural attributes of the landscape elements of the three classes of complex study sites. (source: authors)

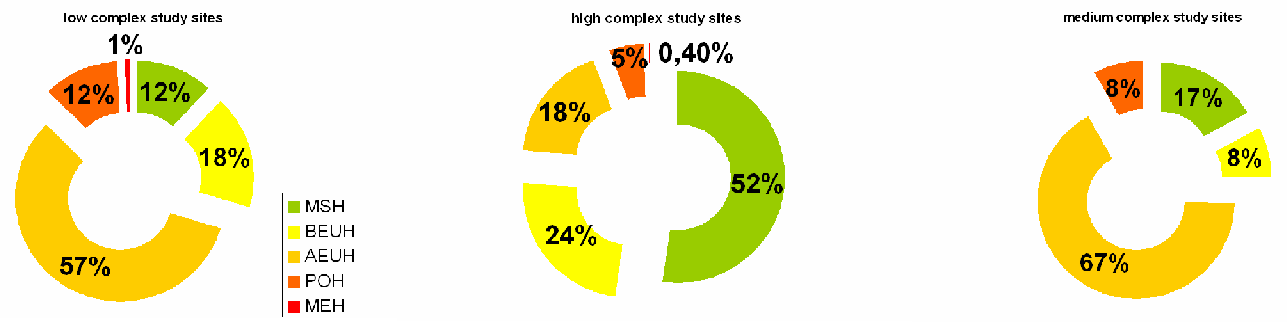
code	low complex sites	medium complex sites	high complex sites
CPL1	6.%	7%	2%
CPL2	23.%	12%	15%
CPL3	69.%	77%	53%
CPL4	2.%	4%	30%
DIA1	1.%	0	0
DIA2	15.%	16%	53%
DIA3	69.%	60%	20%
DIA4	9%	17%	5%
RGL1	0,03%	0	3%
RGL2	15%	8%	9%
RGL3	0,43%	1%	0
RGL4	0,20%	5%	2%
RNR2	0	0,8%	3%
RNR3	0	0,3%	0
RNP2	0	2%	14%
RWD2	0	2%	14%
RWW2	10%	0,7%	3%
RWW2	0	0,3%	0

Note: CPL (change of persistent landunits), DIA (anthropogenic disturbance), RGL (the actual and potential regeneration state), RNR (resource nutrient rich), RNP (resource nutrient poor), RWD (resource water dry) RWW (resource water wet).

4.1.3 Hemerobic value

Whereas the lcs showed similar values of hemeroby to the medium complex sites **(fig. 2)**, the hcs differ a lot. Landscape elements classified as alpha-euhemerob dominated in the first two categories (lcs and mcs). There was a slight increase of mesohemerob and a decrease of polyhemerob elements at the mcs in comparison to the lcs. Approximately the half of the total area (52 %) of the hcs are mesohemerob.

Fig. 2 Hemerobic values of the three classes of complex study sites. (source: authors)



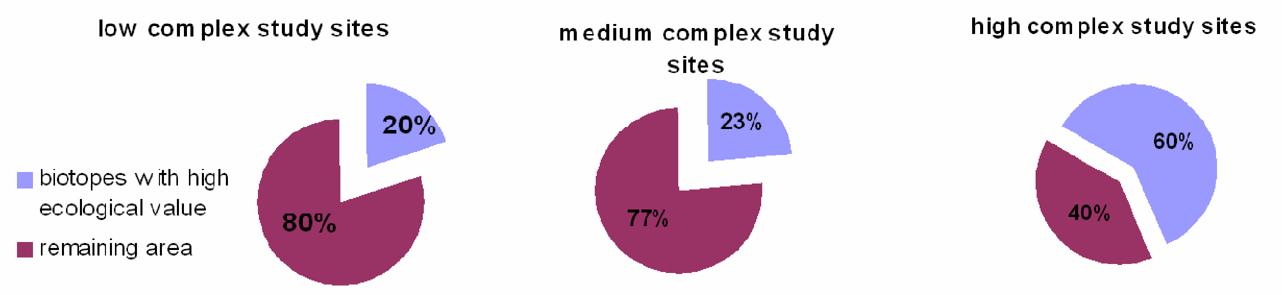
Note: MSH (mesohemerob), BEUH (beta-euhemerob), AEUH (alpha-euhemerob), POH (polyhemerob), MEH (metahemerob).

4.2 Habitat mapping analysis

4.2.1 Biotope value

The lcs and mcs consisted of approx. equal percentage of area of biotopes with high ecological value. Among the hcs more than half of total area was identified as biotopes with high ecological value. **(fig. 3)**. Whereas the highest value was 7, which was assigned to the lcs, two of the biotopes among hcs reached the biotope value 13 **(tab. 3)**. All in all the hcs obtained also the highest sum of biotope value (209).

Fig. 3 Percentage of area of the biotopes with high ecological value for each complexity class. (source: authors)



Tab. 3 Number of biotope values for each complex class. (source: authors)

low complex sites	
biotope value	number
3	10
5	8
6	1
7	5
sum of biotope values	**111**

medium complex sites	
biotope value	number
3	6
5	5
6	2
7	8
9	2
10	1
11	3
sum of biotope values	**172**

high complex sites	
biotope value	number
3	4
5	4
6	2
7	7
8	2
9	7
11	1
13	2
sum of biotope values	**209**

4.2.2 Endangerment

All three classes showed similar results according to their endangerments. The lcs were characterised by a high number of "current" and "potential" endangerments. The hcs had the lowest number of potential endangered biotopes, but a relative large amount of "current" endangerments **(tab. 4)**.

Tab. 4 Number of current and endangered biotopes for each complex class. (source: authors)

	number of "current" endangered biotopes	**number of "potential" endangered biotopes**
low complex study sites	47	65
medium complex study sites	36	47
high complex study sites	41	31

4.3 Vegetation analysis

Lcs were characterised by nutrient rich communities *(Pruno-Ligustretum sambucetum nigrae* 7%). The mcs contained of plant communities with higher vascular plant-diversity (*Filipendulo vulgaris-Arrhenatheretum,, Polygalo majoris-Brachypodietum pinnati*) **(tab. 5)**. *Tanaceto-Arrhenatheretum,* a community of ruderal plants on fallows could be found in all three classes with a high percentage of area.

Tab. 5 Percentage of area of the selected plant communities for each complexity class. (source: authors)

	low complexity	**medium complexity**	**high complexity**
total area of the selected plant communities in m2	17713	13084	32821
fallows, boundary ridges			
Erigeronto-Lactucetum serriolae			2,00%
Tanaceto-Artemisietum vulgaris	2,00%		
Chaerophylletum aromatici			1,00%
Humulus lupus-Gesellschaft			0,29%
Phragmites australis-Gesellschaft		0,30%	
Clematis vitalba-Gesellschaft	1,00%	0,32%	
Rubus caesius-Gesellschaft		1,00%	
meadows			
Filipendulo vulgaris-Arrhenatheretum		2,00%	4,00%
Tanaceto-Arrhenatheretum	4,00%	4,00%	**10,00%**
Cirsio-Brachipodion pinnati			1,00%
Polygalo majoris-Brachypodietum pinnati			**5,00%**
hedgerows			
Pruno-Ligustretum typicum		2,00%	**7,00%**
Pruno-Ligustretum sambucetum nigrae	**7,00%**	3,00%	1,00%
Roso-Ulmetum campestris	1,00%		1,00%
Crataego-Prunetum spinosae cornetosum sanguinei	2,00%		
Chelidonio-Robinetum	1,00%	1,00%	
Carpinion betuli			1,00%

4.4 Comparison of methods

When comparing the three different methods (landscape mapping, habitat mapping and vegetation inventory) for assessing ecological value, it was obvious that the results were a bit different. According to the land use types, there existed only a significant difference between lcs and hcs **(tab. 1)** Whereas the output of the landscape mapping analysis **(fig. 2 and**

tab. 2) of the lcs and mcs didn´t differ a lot, the results of habitat mapping showed a more differentiated dataset **(tab. 3)**. This selective biotope evaluation carried out the ecologically valuable biotopes which were of great interest for nature conservation. The biotope values of the three classes differed clearly of each other. Whereas the lcs consisted of biotopes of lowest biotope value, the hcs represented biotopes with the highest biotope values. The hcs provided a higher amount of ecologically valued biotopes **(fig. 3)**, but these sites are commonly endangered **(tab. 4)**.

The plant inventory provided more information on biodiversity within the selected biotopes and allowed therefore a more specific classification. In comparison to the hcs, the lcs and mcs featured more ruderal plant communities. The hcs consisted of larger biotopes with plant communities of higher ecological value **(tab. 5)**. The higher number of resource patches among hcs **(tab. 2)** were also qualitatively reflected in the occurrence of certain plant communities (eg. Cirsio Brachipodion pinnati, Polygalo majoris Brachipodietum pinnati).

5. Discussion

5.1 Relationship between Landscape structure and biodiversity

The primary classification of landscape complexity based on the interpretation of orthofotos could be partly affirmed by ground truthing. Whereas the differences between lcs and hcs are significant, the characterisation of mcs are not clearly defined. There exists a relationship between landscape structure and ecosystem functionality, which is also proven by other authors (Schindler et al. 2007).

The lcs are characterised by a fragmented matrix. Although they consist of the highest amount of landscape elements, land use diversity is low. Benton et al. (2002) claim that fragmentation of remaining natural habitat is major cause of extinction of fragmented, small and isolated populations. In this study the relationship between landscape structure and species richness wasn´t directly investigated, however hemeroby and biotope values provide applicable indicators for assessing biodiversity (Peterseil et al. 2004; Wrbka et al. 2003a). As the lcs consist of more polyhemerob and metahemerob landscape elements than the more complex sites and obtain only biotopes with low ecological values, it can be affirmed that low landscape complexity doesn´t enhance biodiversity. Agricultural land use intensification may not only increase extinction of species, but also more resource enhancing populations (Tscharntke et al. 2005). Also in this study the lcs contain ruderal and nutrient rich plant communities. By contrast the hcs consist of the largest area of ecologically valuable biotopes with high plant diversity. Many other studies have also shown a positive effect of heterogeneous landscape on species richness (Robertsson et al. 1990; Weibull et al. 2000; Schneider, Fry 2001). The increase in species richness with landscape heterogeneity can partly be explained by the fact that the number of habitats often increase with heterogeneity (Rosenzweig 1995), which can also be demonstrated in this study.

5.2 Nature conservation

This study highlights ecologically valuable biotopes and their endangerment. Lcs and mcs are mainly characterised by alpha-euhemerob landscape elements. This phenomenon is due to the fact that these landscape elements are mainly affected by the proceeding urbanisation. More and more vineyards are converted to land for building, lie fallow or they are intensively managed in order to carry a high yield. The hcs which are embedded in more rural areas, consist of a large mesohemerob area and are represented mainly by old orchards, extensively managed meadows and vineyards. Although we found a high amount of biotope with high ecological values among these sites they are in danger to disappear.

In order to protect the ecologically valuable biotopes it is important to distinguish between the 3 categories of landscape complexity in regard to the conservation strategies. As the hcs consist of the largest mesohemerob area and of the highest amount of ecologically valuable biotopes, nature conservation should concentrate on these sites, in order to maintain biodiversity.

Although the landscape sites in Lower Austria are embedded in a landscape protection area and all landscape sites are situated in the biosphere reserve Wienerwald, according to the results several biotopes are in danger to disappear. As agri-environment schemes are often applied to small patches of land, such as field boundaries, they provide an applicable possibility for nature conservation (Wrbka et al., in press). One of the main aims of agri-environment schemes is to increase biodiversity on farmland. The EU and Austria finance environmental measures of farmers via the Austrian Environmental Programme ÖPUL. There exist different measures, which can be engaged (see BMLFUW 2006). However recent evaluation studies (Wrbka et al. 2007) have shown that the strategies which are relevant for nature conservation are not well accepted by farmers. Maintenance of biodiversity and ecosystem functioning requires closer collaboration with farmers (Jackson, Jackson 2002).

6. Conclusion

We can verify that landscape mapping analyses provide accurate and useful information about patch genesis and about their human impact. However, to identify high ecological valuable biotopes, so called "hot spots" in agricultural landscapes, habitat mapping is indispensable. The combination of landscape mapping analysis and biotic data provides an applicable tool for ecologically valuable assessments of agricultural landscapes.

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Risk analysis of riparian trees and large woody debris in the managed river ecosystems

(case study from the National park Podyjí, Czech Republic)

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Abstract

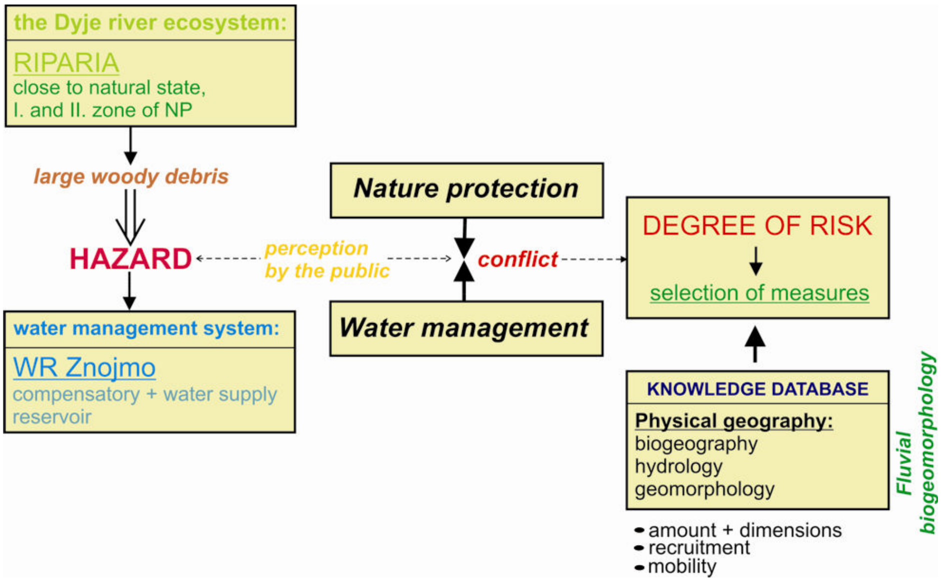
Riparian trees and large woody debris (LWD) have become recently the subject of research also in the Czech Republic. The presented paper deals with the mapping and measurement of LWD in the riparian zone of the Dyje River upstream of the water reservoir Znojmo. The main objective of the study was to find out the number, dimensions, volume and spatial distribution of individual LWD pieces as well as LWD accumulations. Mapping of the LWD was initiated by the hazardous situation during the flood in March 2006, when the large amount of woody debris was transported to Znojmo reservoir and threatened its earth dam. Mapping in the 3.4 km long stretch of the Dyje River showed the presence of 1 108 pieces of LWD which represents 215 m^3 of tree biomass. Altogether 110 wood jams are present which are located within the riparian zone. Transport potential of the river during floods is high, however, highly sinuous valley morphology and well developed riparian vegetation inhibit the transport of LWD for long distances.

Keywords: riparian vegetation; large woody debris; fluvial ecosystem; national park Podyjí/Thayatal; Czech Republic

1. Introduction

It is possible to perceive the increased research interest in the various aspects of river landscapes among the Czech scientific community in the recent years. One of the themes that is paid attention to is the riparian woody vegetation and dead wood biomass, which originates in the riparian zone and which is then stranded along the river banks or enters the stream and river channels. The phenomenon of the in-stream large woody debris become more familiar even among the general public during the catastrophic floods of 1997, 2002 and most recently 2006, when large volumes of wood was transported and accumulated in rivers and streams and also on water constructions (e.g. dams, weirs) (see e.g. Hrádek 2000; Kožený, Simon 2006). Public attention was especially drawn to the inflow and accumulation of extensive amount of wood to the water reservoir Znojmo at the end of March 2006, when extreme flood caused by the fast snow melt occurred. Wood was transported from the territory of the national park Podyjí, where river banks are covered by the stands free of forest management at almost entire length. The conflict arose between the state nature protection agencies and water resources managers; the analysis of the situation components is presented in the fig. 1.

Fig. 1 The analysis of the situation showing the conflict elements of water management system Vranov – Znojmo (reservoir dam versus large woody debris) and the position of the involved parties… (source: authors)

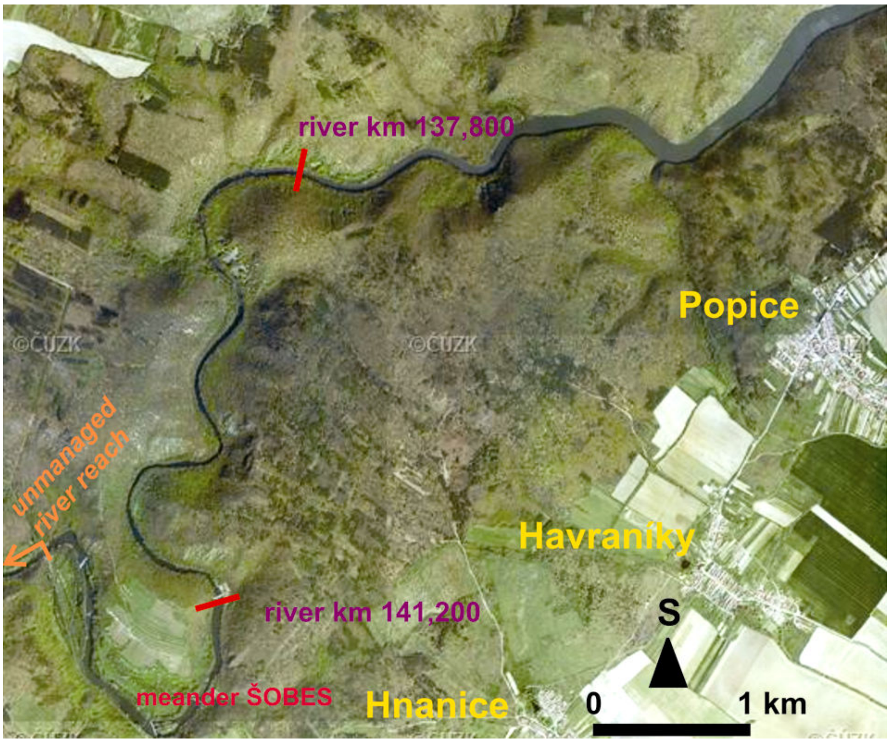


Note: [title continues] …which are the River authority the Morava drainage basin and the headquarters of national park Podyjí as the authorities representing the state governance upon the region. Scheme also shows the importance of the knowledge base about the phenomenon of large woody debris, which may be supplied by the academic sphere.

2. Historical context of floods and riparian vegetation management

The large flood occurred on the Dyje River at the end of March 2006, which culminated at the gauging station Vranov nad Dyjí just downstream of water reservoir Vranov with the discharge 306 m^3/s on 31st of March. The Dyje River is canalised below the water reservoir and its capacity is designed for the conveying of the discharge 150 m^3/s, further downstream within the territory of the national park the natural channel has the capacity 50 m^3/s. The amount of water flowing through the national park was determined by the manipulation on the water reservoir Vranov, whereas the inflow to the reservoir was in the day of flood culmination 485 m^3/s, which is considered to match the 500 year flood. Thus, the water reservoir decreased the flood wave by 37 % (Ogink 2006). The flood which attacked the valley floor of the Dyje River then transported the excessive amount of woody debris into the water reservoir Znojmo, which is located 42,5 km farther downstream. The Znojmo water reservoir has an earth dame with the height of 28,87 m and length 115 m. Floating wood covered the water level in the area behind the dam and threatened with the blockage of the dam outflow. The apprehension arose about the overflow and damage (erosion) of them earth dam. The similar situation arose already in August 2002, when according to the personal communication with the dam staff the single tree blocked the dam outflow, which was removed during the flood only with big difficulty. River authority (Morava drainage basin authority, state company) subsequently undertook as a reaction to this hazardous situation the clearance of the bank vegetation at the territory of the national park in the years 2002 to 2004. The amount of cleared wood biomass equalled 1 200 m^3.

Fig. 2 The location of the studied river reach within the national park Podyjí west of town Znojmo. (source: authors)



The volume of wood deposited in the water reservoir was counted by the workers of the T.G. Masaryk Water Research Institute immediately after the ceasing of the flood wave (Kožený, Simon 2006). They assessed the amount of deposited large woody debris (minimal diameter 0.1 m and minimal length 1 m) by the image analysis of a series of the oblique ground photos. They concluded that water reservoir contained 1 250 pieces of large woody debris with estimated volume 80 m^3. An interesting outcome of the analysis was that 49% documented pieces of large woody debris were cut by the chain saw, which means that substantial amount of wood had human origin. On the contrary, only two snags with complete root balls were identified on the whole water level of the reservoir. There were identified broken trunks or branches in 17 % of all cases, in other cases it was not possible to identify from the photographs the form of the wood. The large woody debris pieces have in most cases rather small dimension. Most frequent are short pieces with the length less than 2 m. The clear output of the study is that substantial proportion of deposited wood has its origin in the cutting of riparian forest, which was done by the river authority after the flood in the year 2002. The trunks cut into shorter pieces and let on the place to be rotten were mainly transported by the flood and deposited in the water reservoir.

3. Research methods

The aim of this work was to enhance the knowledge about bank and floodplain woody vegetation and dead wood lying in the river channel and on the floodplain surface at the territory of the national park Podyjí with main emphasis on the risk of wood floating to the water reservoir Znojmo. Thus, we focused mainly on the quantity, dimensions, spatial distribution and potential mobility of large woody debris which is present in the channel and riparian zone of the Dyje River.

Mapping and measurement of large woody debris was done in September and October of 2007 in the river reach between large incised meander Šobes and the beginning of the water reservoir Znojmo (river km 137,800 to 141,200). The recruitment of wood is possible from all the territory of the national park, however, the river reach just upstream of the water reservoir was probably the most important source of the deposited wood. That is the Dyje valley is very sinuous with distinctive incised meanders and there is high probability that large pieces of wood will be captured on the concave banks of meanders and the transport distance will be thus rather short. We divided the study river reach into the 100 m long segments and we made the detailed mapping and documentation of all large pieces of wood in each segment, including wood accumulations. We recorded mainly the structural parameters of large woody debris: number, dimensions, orientation to channel axis, vertical angle, degree of decay, presence of root ball, whether it was logged tree (i.e. cut by chain saw) or not, position within the river corridor, tree species, and whether the wood was of local origin (autochthonous) or brought by the river flow (allochthonous). All wood pieces for which the stub or source tree could not be find were considered as allochthonous, no matter what distance they were transported. In the case of wood accumulations, we measured the dimensions of block with the best fit to the shape of accumulation, number of wood pieces included in the accumulation and possibly, if conditions allowed, we measured dimensions and volume of each individual wood piece in the accumulation.

4. Results and discussion

The mapping showed that in the study reach are present altogether 1 108 pieces of large wood, which represents the volume of 215 m^3 wood biomass. This amount surpasses more than twice the estimated volume of wood deposited into the water reservoir Znojmo in March 2006. The selected characteristics of large woody debris are displayed on **fig. 2 and 3**. High mobility of wood is indicated by the high proportion of alochtonous (transported by the river) wood pieces all over the studied river reach. In most of the 100 m river segments more than half of wood was brought and deposited by the flood. The high degree of mobility is also illustrated by high number of wood accumulations, altogether 110 accumulations were recorded (40 on right bank and 70 on left bank). The largest accumulations consisting of mixed material of logs and finer organic debris were found immediately upstream the backwater of the Znojmo water reservoir. There is high potential for wood mobility and transport on the Dyje River because the channel width is substantially wider than the height of the trees which enters the river. Thus trees may not be easily trapped between the river banks. High transport potential of the river during the floods is also indicated by the fact that in the channel itself were found only 34 from the overall number of more than 1 000 wood pieces. There were recorded another 84 wood pieces which partially protruded into the channel. The remaining amount of large woody debris was trapped in the riparian woody vegetation.

From the above mentioned results is possible to induce that the potential of the river for the wood transport is very large, nevertheless, wood is not moved for log distances because it is effectively trapped on the concave banks or river meanders (positive influence of valley morphology) and also captured within the riparian vegetation outside the channel (positive influence of riparian forest). The influence of channel plan-form is well evident when comparing the number of wood pieces captured at right and left river bank. We recorded almost twice more wood pieces on the left bank, where concave banks predominates. Thus, the initial presumption was confirmed, that during flood transport wood is forced against concave banks, where it is caught in riparian woody vegetation. An unfavourable factor is that large portion (85 %) of wood pieces has not its root ball preserved; root ball can stabilize fallen tree by its weight and shape and protect it against floating away. It is also worth to note that 30 % of large wood pieces were cut by a chain saw.

Fig. 3 – Plots showing the distribution and quantity of large woody debris in the studied reach of the Dyje River separately for right and left river bank (river km 137,800 to 141,200), ratio between the number of individual and accumulated wood pieces, number of wood accumulations and ratio between autochtonous (local) and alochtonous (floated) wood pieces. (source: authors)

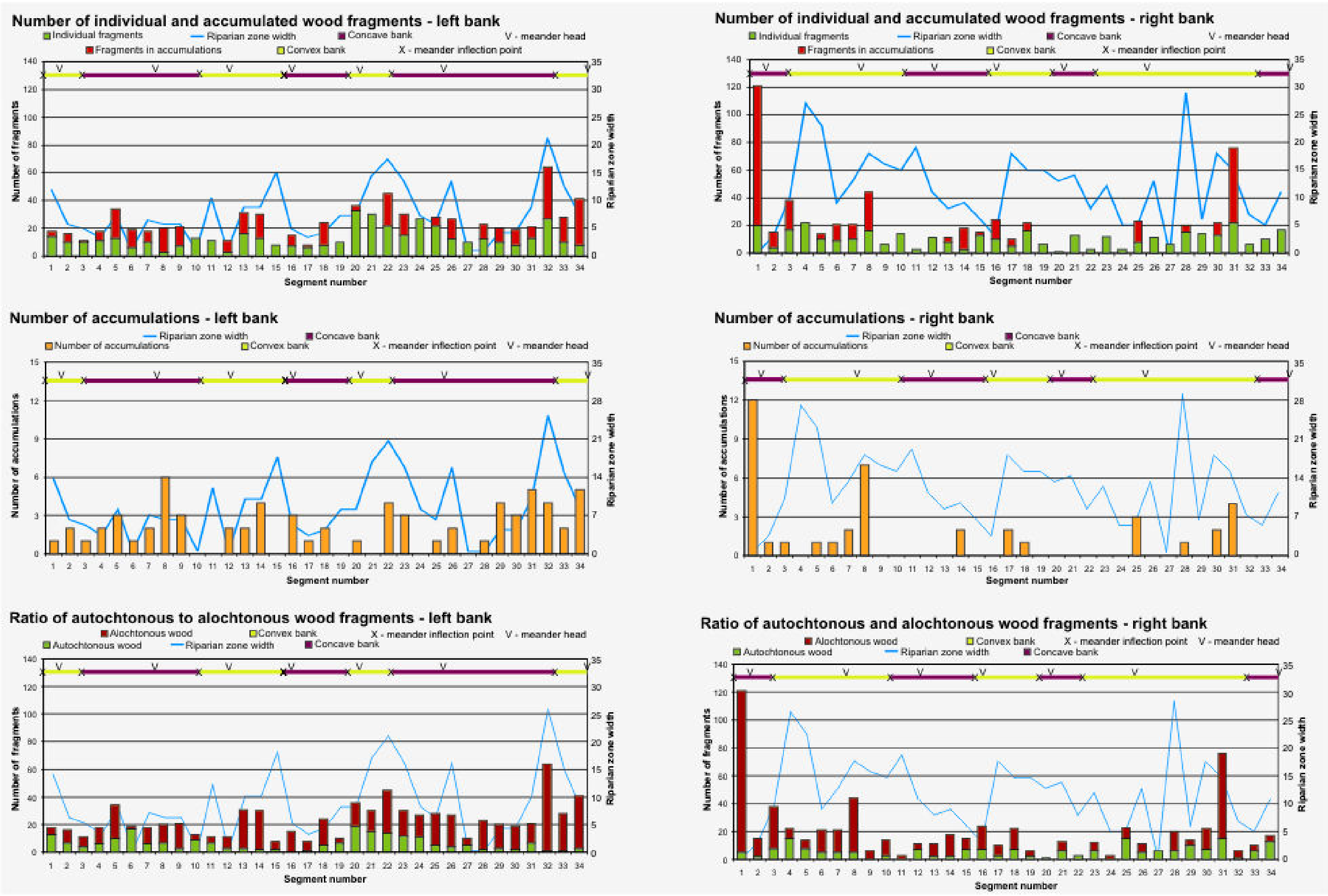
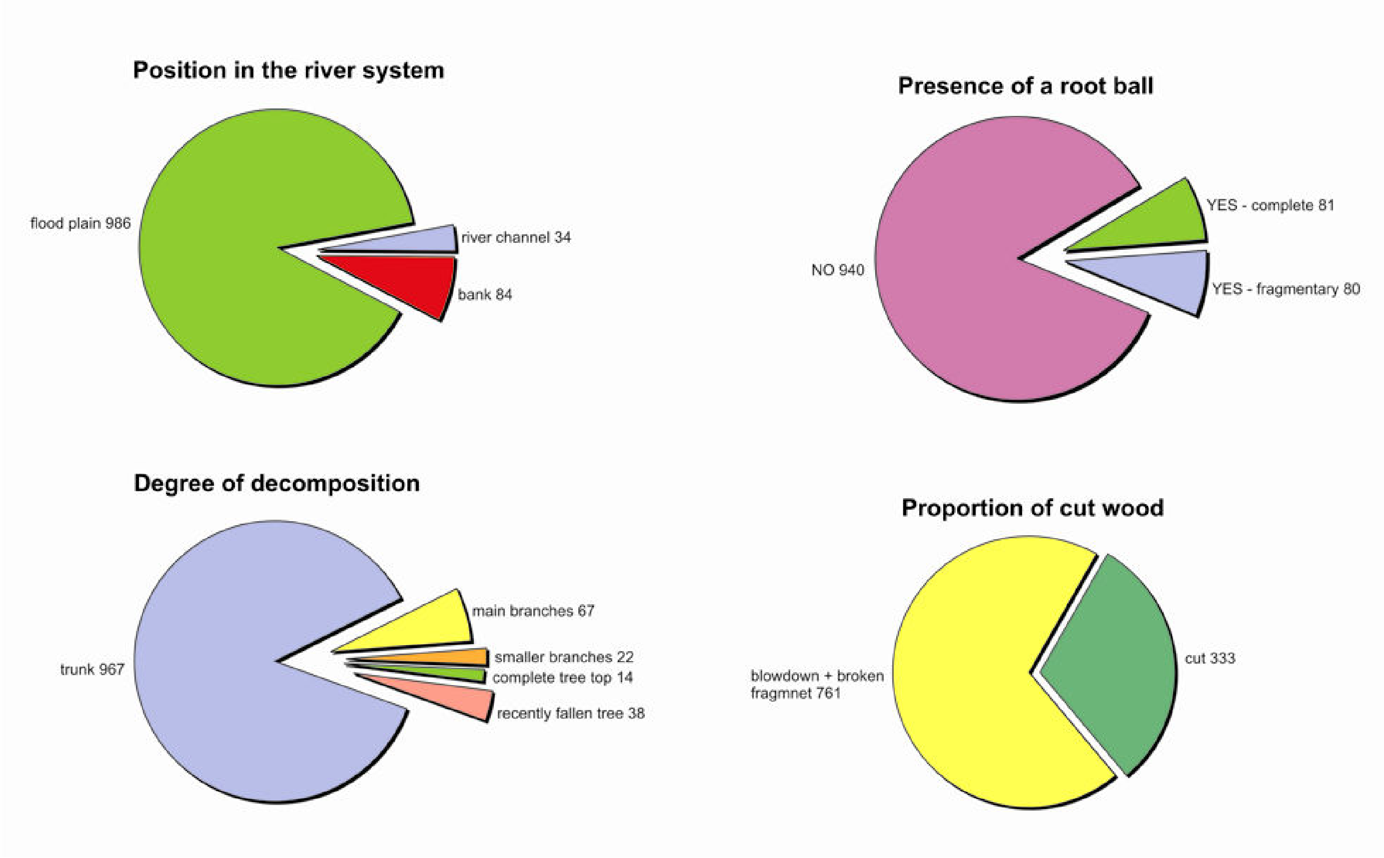


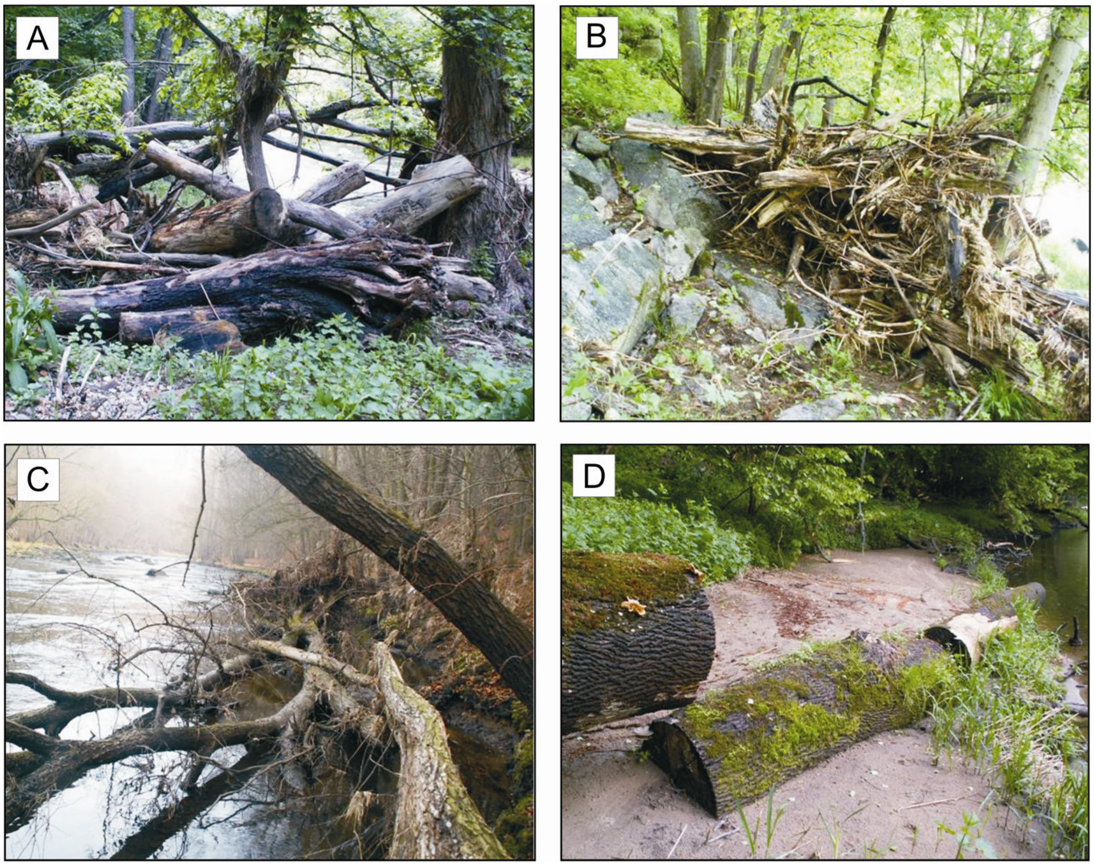
Fig. 4 – Plots showing the selected characteristics of large woody debris in the studied river reach (river km 137,800 to 141,200); indicated is the position of the wood in the river corridor, presence of the root ball as a stability indicator, degree of decay and the proportion of wood pieces cut by chain saw indicating human influence. (source: authors)



5. Conclusions

From the point of view of the safety of the water reservoir Znojmo and in the same time ensuring the conservation goals of the national park it seems reasonable not affect riparian vegetation by adverse management practices like logging. Riparian forest has large importance for capturing the floating woody debris during floods, and impede further transport of wood downstream. Trees that lean towards the channel and threaten to fall to the river can be cut and let decaying in the riparian zone. Respectively, it is possible to anchor them behind the wooden pilots and place them in such an orientation to form an obstruction for further wood floating during floods (i.e. perpendicularly to the axis of the channel). It is dangerous to cut fallen trees to smaller pieces which are let at ground for decay. Though, such a wood is not much hazardous for obstructing the outlet of the water reservoir dam, nevertheless, if the complete tree with a tree top and root ball is let lying on the ground to slowly decay, it is almost impossible to float it away during a flood. Thus, fallen trees may conduct important ecological functions in the riparian ecosystem without threatening the Znojmo water reservoir. Trees which fall directly to the river channel can be fixed to the large stones by steel rope or by wooden pilots injected to the channel bottom.

Fig. 5 – Examples of the forms of large woody debris in the studied river reach of the Dyje River (river km 137,800 to 141,200). (source: authors)



Note: A: log jam formed by the wood trapped in the riparian forest, B: small wood accumulation consisting predominantly from fine organic debris which originated between the rocky foot slope and the tree of riparian forest, C: a cluster of freshly uprooted trees to the river channel, the cluster is oriented parallel with the direction of the river flow, D: transported wood fragments which have been left behind in the floodplain by the river authority after the logging of riparian zone after the 2002 flood.

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What threatens landscape heterogeneity of peat lands of Biela Orava catchment?

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Abstract

The research was focused on vegetation and the mapping of peat lands in the Biela Orava catchment Only few mosaics of peat lands have been preserved there, including three large separate bogs which were listed into NATURA network in 2004 as candidate Sites of Community importance as “Bogs of Biela Orava”. The phytosociological sampling was carried out and other ecological conditions as a quality and a level of underground water (pH, conductivity), threats of peat land, and realization of management measures were observed as well. Most of the peat lands are not utilised anymore and are threatened by succession. The main threats of peat lands are connected with underground water level declining, as a consequence of reclamation of near-by agricultural plots, straightening of the Biela Orava river trough, climate changes etc.

Keywords: monitoring; peat lands; favourable conservation status; management; threats

1. Introduction

The natural resources of the Biela Orava catchment (gentle slopes, weak permeable substrate, and humid climate) have made possible the creation of extensive peat lands and other types of wetlands. A large part of the peat lands were destroyed or affected by agricultural reclamation. Only few mosaics have been preserved there, including three large separate bogs which were listed into Natura 2000 network in 2004 as Sites of Community importance (SCI) - “Bogs of Biela Orava” The research was focused on vegetation and the mapping of peat lands. The favourable conservation status of habitats was assessed and the major threats and driving forces of their biodiversity changes was studied.

2. Regional setting

The Horna Orava region belongs among the three most important peat land areas in Slovakia. Although a large part of the peat lands were destroyed as a consequence of change to agricultural land (mainly at the end of 60's to 70's in the 20th century), peat mining or flooding as a result of the building of the Orava dam (1953), up to now, raised bogs, transitional bogs, fens and an extensive complex of swamp bog forests have been preserved here on the area of approximately 520 ha. The Biela Orava catchment is situated in the west part of the Protected landscape area (PLA) of Horna Orava. Catchment area is formed by Biela Orava River and its main tributary rivers: Mutnanka, Veselovianka and Klinianka. Peat lands have been preserved as small remnants especially at the alluvium of these rivers. The three large "Bogs of Biela Orava" are: Mutne peat bog, Beňadovo peat bog and Klin peat bog. The areas have been protected by national law: Klin peat bog since 1967, Beňadovo peat bog since 1974 and Mutne peat bog since 1979.

3. Materials and methods

The phytosociological sampling of peat lands was carried out in Biela Orava catchment area since 2001 by methods of the Zürich-Montpellier school. Other ecological conditions as quality (pH, conductivity) and level of underground water, threats of peat land, and realization of management measures were observed as well For the determination of main threats of peat lands, the species richness and favourable conservation status of the habitats was evaluated on the basis of their species composition Favourable conservation status (FCS) of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory (Directive 92/43/EEC).

For the assessment of FCS of peat land, five criterions reflecting species composition and environmental conditions were used (Polák, Saxa et al. 2005): specific horizontal and vertical structure (typical species), locality threats (invasive species, wood and shrubs cover), natural distribution and area size. Each evaluated site has been allocated to one of the following categories, providing an indication of direction of change as well as its current state:

- *Favourable condition* - maintained (A), good or recovered (B)

- *Unfavourable condition* - partially destroyed (C), destroyed (D)

Habitats, which were not representative for assessment of FSC because of absence typical species or small size, were labelled as non-evaluated category (E). Some available historical data, the information relating to the management of the area as well as other activities provided in the vicinity of the peat land was taken into consideration as well. The effect of management measures was monitored in detail at Mutne peat bog in 2007

4. Results

The non-forest peat lands in Biela Orava catchment has been preserved only as a small remnants or isolated islands in agrarian landscape. Together 46 phytosociological releves were done.

Heterogeneity of mapped peat lands such as active raised bogs, alkaline fens, transition mires, wet meadows and quaking bogs were dependent on ecological condition, especially pH and conductivity. These semi-natural habitats, characteristic of the Western Carpathian province, are significantly marked by human influence. Peat lands are represented mainly by communities of bogs of the sub-continental region of Europe: class *Oxycocco-Sphagnetea,* order *Sphagnetalia medii,* and fen communities, class *Scheuzerio-Caricetea fuscae,* order *Caricetalia fuscae,* alliances *Caricion fuscae, Caricion davallianae, Caricion lasiocarpae, Sphagno warnstorfiani-Tomenthypnion.* A part of the alluvial deposit is covered by wet peat meadows, alliance *Calthion.* The sites support with populations of many rare, vulnerable, and endangered species of plants and animals as well as habitats which are threatened at national, European and/or global levels.

The list of Annex I habitats (Habitat Directive):

7110* Active raised bogs - Klin peat bog is one of the largest and most significant raised peat bogs in Slovakia, Mutne peat bog

7120 Degraded raised bogs – Klin peat bog, Mutne peat bog

7140 Transition mires and quaking bogs – Benadovo peat bogs represents one of the most preserved transition mires in Slovakia, several smaller mires preserved at Mutnanka and Klinanka river alluvium.

7230 Alkaline fens – remnants of well preserved alkaline fens at Menzdrovka site (the cadastre of the Novot village) and at the end of the cadastre of the Lomna village.

The most rare non-forest habitats are relics of fens of alliance *Caricion lasiocarpae*, with occurrence of many rare, endangered species or glacial relics (Dítě, Hájek 2004), existing at Mutne and Benadovo peat bog.

The number of species, as the simplest way of expressing species richness, was used for the assessment of biodiversity. Although the number of species (13 or more) was low in some habitats, it should be noted, that some vulnerable habitats on the acid peat are characterized by naturally low species richness, e.g. raised peat land classes *Oxycocco-Sphagnetea,* acidic fens alliance *Caricion fuscae.* Higher species richness (more than 40 species) was recorded at humid meadows alliance *Calthion* as well as transition mires alliance *Caricion lasiocarpae and* alkaline fens alliance *Caricion davallianae,* which occurrence is very rare.

4.1 Favourable conservation status

The assessment of favourable conservation status has been done for all important habitats of Habitat Directive. Each feature on each site was allocated to one of the 4 categories of FCS **(fig. 1)**. Most of the releves were allocated to the category B (good favourable condition) or C (unfavourable partially destroyed condition). Other releves were allocated to the category D (unfavourable destroyed condition), or were not evaluated, because of small size or insufficient number of typical species (category E). They are shown on the map as well, to have an overview as their natural range and areas has been decreasing from the past to the present. Favourable maintained conservation conditions were observed only in transition mires and quaking bogs of *Caricion lasiocarpae* (Benadovo, Mutne peat bogs) and in forest habitats as mixed ash-alder alluvial forests or bog woodland in the north part of Biela Orava catchment area (Spaleny grunik site, Zlatna site).

Threatening of the most important peat land localities:

- Klin peat bog – large, well-preserved peat bog, threatened by drainage system in the vicinity of the area, overgrowing by trees, succession of birch juveniles etc.

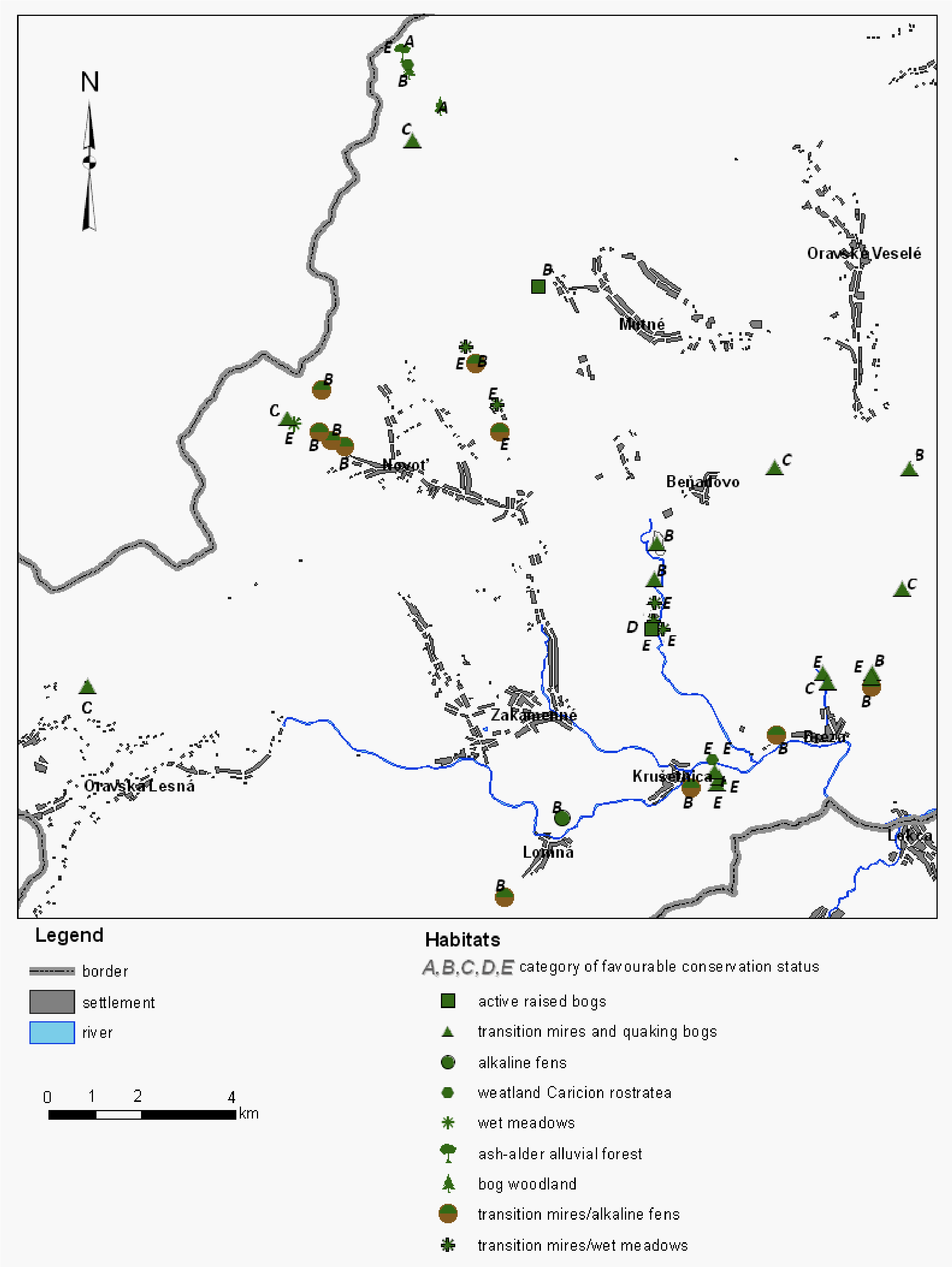
- Mutne peat bog - well preserved active raised bogs with a mosaic of alkaline fens, transition mires and quaking bogs, threatened by succession and decreasing underground water level.

- Beňadovo peat bog, Zakurcinka, Kozubka, Riečka, Bršlica, Tanecnik etc. – transition mire, fens and wet meadows, threatened by abandonment and next succession.

- Lomna, Breza localities – peat land in the vicinity of settlement threatened by reclamation of the surrounding area and by expansion of building area within the cadastre of the village.

As major threats to peat land biodiversity were identified decrease of underground water level, due to existing channel and network of other ditches within the peat bog areas or as a consequence of reclamation of surrounding agricultural plots, straightening of the Biela Orava river trough, climate changes etc. Most of the peat lands and their vicinities are affected to some extent by intensive or extensive agriculture and/or forestry. A disturbed hydrological regime, which is one of the most important conditions for the existence of peat lands, is often a consequence of these unnatural activities and is connected with overgrowing and succession of peat land. Abandonment and succession is other major threat, e. g. succession of *Molinia caerulea, Deschampsia cespitosa* or juveniles and self-seeding of *Pinus sylvestris, Populus tremula, Betula pubescens, Salix sp.* etc. or other autochthonous expansive species, which are more competitive.

Fig. 1 Assessment of favourable conservation status of peat lands. (source: author)



4.2 Management of peat lands

After designation of peat lands as protected areas, they were not managed by land owners any more. Some management measures were undertaken by State nature conservancy administration body (SNC), but it was very irregular and insufficient in dependence on financial sources.

Preparation of management plan of "Biela Orava peat bogs" was carried out in 2001-2002, coordinated by the DAPHNE organization within the project "Conservation and Sustainable Use of Peat lands in Slovakia". On the basis of ecological study, some management measures for improving the hydrological regime were performed, such as building barriers on brooklets, filling the ditches, cutting trees, and mowing. The effect of these measures was monitored in 2007 within the project "Conservation and management of non-forest habitats in the agrarian landscape", supported by the Slovak Research and Development Agency.

The result of the monitoring, which was focused on the efficiency of undertaken management measures, can be summarized to the following conclusions:

- The management measures, undertaken at the peat lands for improving ecological conditions and increasing water level were partly successful, but it is necessary to carry out them regularly.

- By building barriers on brooklets at the Mutne peat bog, the underground water level has increased only locally, and the vegetation restoration on ditches was quite successful.

- By mowing fens and wet meadows, population of some critically endangered species has been vitalized (e.g. *Dactylorhiza* species at Mutne peat bog, *Carex chordorrhiza* at Benadovo peat bog, etc.).

- By cutting trees the microclimate has changed slightly, which can affect the dehydrating of bogs and the expansion of trees self-seeding.

- After single-shot shrub cutting at Benadovo peat bog, new sprouts have grown and multiplied. Such single-shot or non-regulated management can lead to creating thick compact shrub bushes and the extinction of non-forest peat lands.

- Any undertaken measures as cutting trees and shrubs, mowing meadows and fens, seems to be insufficient, if the main reason of declining underground water level persists.

It is in the interest of nature conservation to maintain these threatened peat land habitats and to stop the threats of succession processes by relevant management measures such as regular mowing, cutting trees, filling ditches, etc. The most appropriate solution would be involvement of stakeholders to the regular peat land management. In general way, the management has been executed on agreement between SNC body and landowners or users, or by agreement with other bodies, if the landowners/users were not interested As the hay and biomass of fens and wet meadows is not very valuable for the farmers, the tool for the maintenance of the biodiversity of these habitats for the future could be support from agro-environmental scheme.

5. Discussion

According to the recent assessment of conservation status of threatened habitats, drainage and abandonment are by far the most common reasons for peat land habitat types being threaten. These threats cause, that the conservation status of almost half observed habitats was allocated as "unfavourable" (categories C, D, E).

The main responses are:

- its natural range and areas it covers within that range are not stable and decreasing, as a result of reclamation, disturbed water regime and succession.

- the conservation status of its typical species and specific structure of habitats is threatened by abandonment and competitiveness of expansive species, trees juveniles, as well as changes of ecological and microclimate conditions.

Restoration of peat lands seems to be very complicated process. During the previous years decades ecological conditions of peat lands has been changed and it is not easy to provide the restoration for peat land habitats. These changes were connected with land use changes, declining of underground water level etc. The sensitivity of peat lands as well as other wetlands as the world's most threatened ecosystems is proved by fact, that 50 % of all wetlands has disappeared in the last century. Despite global and national recognition of their importance, Europe's wetlands remain under severe pressure (CEC 1995). To halt biodiversity loss, many projects, plans, strategies, action has been undertaken to the conservation and wise use of wetlands. Several successful projects have been realized within the LIFE projects (the financial instrument for the environment, funded by the European Commission). Since 1992, LIFE has co-funded around 120 wetlands-related projects, oriented towards nature conservation, reflecting the biodiversity value of the wetlands habitats (EC 2007). Restoration is a continuous process from the decision to the monitoring. The feedback exchange between planners, managers and researchers is essential for the improvement and adjusting of methods (Aapala et al. 2008).

The implementation of the NATURA 2000 network has become a new challenge for the planning of sustainable compensation measures in wetlands (Dawson et al. 2003). In Slovakia, there are only few examples of best practice regarding to the sustainable management of wetlands. Some measures, which are necessary for reaching favourable conservation status of the protected habitats and species, are executing now by the nature protection bodies; preference is given to the cooperation with landowners or users. Up to day, there is not elaborated any management plan for Special Areas of Conservation (SAC's), included in the Natura 2000 network. Elaboration of management plan for SAC's is compulsory, as it is included in Act No. 543/2002 on Nature and Landscape Protection. Elaboration of management plans on the basis of research results could improve practical management and restoration of peat land localities not only in Slovakia.

6. Conclusions

To maintain the peat lands and improve favourable conservation status, it is important to know the value of these habitats, to plan their necessary management for improving ecological and hydrological conditions, and to carry out monitoring of activities and their impact on habitats. Restoration can be regarded as an ecologically important tool to improve the quality of protected peat land areas, but it requires an ecosystem perspective. It is essential to restore hydrological functional units that include the entire peat land ecosystem. The dissemination of the research results and activities oriented to the increasing environmental awareness of local inhabitants are also important issues for maintaining peat lands.

Acknowledgements

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Spatial data integration for land use change analysis of the Lower Morava Biosphere Reserve

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Abstract

The aim of the article is the evaluation of the applicability of the developed method of automatic geometric integration of land use vector layers for the conditions of the Lower Morava Biospheric Reserve. The input data were the land use vector layers gained through stepwise vectorization for the period of 1840-2006. The method of automatic geometric integration of land use vector layers to a certain extent tries to copy the process of the so called backward vectorization while using input data gained through stepwise vectorization, which it modifies. The aim of the method is to preserve the most accurate planimetry of identical borders during the whole period under study. For the development and a more detailed testing of the method, two model areas have been chosen while comparing the method outputs with the data of backward vectorization. The results confirm the use of the developed method as appropriate for the adjustment of the inputs of the multitemporal land use changes analysis of the area of the Lower Morava Biosphere Reserve. Data adjustment by means of the developed method almost four times reduced the occurrence of sliver polygons when creating the land use change map of the Lower Morava Biosphere Reserve, as opposed to untreated data.

Keywords: land use; spatial data integration; land use change analysis; land use change map; sliver polygons; the Lower Morava Biosphere Reserve

1. Introduction

Land use change analysis is an important part of the landscape research at present - from the point of view of natural processes and human activities, landscape character or landscape management. A convenient base for the study of land use change are geospatial data which include both the spatial view and the statistic data about the given types of land use. The most frequent sources for geospatial data are aerial photographs or satellite images, that is data gained from remote sensing. As this these data have only been available since the 1930s, they do not capture older periods when due to political and economical situation there were significant changes in the landscape. For illustration of these changes in the conditions of central Europe, old military maps proved useful. This type of surveying was made in the area of Austria-Hungarian empire, or Prussia, Saxony and Bavaria and their successor states (Skokanová 2008).

Tracking land use changes based on old maps usually comprises of several steps. The first step is the digitalisation – scanning and georeferencing - of these maps. The second step is the derivation of mutually comparable vector layers from georeferenced raster maps. Unlike with the data from remote sensing, in the case of maps interpretation, the automated classification in GIS cannot be used and so these maps are vectorized manually. For such manual vectorization several methods can be used. One of them is the method of so called stepwise interpretation, another one is so called backward interpretation (Skokanová 2008). The final step of the landscape change analysis is the analysis of individual vector layers and their overlay. This enables the interpretation of past changes in the period under consideration.

At similar multitemporal land use change analyses, a phase which is often underestimated is the mutual geometric integration of the used layers – that is the preservation of planimetry of identical borders of individual landscape types throughout the whole period under consideration. The integrity of layers is important for the resultant analysis accuracy, especially concerning larger scale studies. Integrated layers can also be more easily reviewed and compared with current spatial data, orthophotograph maps, etc.

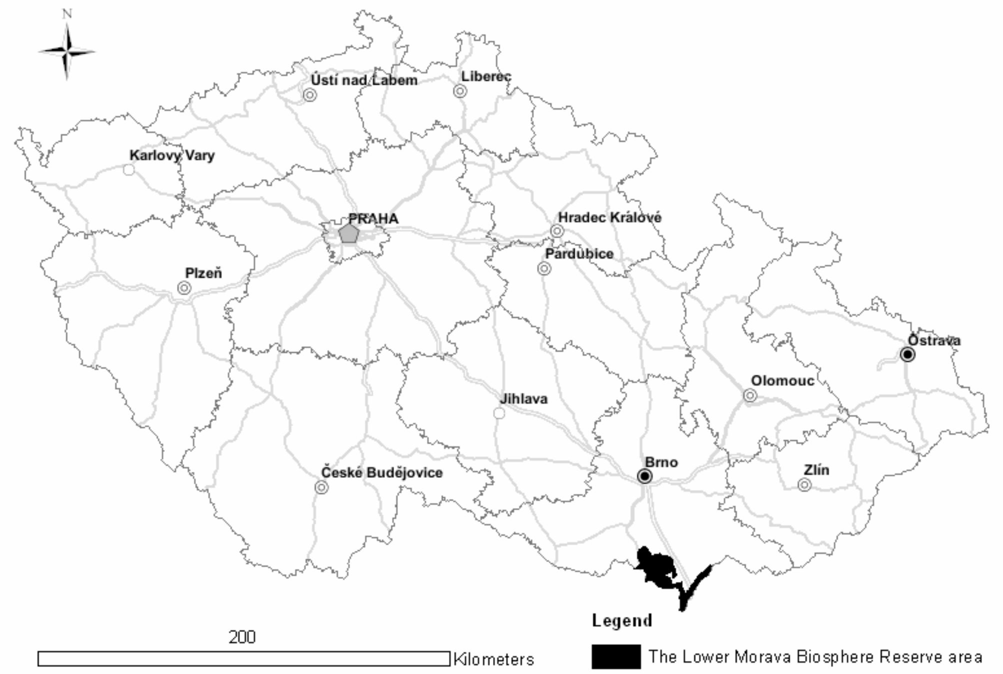
The article aims to evaluate the accuracy of the developed method of automatic geometrical integration of land use vector layers for the Lower Morava Biosphere Reserve and the confrontation of thus gained layers with the input unmodified data (of stepwise vectorization) and the data gained by backward vectorization. The automated method was developed in the *ESRI ArcGIS Desktop 9.2* environment - licence *ArcINFO 9.2* - and it is based on a sliver polygons detection and elimination.

Several authors have attempted to integrate data about landscape from different sources to increase confidence in change detection. Different approach concretely to the integration of multitemporal land use data from different sources is published for example by Petit and Lambin (2002). Their method is based on map generalisation. Geometrical land use data integration is not very often solved by authors of land use change analysis in Czech Republic. Generally, the issue of landscape data integration is solved by Kolejka (2002, 2006) in his digital landscape model (DLM) concept.

2. Regional setting

In 2003 the Committee of the International Coordination Council of UNESCO’s MAB programme in Paris approved the extension of the Palava Biosphere Reserve (designated in 1986) to include the Lednice-Valtice Cultural Landscape and the floodplain forests at the confluence of the Morava and Dyje rivers. The newly designated area, covering over 300 km^2, was renamed the Lower Morava Biosphere Reserve. The reserve encompasses a unique combination of limestone cliffs of the Palava Hills, the rare Central European lowland floodplains along the lower reaches of the Kyjovka, Dyje and Morava rivers and the Lednice-Valtice Cultural Landscape (LM BR 2008).

Fig. 1 Location of the Lower Morava Biosphere Reserve in Czech Republic. (source: authors)



3. Materials and methods

3.1 Data used

For the Lower Morava Biosphere Reserve, vector data in *Shapefile* format from the periods of five years (roughly from periods of 1840, 1880, 1950, 1990 and 2006) created by the stepwise vectorization were available. These data are the output of the research objective of the Ministry of Education, Youth and Sports MSM 6293359101 made by the Silva Tarouca Research Institute for Landscape and Ornamental Gardening. As base for vectorization were used maps from the second Austrian military survey from 1836-1852 at the scale of 1:28 800, maps from the third Austrian military survey from 1876-1880 at the scale of 1:25 000, Czechoslovak military topographic maps from 1952-1955 and 1988-1995 at the scale of 1:25 000 and basic raster maps of the Czech Republic from 2002-2006 at the scale of 1:10 000. The actual georeferencing of old maps brings many problems and is a topic for further studies (such as the Czech Science Foundation project GA205/04/0888). It is difficult to distinguish between the mistakes of the map maker and those of the raster transformation. Even within one map page there might be planimetric shifts. These mistakes thus reflect in the derived vector layers. The accuracy of the georeference of the used source map sets is summed up by Skokanová (2008). In vector layers nine types of land use are observed (in the database marked as the below used codes): 1 – arable land, 2 – permanent grassland, 3 – garden and orchard, 4 –vineyard and and hop-field, 5 – forest, 6 – water area, 7 – built-up area, 8 – recreational area and 0 – other. To gain a certain generalization for the research objective output scale of 1:50 000, areas smaller than 0,8 ha were not vectorized.

3.2 Manual methods of vectorization

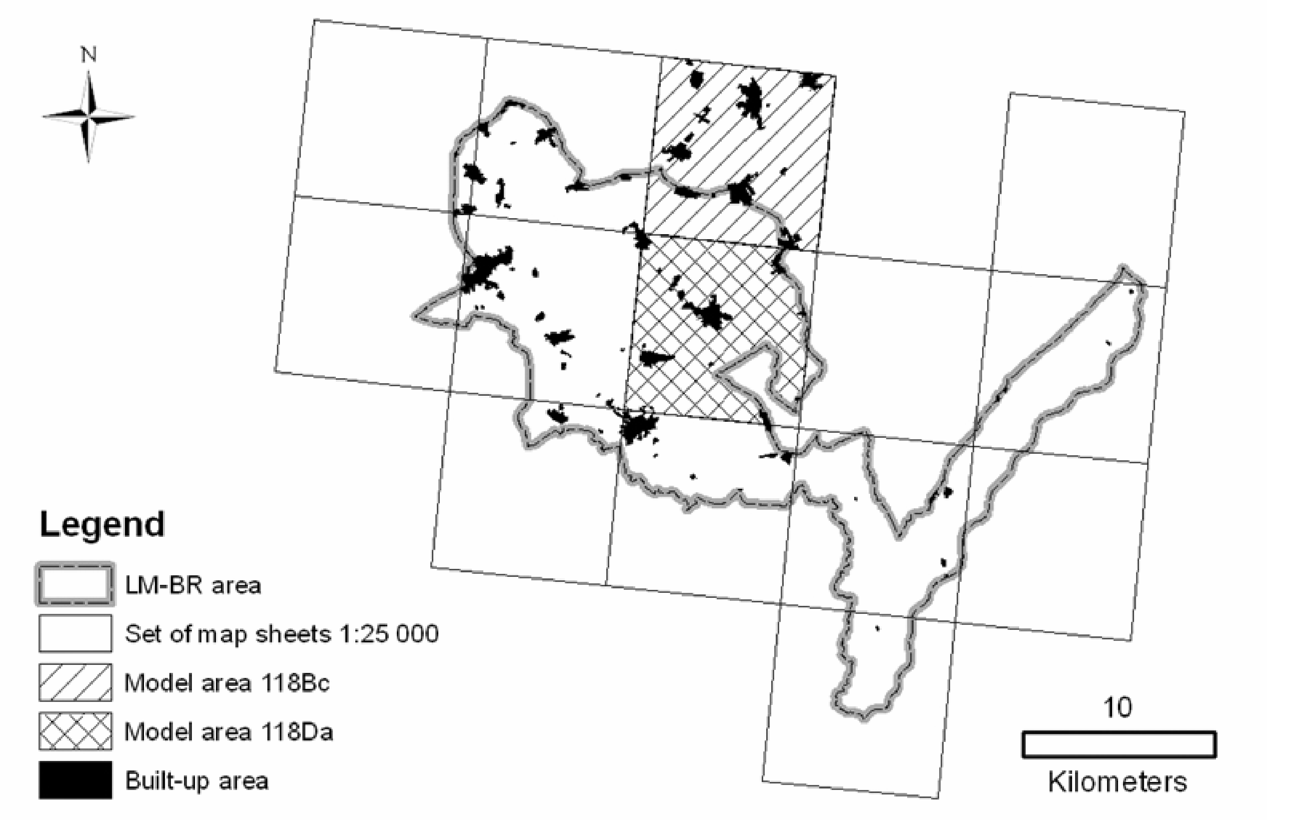
The so called stepwise vectorization method is done by defining areas according to pre-defined categories of land use for each time period separately and independently. The result is an accurate image of the map in vector form including all inaccuracies of the original map maker and digitalisation (especially georeferencing) (Skokanova 2008).

The method of backward vectorization uses a current map as the basis because it is supposed to be of the best quality. A current map is vectorized without any change and is therefore identical with a map from the same period gained through the stepwise vectorization method. From the vector layer gained from the current map, stems the vectorization of the map from previous period – the borders of designated areas only change if there is a real change in comparison with the original map. Vectorized map thus serves as a basis for vectorizing an older map, and so on. The method of backward vectorization is supposed to eliminate inaccuracies made by original map maker and digitalisation (especially georeferencing). One of the main drawbacks of the method of backward vectorization is a substantial subjectivity of the interpretation – distinguishing between real changes and mistakes in the raster base. A more detailed comparison of both methods is dealt with in Skokanová (2008).

3.3 Automatic method of geometric integration of vector layers – Layer Integrator tool

For the development and a more detailed testing of the method, two model areas have been chosen - one of a simpler landscape structure and the other of a more complicated one. These areas were determined based on set of map sheets of military topographic maps at the scale of 1:25 000. The simpler landscape structure – map sheet M-33-118-B-c (hereinafter referred to as *118Bc*) – is represented by the agricultural area near Velke Pavlovice, Rakvice, Pritluky and Zajeci, with landscape types such as large blocks of arable land, vineyards and orchards. The size of this area is 8496,2 ha. The area of the more complicated landscape structure lies in the intersect of the Lower Morava Biosphere Reserve area and the map sheet M-33-118-D-a (hereinafter referred to as *118Da*) near Lednice and Hlohovec, where in the second half of the 20th century the Dyje river bed underwent stream channel regulation. The size of the area is 7348,8 ha.

Fig. 2 Model areas. (source: authors)



The developed method of automatic geometric integration of vector layers to a certain extent tries to copy the process of the so called backward vectorization while using data gained through stepwise vectorization, which it modifies. In the geographic information system *ESRI ArcGIS Desktop 9.2*. (*ArcINFO 9.2)* a special *Toolbox „Land use change analysis tools "* was designed for this purpose, whose core consist of *Layer Integrator* and *Change Analysis* tools . These tools were created as models in the *Model Builder* application thus involving a sequence of tools contained in the functionality matrix *ArcINFO 9.2*.

As at the method of backward vectorization, the system of layer integration is based on the planimetric most accurate vector layer (2006) representing the current land use. The layer from the previous period (1990) is integrated according to this most current layer. The layer from the preceding period (1950) is adjusted according to this newly created, already integrated layer, and so on.

The principle of automatic geometric integration lies in the overlay of two time-contiguous layers with the *Union* tool. The source and the most accurate layer is marked as *A* and at the beginning of the integration, this layer represents the current state – in our case *2006_A*. In the attribute table this more accurate layer has *CODEa* field which contains numerical codes of the observed land use categories (0 - 8). The less accurate layer from the previous period, this means the layer which we want to adjust based on layer *A*, is marked as *B*. Here it is layer *1990_B*. This layer has a field with the observed types of land use in the attribute table marked as *CODEb*. The result of the *Union* operation is thus a new layer *AB_Union* over which other operations are made.

In the first phase the *Layer Integrator* searches for all polygons in the *AB_Union* layer, which were created by the overlay and based on their parameters they can be considered as sliver polygons. These are polygons that do not represent a real change in land use but were created as a result of different planimetry of identical borders. Sliver polygons have the following characteristics:

- the difference of *CODEa* – *CODEb* attributes sets a change in the type of land use

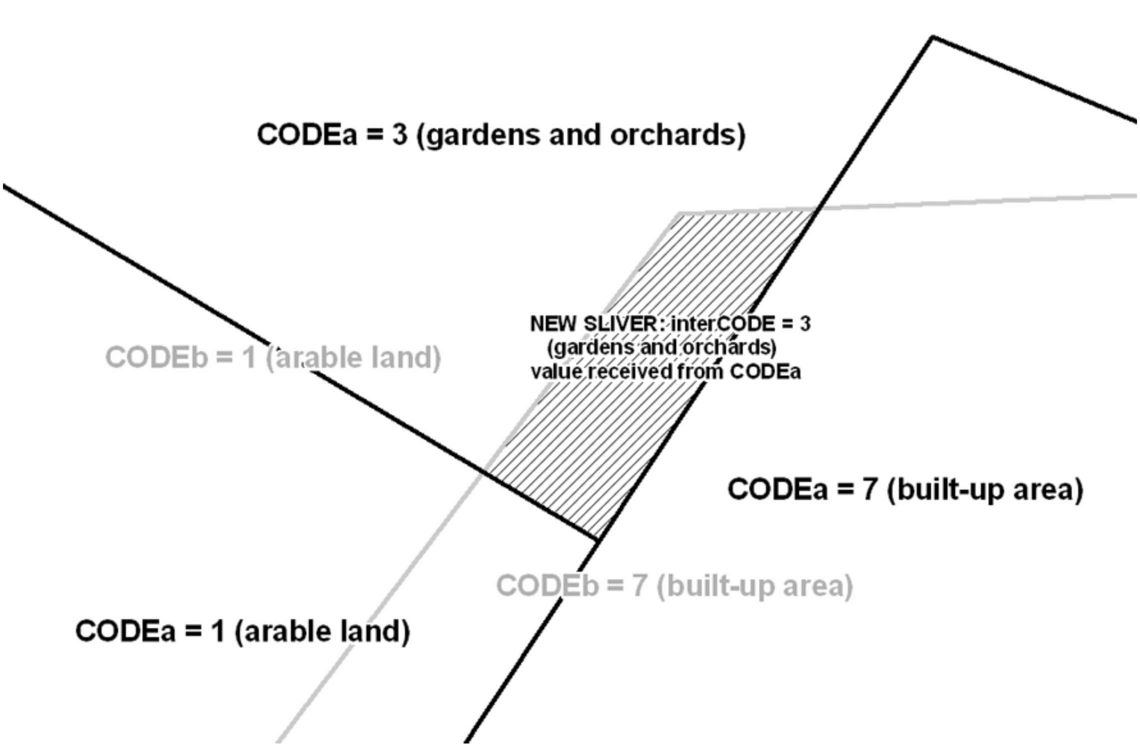
- narrow, elongated shape

- small acreage

The detection of the sliver polygons is rather problematic. Furthermore, there is also a number of coefficients and methods for describing the shape of polygons (for example Mandelbrot 1983; Feder 1988; Maling 1989). Commonly used are coefficients based on the perimeter and area quotient (such as the quotient of the polygon perimeter and the circumference corresponding to circle with same area as a polygon or quotient of the perimeter and the square root of the polygon area, etc.) For this purpose we used a simple quotient of polygon perimeter and polygon area, hereinafter referred to as *AP Ratio*. The *AP Ratio* value was determined by visual evaluation of eliminated sliver polygons on model areas and subsequently on the whole area of the biosphere reserve, it was always adjusted by 1 unit. The preservation of the original landscape structure and the number of chosen polygons were observed. For the used data, the final AP Ratio limit value was set at 10. The *AP Ratio* value also rises with the increasing area of the polygon, the determined value of the coefficient thus limits not only the shape but also the total polygon area. This fact prevents the choice of oblong polygons with a larger size which can represent some real landscape elements (bushy woods, stripes of permanent grassland, blind stream branches). Together with *AP Ratio <= 10*, the *Layer Integrator* marks as sliver all polygons of the size smaller than or equal to 0,5 ha.

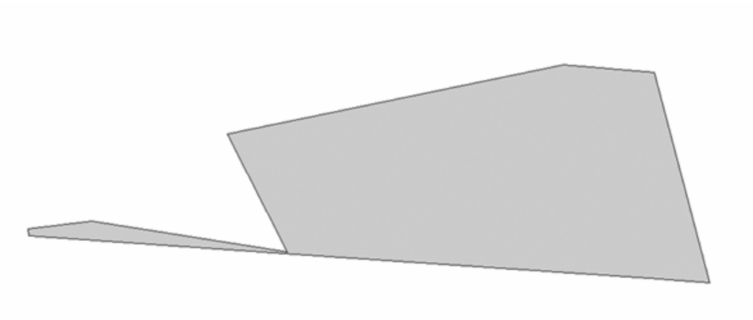
In another phase, to all polygons marked in *AB_Union* layer as sliver the *CODEa* values were assigned (that is values of the more accurate layer – *2006_A*). The *CODEa* values of the selected sliver polygons are put into the *interCODE* field in which other polygons (those not marked as sliver) still bear the value of *CODEb* (*1990_B*). If by means of the *Dissolve* tool we dissolve the borders of the polygons based on the *interCODE* field, we get layer *B_interCODE* (*1990_interCODE*), which is adjusted by the sliver polygons detected in the *AB_Union* layer. In these cases the border of the more accurate layer *A* (*2006_A*) is kept. This type of border correction works in the case of border overlay between the same types of land use such as border overlay *arable land - built-up area,* such as in layer *A* (*2006_A*), and in layer *B* (*1990_B*). If there is an overlay of borders between different types of land use such as *gardens and orchards – built-up area* in layer *A* (*2006_A*) and border *arable land - built-up area* in layer *B* (*1990_B*), then in layer *B_interCODE* (*1990_interCODE*) a new sliver polygon is created of the type *gardens and orchards* **(see fig. 2)**. Sliver polygons created in this way are taken care of in the following process by dropping the shared border with neighbouring polygon on which a change (*CODEa – CODEb*) happened and which is not marked as a sliver polygon. In this way the planimetry of a more accurate border derived from layer *A* (*2006_A*) is safeguarded also in these cases. The correction of the *interCODE* field is in the *AB_Union* layer included in the new field *nCODE* (newCODE). The resultant layer with adjusted borders of polygons *B_nCODE* (*1990_nCODE*) will be created by dissolving borders from polygons in *AB_Union* layer again by means of the *Dissolve* tool. A layer created in this way (*1990_nCODE*) is further marked as *1990_A* (*nCODE = CODEa*) and will be the base layer for the correction of another layer from older period gained with through the method of stepwise vectorization (*1950_B*). Analogically we proceed until the integration of the oldest vector layer is finished – here it is the layer for 1840.

Fig. 3 New sliver polygons in B_interCODE layer. (source: authors)



Polygons which are created by the overlay of layers and are of a relative larger size to which a sliver joins **(see fig. 3)**, present a problem. New sliver polygons might thus arise which are not eliminated in the existing integration algorithm. The occurrence of these polygons can be eliminated already at the overlay process of layers in the *Union* tool by setting an appropriate cluster tolerance (*XY Tolerance*). The tool then considers as identical the nodes and vertices belonging to this tolerance. The problem here is the deformation of layers at the edges of map sheets as well as moving nodes and vertices coordinates within individual layer (even at determining priorities to layers by means of *Rank* values) thus breaking the original polygons. *Layer Integrator* enables to determine *XY Tolerance* as an input parameter. In the scope of these analyses, however, this possibility was not used. Another problem for the given area was caused by small water areas and blind stream branches. Due to a larger shift in planimetry some elements were only partly corrected or the original shape was destroyed, especially at blind stream branches.

Fig. 4. Specific shape of polygons created by layer overlay. (source: authors)



For the above mentioned reasons, it is advisable to subject the individual layers to a manual correction in order to eliminate these problems and always manually correct the newly created integrated layer (*B_nCODE*) before it is used as a pattern for the integration of a layer from the older period. The water areas, which, in the area of concern, create an important landscape element, were therefore manually corrected. Thus the complex process of integration should be classified as semi-automatic. It is important to note that for the whole area of biosphere reserve the operation took less than a working day.

3.4 Change Analysis tool

The second developed tool called *Change Analysis* serves for creating a land use change maps. It enables to determine stable and unstable areas from the outputs of the *Layer Integrator* tool. The principle of the *Change Analysis* tool is again in the overlay of the *Union* type where all layers for the observed period (here 1840, 1880, 1950, 1990, 2006) are combined. Based on the differences of the land use type codes a field called *Changes* is created. The *Changes* field contains a figure about the number of changes in the land use which took place on the given polygon (here changes 0 - 4). Another created field is *xCODE* (a combined code). In the *xCODE* field, stable polygons (0 changes) are marked with numbers 0 to 8 - differentiated according to the type of the land use. Unstable areas with 1 to 4 changes are marked with numbers 11, 12, 13, 14. Based on the *xCODE* field we can then differentiate stable areas according to the land use categories.

In another step of the process, the *Change Analysis* model cleans the land use change map of sliver polygons which had been created by the overlay of all five layers. It uses the *Dissolve* and *Eliminate* tool – in this case it is a mere optical adjustment of the layer because the polygons are merged only based on the longest shared border. From the land use change map the required information is thus more visible. At the end of the process the *Change Analysis* model compares stable areas with the borders of the current layer (2006) and the possible overlappings which have parameters of sliver polygons (*Area <= 5000 OR AP Ratio <= 10*) are merged by dropping the longest shared border with the polygons of unstable areas. This method stems from the idea that if in the given polygon there was no change of land use, its code of land use must be identical with current layer (2006).

4. Results

For modelling areas *118Bc* and *118Da* there were available data both from stepwise vectorization and the outputs from *Layer Integrator* (with manually corrected water areas) as well as data from backward vectorization. For the whole area of Biosphere Reserve of the Lower Morava (*LM-BR*) data from stepwise vectorization and outputs from *Layer Integrator* (with manually corrected water areas) were available. The evaluation of the outputs of *Layer Integrator* and *Change Analysis* tools was, except for visual checks, always done from two basic aspects: the evaluation of changes of relative representation and the quantification of the planimetric shift. On the model areas, the *Layer Integrator* outputs were confronted with data from backward vectorization. Polygons with the area of <= 0,5 ha or AP Ratio <= 10 are further marked as sliver polygons.

In tab. 1 we can see the comparison of relative representation of individual land use types between the stepwise vectorization data and the data corrected by *Layer Integrator* tool both for model areas and for the area of the whole biosphere reserve. Form tab. 1 it is clear that in the individual layers corrected by *Layer Integrator* tool there are no dramatic changes compared to data of stepwise vectorization from the point of view of relative representation of land use types. The comparable area representation of land use types is also preserved in corrected layers. For the simpler area *118Bc* the difference does not exceed the value of 0,07 %, for area *118Da* with a more complicated landscape structure the difference does not exceed the value of 0,30 %. For the whole area of the reserve it reaches maximum difference of values 0,17 %.

Tab. 1 The comparison of the relative representation of land use types [0 - 8] in the outputs of Layer Integrator with the data of stepwise vectorization (values are quoted in [%], [-] it means that the type in the layer does not occur). (source: authors)

	118Bc				***118Da***				***LM-BR***				
	1840	1880	1950	1990	1840	1880	1950	1990	1840	1880	1950	1990	
0	0,00	0,00	0,00	-0,01	0,00	-	0,02	-0,01	0,00	0,00	0,00	0,00	0
1	-0,07	-0,04	0,00	0,01	-0,07	-0,04	-0,09	-0,16	-0,03	-0,01	-0,08	-0,06	1
2	0,06	0,01	0,04	-0,02	0,08	0,05	-0,19	-0,11	0,05	0,05	-0,17	-0,09	2
3	0,00	0,00	0,01	0,00	0,00	0,00	-0,01	0,00	0,00	0,00	0,00	0,00	3
4	0,02	0,02	-0,02	-0,07	0,01	0,02	-0,05	0,01	0,02	0,00	-0,04	-0,04	4
5	0,00	0,01	0,00	0,01	-0,02	-0,02	0,30	0,26	0,00	0,00	0,15	0,17	5
6	-0,03	-0,01	-0,01	0,02	0,02	-0,01	-0,03	-0,03	-0,03	-0,03	0,13	0,00	6
7	0,02	0,00	-0,02	0,05	-0,03	0,00	0,05	0,03	-0,01	-0,01	0,01	0,02	7
8	-	-	-	-	-	-	-	0,00	-	-	-	0,00	8

Tab. 2 shows the count and total area of slivers which were corrected by *Layer Integrator* tool in the layers gained through stepwise vectorization. On both model areas as well as on the whole reserve area the number and the size of corrected slivers reaches the maximum for the first corrected layer -1990. At the simpler area *118Bc* there are 678 slivers which amounts to 1,20 % of the total area. For the more complicated area *118Da* there are 1594 slivers (2,76 % of the total area) and for the whole area of the reserve there are 5789 slivers, making up 2,16 % of the total size. The *Layer Integrator* is able to adjust the lowest number of slivers, which also take up the smallest area, for the whole area of the reserve for the year 1880. The small size of corrected slivers can also signalize either a significant similarity of time contiguous layers or the contrary – substantial planimetric shifts of identical borders, which have parameters exceeding those for the detection of slivers. In the case of 1880 (it means the measure of similarity of layers of 1950 and 1880) the second possibility seems more probable.

Tab. 2 Quantification of corrected slivers by Layer Integrator tool. (source: authors)

	118Bc - Slivers			***118Da - Slivers***			***LM-BR - Slivers***			
	Count	Area [ha]	Area [%]	Count	Area [ha]	Area [%]	Count	Area [ha]	Area [%]	
1990	678	102,10	1,20	1594	203,17	2,76	5789	764,38	2,16	1990
1950	347	44,30	0,52	1166	135,02	1,84	3474	450,41	1,27	1950
1880	346	52,28	0,62	716	109,15	1,49	2326	338,04	0,95	1880
1840	588	94,79	1,12	780	118,40	1,61	3097	463,23	1,31	1840

In **tab. 3** for model areas the layers of backward and stepwise vectorizations and layers of backward vectorization with *Layer Integrator* outputs were compared. The comparison was done based on the change of the land use type code against the layers gained through backward vectorization. This concerns any polygon in which the change of land use proceeded. In other words, this is the difference from the data of backward vectorization. In both model areas and in all periods the *Layer Integrator* outputs are more similar to backward vectorization data. When comparing with the backward vectorization data from the simpler model area *118Bc*, the *Layer Integrator* outputs differed from stepwise vectorization data most for the years 1840 and 1990, where the difference amounted to 0,81 % and 0,75 % of the total area. The manual correction of the category of water areas during the integration is reflected in the good result for the year 1840 which can also be seen in the small difference in the number of slivers (only 24 slivers) which take up quite a large area. When comparing with the backward vectorization data of the model area *118Da,* the *Layer Integrator* outputs differed from the stepwise vectorization data most for the year 1990. The difference amounted to 1367 slivers, i.e. 2,06 % of the model area.

Tab. 4 evaluates one of the outputs of the *Change Analysis* model. It concerns a mere layer overlay with the *Union* tool for all five periods and the summary of the occurrence of slivers created by this overlay. From the results for the model area *118Bc* it is clear that from the stepwise vectorization data 5582 new slivers were created by the layer overlay which take up 6,31 % of the size of the model area. For the *Layer Integrator* outputs it is only 1929 slivers (3,90 %) and for the backward vectorization data 1232 slivers (2,38 %). In the case of model area *118Da* for the stepwise vectorization data there occur 11346 slivers (10,54 %), for *Layer Integrator* outputs there are 2388 slivers (4,71 %) a for backward vectorization 2197 slivers (4,33 %). For the total area of the biosphere reserve by the stepwise vectorization layer overlay 41360 slivers are created amounting to 9,13 % of the total reserve area. For the *Layer Integrator* outputs there are 11383 slivers, amounting to 4,55 % of the total size. It can thus be said that the layer correction in the *Layer Integrator* tool almost four times reduces the occurrence of new sliver polygons when creating the land use change map.

Tab. 3, Quantification of the stepwise vectorization data and the Layer Integrator outputs difference from the backward vectorization data (for model areas). (source: authors)

	(1)Backward - Stepwise			*(2)Backward - LayerIntegrator*			*Difference (1) - (2)*			
	Pg. Count	Area [ha]	Area [%]	Pg. Count	Area [ha]	Area [%]	Pg. Count	Area [ha]	Area [%]	
118Bc										*118Bc*
1990	1028	167,78	1,97	513	103,81	1,22	515	63,97	0,75	1990
1950	1479	143,62	1,69	1343	127,66	1,50	136	15,96	0,19	1950
1880	1782	157,69	1,86	1631	149,79	1,76	151	7,91	0,09	1880
1840	2032	396,84	4,67	2008	327,78	3,86	24	69,05	0,81	1840
118Da										*118Da*
1990	2164	310,82	4,23	797	159,46	2,17	1367	151,36	2,06	1990
1950	1706	132,28	1,80	1163	117,61	1,60	543	14,66	0,20	1950
1880	1222	229,65	3,13	1050	210,08	2,86	172	19,57	0,27	1880
1840	1435	316,17	4,30	1241	293,23	3,99	194	22,95	0,31	1840

Tab. 4 The quantification of new sliver polygons *crea*ted by the overlay of layers 1840, 1880, 1950, 1990 and 2006. (source: authors)

	118Bc - Slivers			*118Da - Slivers*			*LM-BR - Slivers*			
	Count	Area [ha]	Area [%]	Count	Area [ha]	Area [%]	Count	Area [ha]	Area [%]	
Stepwise	5582	536,00	6,31	11346	774,43	10,54	41360	3233,60	9,13	Stepwise
LayerIntegr.	1929	286,91	3,90	2388	345,76	4,71	11383	1610,49	4,55	LayerIntegr.
Backward	1232	202,48	2,38	2197	318,42	4,33	-	-	-	Backward

Tab. 5 is similar to **tab. 3** but this one is for the final outputs of the *Change Analysis* tool – the land use change maps. These layers were created by the overlay of all five layers, in which sliver polygons were eliminated and the area borders with zero number of land use changes were corrected according to the most accurate layer (2006). Even from this table **(tab. 5)** it is clear that *Layer Integrator* outputs resemble more the backward vectorization data. When comparing with the land use change map created from the backward vectorization data, for simpler model area *118Bc*, the difference between the land use change map from *Layer Integrator* outputs and the land use change map from stepwise vectorization data was 291 slivers, making up 0,89 % of the model area acreage. For model area *118Da* the difference is 543 slivers, representing 0,79 % of the total size.

The last table **(tab. 6)** shows for both model areas the overview of relative representation of stable (0 changes) and unstable areas in final outputs of the *Change Analysis* tool. This concerns the land use change maps in which the sliver elimination and correction of borders of stable areas has already taken place. The results show that even in the case of a relative areal representation the land use change maps created from *Layer Integrator* outputs are more similar to the maps of backward vectorization data more than maps gained from unmodified data of stepwise vectorization.

Tab. 5 Quantification of the land use change maps gained from stepwise vectorization data and Layer Integrator outputs difference from the land use change maps gained through backwards vectorization data (for model areas). (source: authors)

	(1)Backward - Stepwise			***(2)Backward - LayerIntegr.***			***Difference (1) - (2)***			
	Pg. Count	Area [ha]	Area [%]	Pg. Count	Area [ha]	Area [%]	Pg. Count	Area [ha]	Area [%]	
118Bc	3797	538,65	6,34	3506	462,73	5,45	291	75,93	0,89	118Bc
118Da	2900	507,40	6,90	2357	449,24	6,11	543	58,16	0,79	118Da

Tab. 6 The relative representation of the land use change map categories for model areas ([CH 0 – 4] means 0 to 4 changes in the land use type). (source: authors)

	118Bc			***118Da***			
	Backward	Layer Integrator	Stepwise	Backward	Layer Integrator	Stepwise	
	Area [%]	Area [%]	Area [%]	Area [%]	Area [%]	Area [%]	
CH 0	51,80	50,96	50,57	53,00	51,14	50,75	CH 0
CH 1	32,68	32,50	32,34	28,27	28,01	27,41	CH 1
CH 2	11,40	11,75	12,09	13,83	15,23	15,81	CH 2
CH 3	3,51	4,09	4,27	4,19	4,67	5,07	CH 3
CH 4	0,60	0,70	0,73	0,71	0,95	0,97	CH 4

5. Discussion

From the given results we can claim that the outputs gained with *Layer Integrator* tool (in which water areas were manually corrected) are more similar to data derived through the method of backward vectorization. The ability of the *Layer Integrator* to correct the geometry of the borders logically depends on the extent of mutual similarity of map sets from which the vector layers are derived. The crucial part here is played by the quality and the scale of the original surveying as well as the quality of digitalisation, especially of georeferencing. *Layer Integrator* is able to correct the extent of planimetry shifts which is limited with defined parameters of sliver polygons. This tool thus gets the best results at the correction of layers which are derived from map sets with the smallest mutual planimetry shift. The efficiency of the corrections gained with *Layer Integrator* tool was generally lower in vector layers derived from map sets of the 2nd and 3rd Austrian military surveying where there are unsystematic shifts (even within one map sheet) with parameters comparable to some landscape elements or real changes of border planimetry.

Layer Integrator outputs preserve a comparable relative areal representation of individual land use types towards the stepwise vectorization data. From this characteristic we can deduce that by the correction of the stepwise vectorization layers in Layer Integrator tool, dramatic changes in the landscape structure do not occur. The statistic information carried by the original layers is thus well preserved. The adjustment of individual stepwise vectorization layers naturally brings more accurate land use change map which is created by the overlay of layers of the period under consideration. By the correction of the layers with the Layer Integrator tool for the whole area of the biosphere reserve the occurrence of sliver polygons at the creation of the land use change map was reduced almost four times which safeguardes that these polygons are correctly localized. The difference in the land use change maps gained from the Layer Integrator outputs in comparison with maps derived from stepwise vectorization data is clearly visible also from the relative representation of stable and unstable areas.

The topic to be further discussed is the method of derivation and the used parameters of the detection of sliver polygons. From the method of determining AP Ratio value as described in chapter 3.3 follows a partly subjective influence of results. On the other hand, visual evaluation is crucial at recognizing at which parameters of sliver polygons detection there occurs the selection of real landscape elements or not. Concerning the detection of slivers, another problem which should be further looked into, are the polygons created by relative large area on which a sliver polygon joins (see chapter 3.3). When we are using *Layer Integrator* tool we should also notify that the planimetric accuracy of current land use vector layer (or another land use layer which is source for whole integration process) is crucial as well for planimetric accuracy of all *Layer Integrator* outputs as for whole land use change analysis. The verification of accuracy of land use vector layers gained from basic raster maps of the Czech Republic from 2002-2006 at the scale of 1:10 000 was not purpose of this paper.

6. Conclusions

The *Layer Integrator* tool serves for the integration of vector layers. As source data it uses layers gained through stepwise vectorization, which are mutually compared and corrected. The aim is to preserve the most accurate planimetry of identical borders throughout the period of consideration. In principle it imitates the method of backward vectorization. The function of the algorithm is limited by the extent of mutual planimetric shift in source layers. In the studied areas, especially in layers derived from maps of the 2nd and 3rd Austrian military surveying there are planimetric shifts which the developed algorithm is unable to efficiently solve. There are also problems with polygons created by quite a large area on which a sliver polygon joins. The present algorithm is unable to recognize and mark these polygons as slivers and this may give rise to new slivers. Throughout the layer integration it is therefore advisable to check the outputs visually and remove mistakes if necessary. In order to get better accuracy of the analysis, the water areas (which present an important landscape element in the area under investigation) that the *Layer Integrator* tool was unable to efficiently correct automatically, were corrected manually. The results gained for the model areas and the Lower Morava Biosphere Reserve area confirm the use of *Layer Integrator* tool as an appropriate part of the multitemporal land use change analysis. The treatment of stepwise vectorization data in the *Layer Integrator* tool before creating the land use change map of the Lower Morava Biosphere Reserve area reduced almost four times the occurrence of sliver polygons as opposed to the land use change map gained from untreated layers.

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Geographical aspects of commuting with door-to-door approach

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Abstract

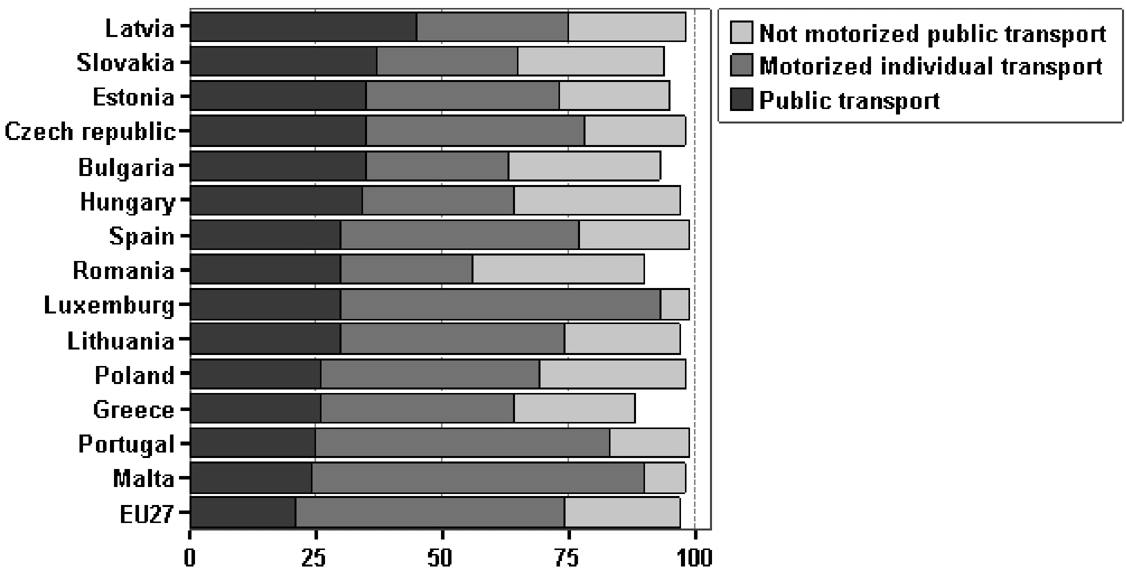
This paper would like to present the results of a bigger project named "Modelling of door-to-door commuting on the sample of chosen companies in the Moravian-Silesian Region". This project tries to analyze three main types of commuting – via public transport, individual transport and car-pooling on the micro-level. The main benefit of this work is door-to-door approach, which was used by all analysis. It means that it was counted with walking distances to the most useful stops near houses of commuters and with walking distances from the best stops near the chosen employers in the Region. The commuters have possibility to choose and so it was not count only with the nearest stop to house. The influence of this walking process was counted too and each house was classified in particular distance interval. Service areas of each and active stop were counted as well. Travel times and prices were taken from database of connections, which were created from valid time orders. The situation of commuting can be different in parts of the Region, so it was analyzed influence of some factors like altitude of building of origin, usage of building, number of flats inside the building, working region, etc.

Keywords: commuting; door-to-door; public transport; stop; micro-modelling

1. Introduction

Spatial mobility of people can be divided (Drbohlav 1998) in migration movements and commuting. Migration is not so regular movement like commuting; there are people, who did not migrate during the lifetime. In contrast commuting belongs to irregular daily movements – almost everybody take some journeys to shop, to have fun or regular movements mainly to work. More than 90% of the population in the Czech Republic have different place of living and working and that is why they have to commute daily and travel a long distance to reach the workplace many times (Czech Statistical Office 2001). Two basic principles for study of commuting exist - first one is the macro-approach and the second is micro-approach. The macro-measure brings a lot of inaccuracies and generalizations; it works with census data, so not with individual factors. In this paper, is worked on the micro-level with focusing in individuals. Three main aspects have to be consider – the selection of the target of travel, the time for the travel and the way how to reach the target. Whole project is focused in the commuting to chosen employers in regions of the Moravian-Silesian Region in the northeast of the Czech Republic – this defines the target of commuting. The type of mobility – commuting – defines the second aspect as well. Employee has to reach the place of work in time before the start of working shift – it can be morning, afternoon or night shift. The third aspect is the way of travelling. Here can be distinguished two main types – public transport and individual transport. In the Ministry of transport's year-book (Ministry of transport 2007) is counted the ratio of people who use public transport to commute. There were 56% of people who use public transport in the Czech Republic in 2007. Although this ratio has decreased about 3.5% since 2000 and this decrease will probably continue, it is still more than a half of all commuters. Just this commuting via public transport plays the main part in this project.

Fig. 1 Main mode of transport for daily activities in countries of EU (selection). (source: Attitudes … 2007)



Note: In %, Base: all respondents.

Results of the European survey (Attitudes on issues related to EU Transport Policy 2007) suggest that situation is similar in other post-communist countries in the European Union. The survey covered all 27 Member States of the European Union on a randomly selected sample of over 25767 individuals of at least 15 years of age. Graph above **(fig. 1)** shows selection of answers for one question of survey – "What is the main mode of transport that you use for your daily activities?" Values for Czech Republic are different from that in the transport's year-book (Ministry of transport, 2007). This is caused by different data source. In reality should be the public transport usage a little bit more popular. Public transportation is notably more popular in the New Member States than in the EU15 bloc. Definite exceptions from this are Cyprus and Slovenia. Using public transportation is most popular in Latvia (45%) and Slovakia (37%), and is the least popular in the Netherlands and Slovenia (both 11%).

Not only by public transport way of travelling is very necessary the travel time and the travel distance (from the stop near home to the stop near workplace), but here is very important the walking time or the walking distance from home to near stop and from stop near workplace to target of whole journey as well. In many studies is this walk to stop not a part of analysis although can have a big influence on overall results in time or in distance component of commuting. This approach of analysis is called door-to-door (D2D). We try to count, how big can this influence be and how much longer is the journey to work in time-space.

2. Service areas of public transport stops

There are 3898 public transport stops in the Moravian-Silesian Region in 2008. From this number belongs 170 to train and 3728 to bus transport system. The spatial distribution of these stops can be analyzed in many ways. One of these is the construction of regions, whose boundaries define the area that is closest to particular catchment stop – Thiessen polygons can be built above layer of public transport stops. These polygons are shown in map below **(fig. 2)**. Average surface of these service areas is 2.4 square kilometers, but median is much smaller – only 1.5 square kilometers. This situation indicates big number of smaller regions. This is understandable, in Moravian-Silesian region is a lot of bigger cities, the whole region is the most populated in the Czech Republic (1 249 897 people in 31/12/2007). Because of this the need for bigger number of stops exists in this region and for bigger density of stops. More than 30% of all areas are smaller than 1 square kilometer and more than half of all areas have the surface less than 2 square kilometers. But there are some regions (more then 10%), that are bigger than 5 square kilometers. Just in these bigger service areas, but even in that smaller, can be the door-to-door approach significant. In these bigger regions is the longer distance between home and stop very interesting and in the smaller areas there is the problem with complicated street network along a huge number of houses and so the walking time to the stop can take more time as well as in bigger areas.

The other problem is in these service areas the fact, that some of stops are irrelevant for transport accessibility. This irrelevance practically means that only a few traffic links stop here or they stop here in some unusable hours for commuting. These factors will be analyzed as well.

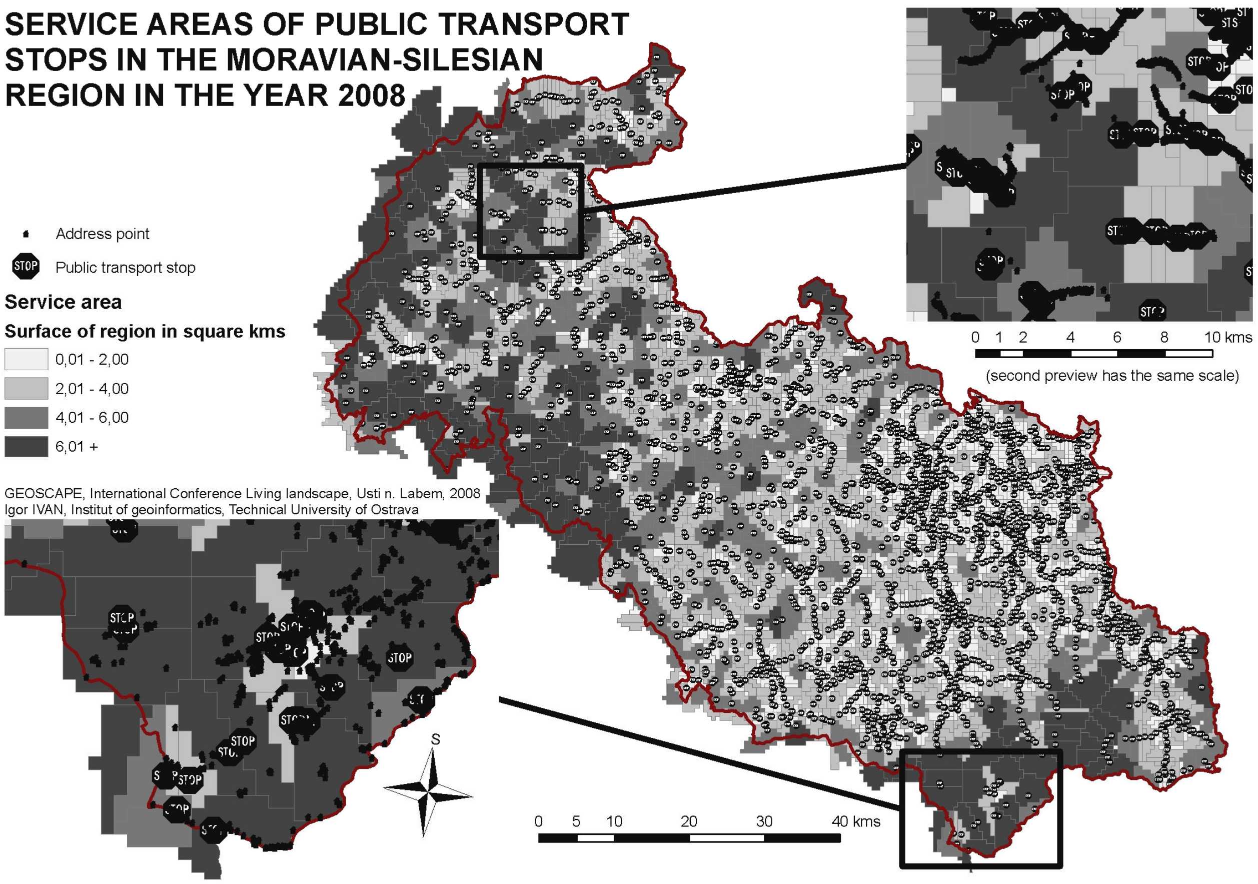
Tab. 2 Basic statistic of service areas. (source: author)

Arithmetic mean	2,4 km^2
Median	1,5 km^2
Standard deviation	2,6 km^2
Minimum	0,01 km^2
Maximum	33,0 km^2

Statistical minimum of areas is 0.01 square kilometers and this is too small, the mistake was caused by raster-vector conversion. But as is shown below in the map, in the Moravian-Silesian region is a lot of very small regions. More interesting for this analysis are bigger service areas. The biggest area in region has 33 square kilometers. Service stop for this area is near west boundaries of the region in Jeseníky Mountains – Malá Morávka/Ovčárna. So others big service areas are situated in highland around Jeseníky Mountains, Beskydy Mountains but so around city Bruntál or Vítkov. In detail previews of parts of the region in the map below are displayed address points as well and there are also located a in the darkest map interval with areas bigger than 6 square kilometers. A few of these dark areas are irregular scattered in the whole Moravian-Silesian Region.

The service areas are not trimmed by region boundaries, but there exist overlaps in both ways – it means that service areas of stops in the region overlap into surrounding regions (Zlín Region and The Olomouc Region) and again in Moravian-Silesian Region can be found areas from stops in surroundings regions. But from north and east are the areas trimmed by national boundary with Poland and Slovakia.

Fig. 2 Service areas of public transport stops. (source: author)



2.1 Service areas of active public transport stops

As was written above, from all stops can be specified no small amount of stops that have only a local importance. There are practically useless for longer commuting out of the local area. Some condition for all stops had to be stated, which can eliminate these local stops. Most of the commuting targets are situated in bigger important cities and there are some preferred hours, when to commute. The most important hours for commuting are in the morning time. Most of employers start to work between six and eight o'clock in the morning. So the scholars should be in their schools before eight o'clock as well as most of all services open at 8 o'clock in the Czech Republic. So the first connection time is eight o'clock. The second connection time was stated as 14 o'clock, because in this time starts the afternoon shift and people start to travel to bigger cities for some other services after morning shift. The maximal duration of travelling is one and half hour and the earliest arrival to target stop should be one hour before (between 7 and 8 o'clock or between 13 and 14 o'clock), in agreement with methodology (Horák, Horáková, Šeděnková, Šimek, Růžička, Peňáz 2006 or Horák, Šeděnková, Ivan 2008).

Two target stops were chosen – the most important train stations and bus stops in LAU (local administrative unit) centers, one train station and one bus stop for each city. The only exception is the regional city Ostrava. Here were chosen two train stations (Ostrava - main station and Ostrava Svinov), because both of them are very important for transport accessibility in the whole Region. The connection searching process was accomplished in the NEWDOK application. This application was utilized for needs of Ministry of Social Affairs (more in Horák, Šeděnková, Ivan, Fojtík 2007).

The whole conditions were stated as: there must be possible to reach one of the chosen stop in some LAU centre in the Region for 8 and for 14 o'clock or only for 8 o'clock, the duration of that connection can be not longer than 90 minutes and the arrival cannot be earlier than one hour before. Every stop, which fulfils these conditions, will be called as active stop.

From results (Appendix A) can be figured out the least connected stops from all chosen. These two stops are in Bruntál. Train station is connected for each of analyzed hours from more than 300 stops and bus stop is connected only from 154 or 180 stops. That is caused by absent of some electric railway or trunk road. In contrast to Bruntál, the best results have the train station in Ostrava Svinov, which is connected from more than 2000 stops in the Region. Second is the other Ostrava train station with almost 2000 connected stops. Similar number of connected stop has the best bus stop is in Frýdek-Místek. What area is covered by the service regions, if we do not count with selected local stops? That means with stops from where does not exist any connection to LAU centre for 8 and for 14 o'clock under given conditions.

Tab. 2 Basic statistic of active stop service areas. (source: author)

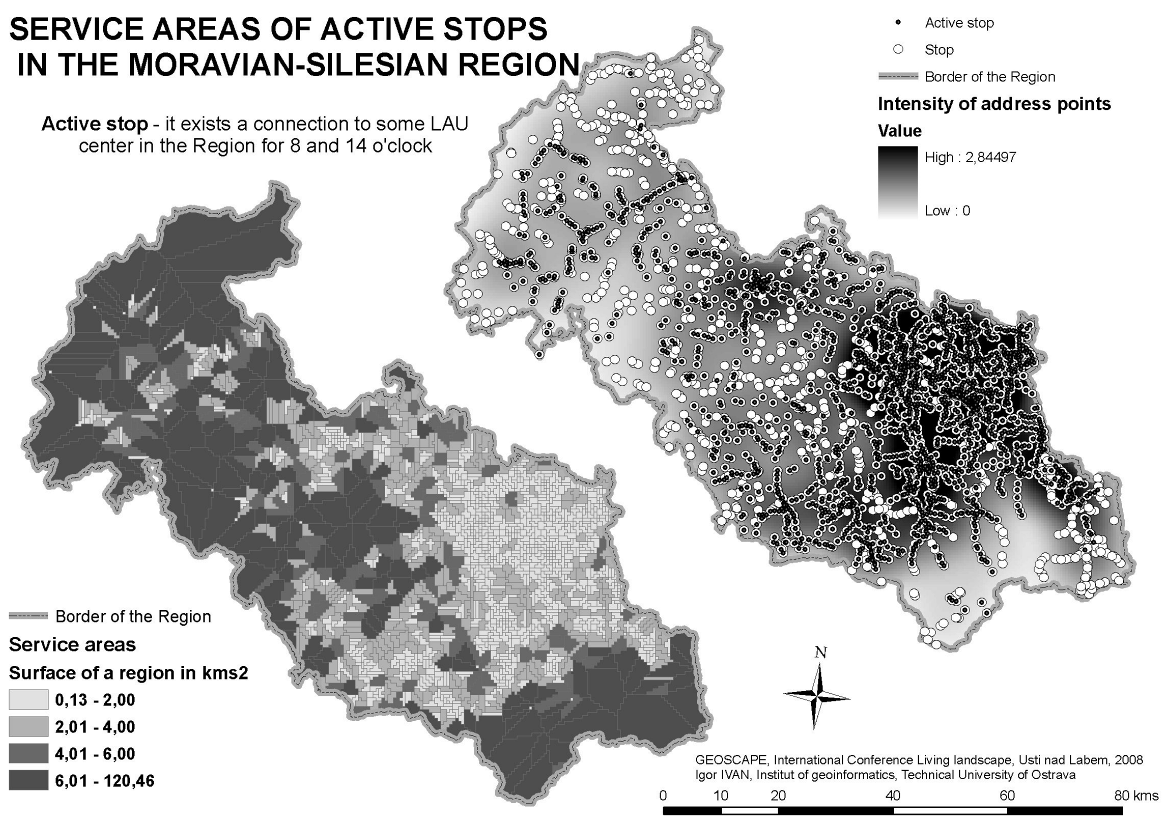
Figure	**for 8 o'clock**	**for 8 and 14 o'clock**
Arithmetic mean	2,6 km^2	3,1 km^2
Median	1,5 km^2	1,6 km^2
Standard deviation	4,6 km^2	6,8 km^2
Minimum	0,01 km^2	0,01 km^2
Maximum	102,6 km^2	120,5 km^2

In comparison of results for all stops **(tab. 1)** and results only for active stops **(tab. 2)** is obvious bigger average surface for service areas around active stops. Standard deviation is bigger as well, what is explained with more scattered values of area sizes. This idea is supported by very big maximum. The biggest service area has over 120 square kilometers and is located in northwest part of the Region near the Osoblaha city. But it has to be point out little change in methodology against previous service areas calculation. In this case is not calculated with stops out of the Moravian-Silesian Region and so the results near boundaries can suffer from bias. The results of all statistical values for the second condition (connection for 8 o'clock) are between results for all stops and for results for active stops with connection for 8 and 14 o'clock.

In the map below **(fig. 3)** are in the right map field displayed with white points all public transport stops in the Moravian-Silesian Region. Above some of these white points lie smaller black points, which correspond to the active stops (connection for 8 and 14 o'clock). There are obvious some stops with micro regional meaning. The biggest occurrence of these local stops is in northwest part of the Region – Osoblaha region, in southwest part, middle part and southeast part of the region – Jablunkov region and Beskydy Mountains. Below these stops is displayed intensity of address points in the Region. In most settled parts of the Moravian-Silesian Region is the biggest density of active stops as well. But we can find some exceptions, for example in the east part near the city Třinec or Jablunkov or in the central part of the Region.

From active stops were created service areas, as well as in case with all stops in the Region. These service areas are displayed in the same map as active stops. The map intervals are identical to the previous map with service areas of all stops. At first sight is clearly evident growing number of regions with size 6 and more square kilometers. Distribution of larger areas in the Region responds to distribution of inactive stops.

Fig. 3 Service areas of public transport stops (for 8 and 14 o'clock). (source: author)



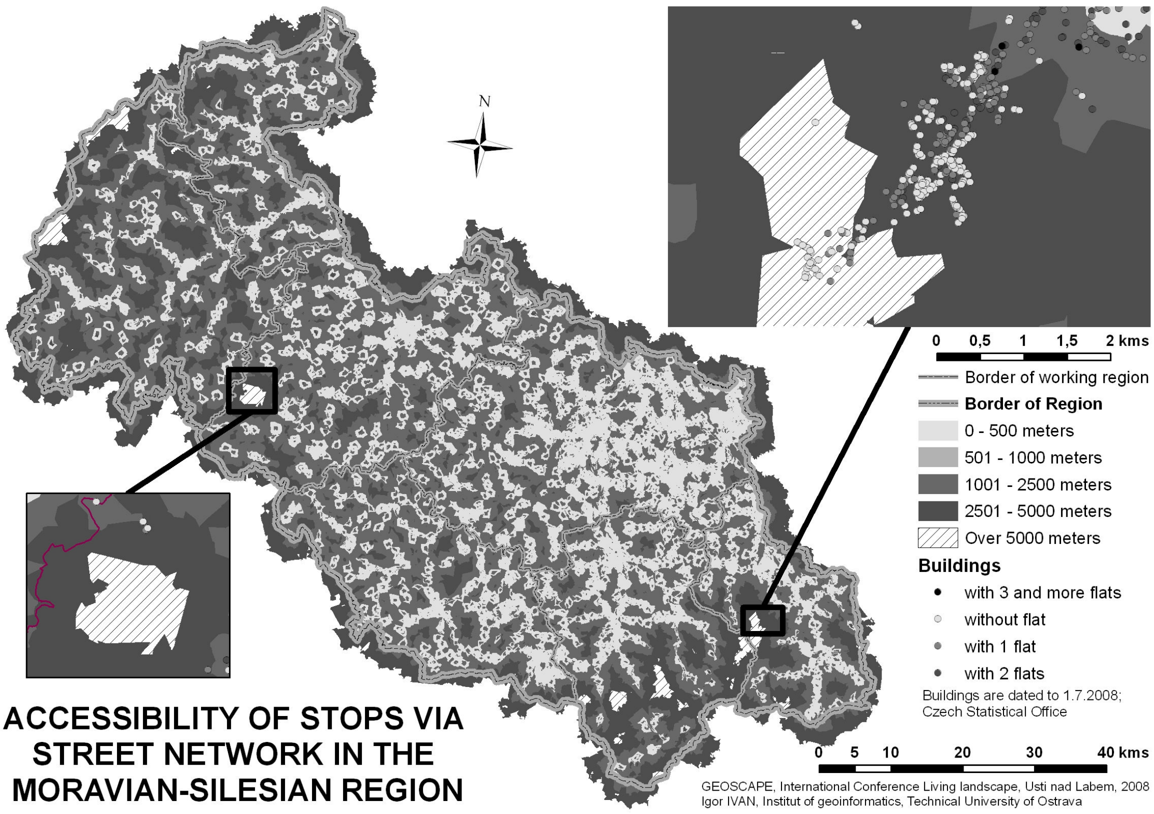
3. Walking accessibility of stops via street network in the Region

From all results above is clear, that in Region exist some areas, where the service areas are very large and so the people have to walk for some time. We try to reply in this chapter to the main questions – how important is the walking distance to stop in the whole process of commuting? Is the door-to-door approach really necessary?

The distance from stop was divided in 4 intervals up to 500 meters, between 500 and 1000 meters, between 1000 and 2500 meters and between 2500 to 5000 meters. The average walking speed was 4 kph. Time distance can be evaluated as well. It was calculated only with stops inside the Region, so the boundary parts can be a little bit affected (particularly areas near other Czech Regions – Zlin or Olomouc Region).

These distance intervals were displayed in map below **(fig. 4)**. Most of the Region is in distance up to 2.5 kilometers from the nearest stop, what in time space means up to 37.5 minutes. But there are some areas, which are quite remote from the nearest public transport stop. The darkest colour display areas in distance from 2501 to 5000 meters. It is interesting, that these areas create some boundaries in Region. From these parts people have to walk to the nearest stop for up to 75 minutes. But there are also some regions, which are so much remote, that people have to walk more than 5 kilometers or 75 minutes to reach the nearest public transport stop (for example in Beskydy Mountains). In these remote parts are not very often any inhabited house, there are some cottages or weekend houses, but even there we can find some of inhabited house as is shown in detail preview in the map below. Walking time to the stop could be for the whole process of commuting in some parts of the Region very important, especially if you realize that you have to walk from home to the start stop and from the final stop to the workplace. The walking time could be than even 2.5 hours. But employers are located mostly near some public transport stop.

Fig. 4 Accessibility of stops via street network. (source: author)



If we focus in buildings and their flats inside in particular distances from stop, we can evaluate more precisely the average walking time to the nearest stop. We will calculate these distances for each region and for the Moravian-Silesian Region. As data source for coordinates of buildings and number of flats inside was based on the Register of buildings (Czech Statistical Office) and is actual to 1/7/2008.

In table below **(tab. 3)** are displayed results for weighted average walking time from all flats and from all houses in the Region to the nearest public transport stop. The weight is equal to percentage of flats in the space distance from nearest stop. More than 55% of all flats are up to 500 meters from the stop and people from here walk more than 2 minutes to the stop. About 10% of flats are farther than 1 kilometer. Generally people in the Moravian-Silesian Region have to walk more than 6 minutes to the nearest stop. As written above commuters have to walk twice – firstly from home to stop and than from stop to work place, so the totally walking time can take more than 12 and half minutes. This number can be even higher, if we count only with active stops instead of all stops. Walking time from all houses in the Region is about 1 minute higher than in previous case.

Tab. 3 Weighted average walking time from houses to stops in the Moravian-Silesian Region. (source: author)

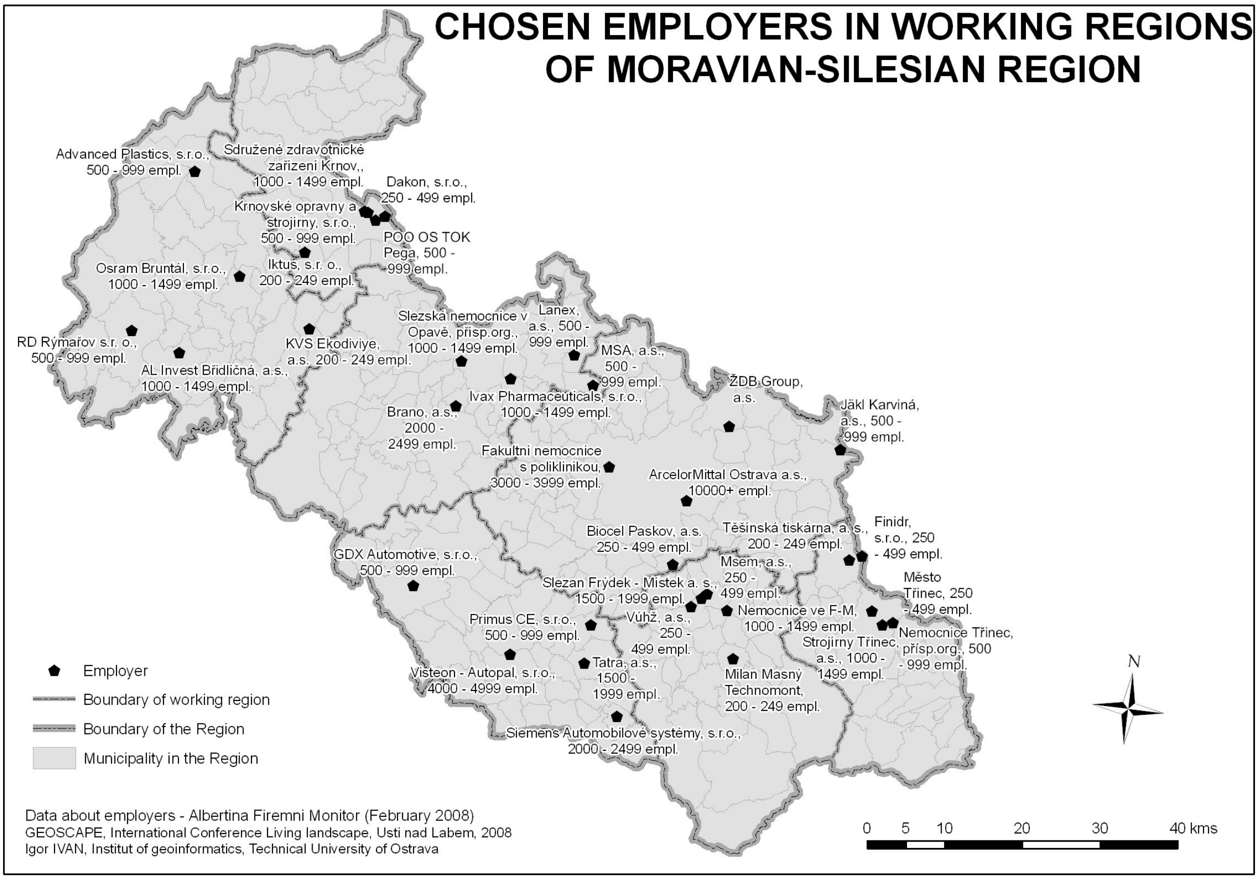
Space distance	**Weighted average walking time from flats***	**Weighted average walking time from houses***
to 500	2.12	1.93
500 - 1000	2.65	2.60
1000 - 2500	1.48	2.40
2500 - 5000	0.11	0.41
more than 5000	0.002	0.02
average walking time	6.36	7.36

Note: * in minutes

4. Door-to-door comuting to chosen employees

In the previous chapter the value was calculated with connection between all houses or only with houses with some flat. But what is the situation in some practical cases – in commuting to real employers. This walking situation was analyzed in special regions of the Moravian-Silesian Region. These special regions were calculated according to methodology from professor Hampl (Hampl 1996 or Ivan, Tvrdý 2007). The Region was divided in seven regions based on the commuting data from census in 2001. These can be named as working regions with one working center. The center was stated according to value of coefficient of functional size and the municipality in regions according to the most significant commuting flow from the municipality of origin to the municipality with work place. All seven working regions are relatively workingly closed and most of commuters commute to the regional center. It was chosen five employers in each working region, so totally 35 of them. It was tried to choose the biggest employers and the location of them should be more scattered, so the result is displayed in figure below **(fig. 5)**. The main goal is to compute the average walking time to stop of origin, walking time from target stop, time of journey and prize of journey from all houses in working region to all 5 employers. First of all was calculated the distance matrix between all stops in the Region with some overlap to surrounding Regions (5 kilometers behind the border, totally 4344 stops). Particular distances were taken from actual traffic order with utilization of NewDOK (see the chapter 2). The matrix is not complete, because between some of stops cannot be found any reasonable connection. Now we have computed the middle part of door-to-door commuting via public transport. The next stop is to calculate walking distances between houses and stops. Like it is written above, the commuter should have the possibility of choice, which stop he will use. But some condition had to be stated, so each commuter can choose from five closest stops and maximally 5 kilometers from house via street network. After this step was calculated other distance matrix – between all houses and five closest stops (if those exist within 5 kilometers) – and we have the first and the last component for door-to-door commuting calculation. Then we can choose minimal values of travel distance between all houses and 35 buildings as work places.

Fig. 5 Chosen employers in working regions. (source: author)



4.1 The most usable stop

From results can be calculated utilization of each of chosen five closest stops in working regions. As it is displayed in **tab. 4**, most of commuters should use the closest stop to their home in each region (between 27 to 40 % of houses), then the third or the fifth. The situation in regions is similar.

Tab. 4 Order of used stop by walking from home to stop. (source: author)

Working region	**Order of used stop (in %)**				
	1	2	3	4	5
Bruntál region	27.4	14.4	20.3	16.6	21.4
Frýdek-Místek region	28.1	14.4	20.7	14.5	22.2
Třinec region	33.0	15.5	19.2	12.8	19.6
Krnov region	39.5	16.5	17.2	11.5	15.4
Nový Jičín region	28.6	17.6	20.1	15.9	17.8
Opava region	34.8	17.9	18.9	12.7	15.7
Ostrava region	36.0	8.5	23.7	8.5	23.3

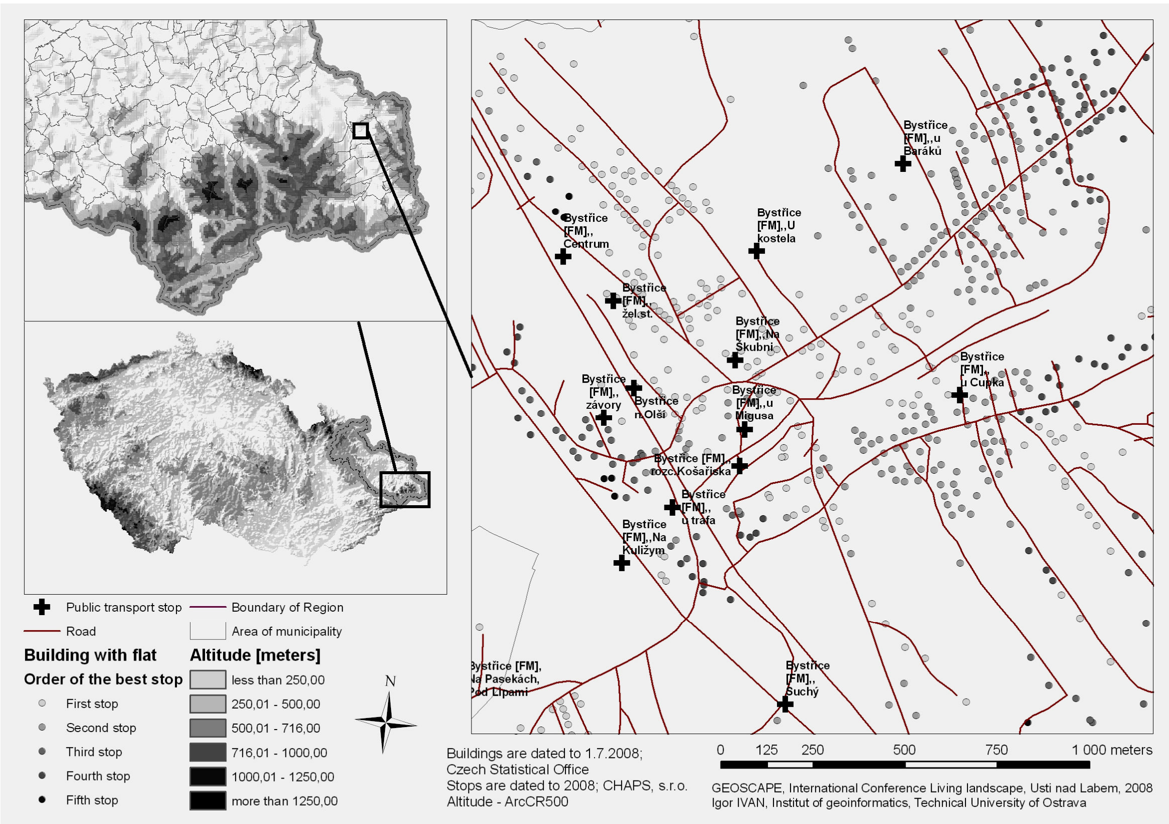
The situation with the utilization of the stop near work place is displayed in the next table **(tab. 5)**. These results are similar to the previous. In regions of Bruntál and Ostrava is most used the first stop and then the third and the fifth. Very interesting and unique usage of stop is in Třinec region, where more than 60% of all commutes should use the fourth closest stop. In other regions is the best choice to use the third stop.

Tab. 5 Order of used stop by walking from stop to work place. (source: author)

Working region	Order of used stop (in %)				
	1	2	3	4	5
Bruntál region	33.3	12.2	16.7	20.1	17.8
Frýdek-Místek region	34.4	4.2	10.3	45.6	5.4
Třinec region	14.7	0.8	64.6	0.2	19.7
Krnov region	24.3	21.2	11.5	11.0	32.1
Nový Jičín region	22.8	44.7	11.2	19.0	2.2
Opava region	27.6	12.5	25.7	31.4	2.8
Ostrava region	42.4	1.8	24.8	1.3	29.7

In map below is displayed the situation in small area near Třinec in Bystřice nad Olší. Particular houses are colored under the rank of best stop to use and so grouped to bigger blocks. There are some buildings, which are very close to some stop, but the color of the building shows, that commuter should use some farther stop.

Fig. 6 Situation with stop preferration in small area. (source: author)



4.2 Walking time to and from the most useable stop

In chapter above were computed the walking times to the closest stop. Now this evaluation can be upgraded and these times can be evaluated to the best stop to use for commuting to one of five employers in each working region. The results are in **tab. 6**. If the situation with walking time on previous case was about 7 minutes, now is this situation in average about 14 minutes. This is caused by usage other than the closest stop. The longest is the walk to stop in Bruntál region (more than 16 minutes) and the smallest in Ostrava region (less than 12 minutes). In all regions is the walking time less in case of walk from stop to work place then from home to stop. This can be explained with better location of these big employers considering to location of stops. Even more evident is this situation in maximum, where is the difference about 40 minutes.

Tab. 6 Average walking time to and from the most useable stop. (source: author)

Working region	Mean*		Std. Deviation*		Maximum*	
	to stop	from stop	to stop	from stop	to stop	from stop
Bruntál region	16.17	14.50	12.73	8.13	62.43	26.73
Frýdek-Místek region	15.52	13.00	9.91	8.63	62.49	26.89
Třinec region	15.85	12.50	11.57	4.59	62.42	18.89
Krnov region	12.85	12.17	9.90	5.57	62.19	23.94
Nový Jičín region	13.25	9.36	8.58	3.00	60.57	22.99
Opava region	12.01	10.66	9.77	3.76	62.01	16.05
Ostrava region	11.68	6.10	7.58	3.02	53.73	13.35

Note: *In minutes.

4.3 Impact of altitude on commuting

The situation with transport services can depend on many elements. One of these is surely the altitude. In higher altitudes live less people, so with higher altitudes should be the transport services poorer. This idea is supported with results in **tab. 7**. With higher altitude are higher walking times to stop as well. In first interval to 200 meters is average walking time about nine minutes to stop near home and 5 minutes from stop to work place. But in interval between 400 and 500 meters above sea-level is this time almost 16 minutes (11.5 minutes). In the highest altitudes is the situation worst. The walking time is more than 25.5 minutes. The increase of walking time from final stop to work place is not so evident, because the commuters could use the same final stop. Only if the bus or train link from higher altitudes has stop near work place, but not so close as other links from lower altitudes.

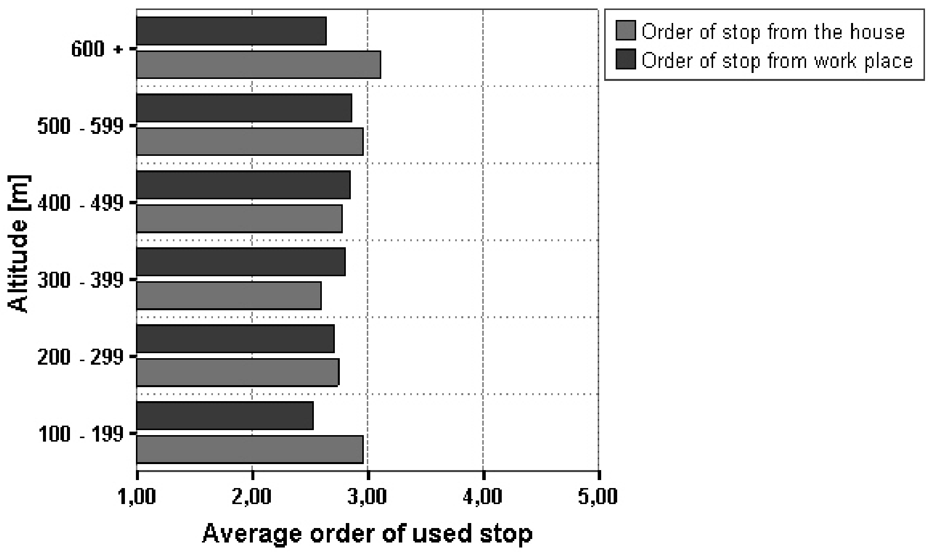
Order of best stop to use is different in each altitude interval. In graph below is displayed the average order of stop to use. The highest number of stop is in altitude interval 600 and higher meters, where commuters should use third and farther stop. Similar situation is on the other side, in altitude less than 200 meters and between 500 and 600 meters. Only in altitude from 300 to 500 meters is the average order of stop higher in the journey from stop tp work place than from house to stop. In any region is not the average order of stop less than 2.5.

Tab. 7 Average walking time to and from the most useable stop in accordance to altitude. (source: author)

Altitude [m]	Mean*		Std. Deviation*		Maximum*	
	to stop	from stop	to stop	from stop	to stop	from stop
100 - 199	9.10	5.33	5.66	3.56	37.09	10.85
200 - 299	11.46	7.31	7.38	4.02	60.51	23.94
300 - 399	12.81	11.11	8.48	6.23	62.21	26.89
400 - 499	15.85	11.46	10.55	6.47	62.49	26.73
500 - 599	17.94	13.11	12.56	7.38	62.45	26.89
600 +	25.66	13.08	15.67	8.03	62.45	26.89

Note: *In minutes

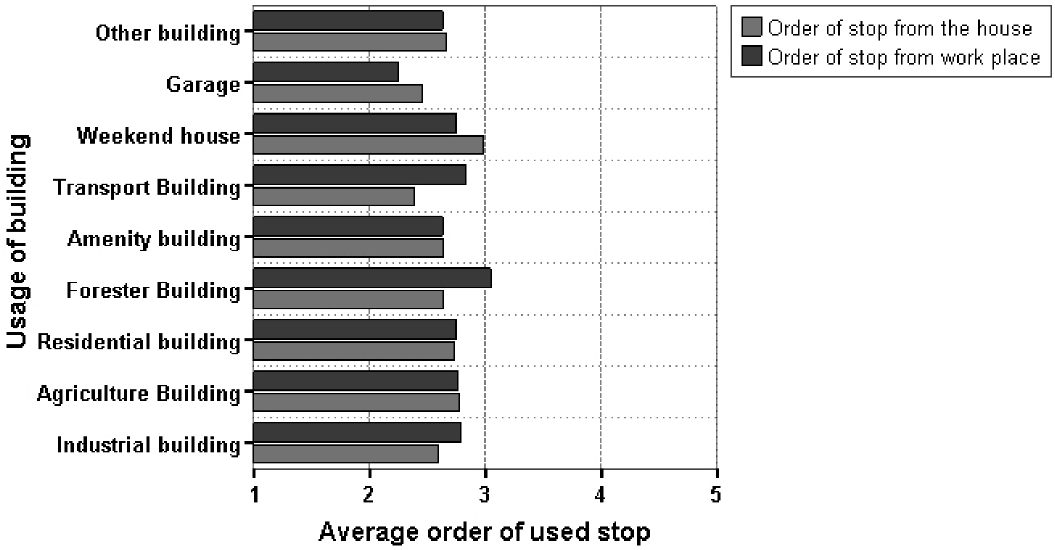
Fig. 7 Average order of stop to use in accordance to altitude. (source: author)



4.4 Impact of usage of building on commuting

The used data source – register of buildings – includes many attributes about buildings. One of these is the usage of building. Buildings are divided in nine groups, which are named in graph below. In this graph is displayed the average order of stop to use according to usage of that building. The most important type for commuting are residential buildings, which are not extraordinary in comparison to others types. The commuters from here should not prefer the first or last stop, but the second or third. The difference in chosen stop order near house and work place is not significant.

Fig. 8 Average order of stop to use in accordance to usage of building. (source: author)



Very interesting is the situation in walking times to the best stop based on types of buildings. The smallest times are by amenity and transport buildings or garages, where is the average walking time to stop between 9 and 10 minutes. These types of buildings are mainly located in city centres, so closed to many stops, what confirms the situation in graph above, where are the smallest values in average rank of used stop for commuting. Average walking times from residential buildings are similar to industrial buildings and commuters should commute in average from 11 to 12.5 minutes. By buildings that are mainly located in rural areas are the biggest walking times, because usable stops for commuting are situated farther. To these buildings belong agriculture buildings where the average walking time is more than 15.5 minutes and weekend houses with almost 23 minutes. Walking times from target stop to work place are very similar and the explanation is the same as in previous case.

Tab. 8 Average walking time to and from the most useable stop in accordance to usage of building. (source: author)

Usage of building	Mean*		Std. Deviation*		Maximum*	
	to stop	from stop	to stop	from stop	to stop	from stop
Industrial building	11.09	11.74	7.68	6.46	61.84	26.89
Agriculture building	15.65	9.36	10.22	5.34	61.28	26.73
Residential building	12.52	8.90	8.65	5.54	62.43	26.89
Forester building	19.51	11.97	14.03	6.28	60.39	25.01
Amenity building	9.54	9.80	8.29	5.81	60.12	26.89
Transport building	9.06	11.37	7.18	6.11	39.42	25.01
Weekend house	22.83	12.05	12.29	7.42	62.49	26.89
Garage	9.66	9.53	5.22	4.87	30.42	25.01
Other building	12.80	9.48	9.35	5.36	60.30	26.89

Note: *In minutes.

4.5 Impact of number of flats inside the building on commuting

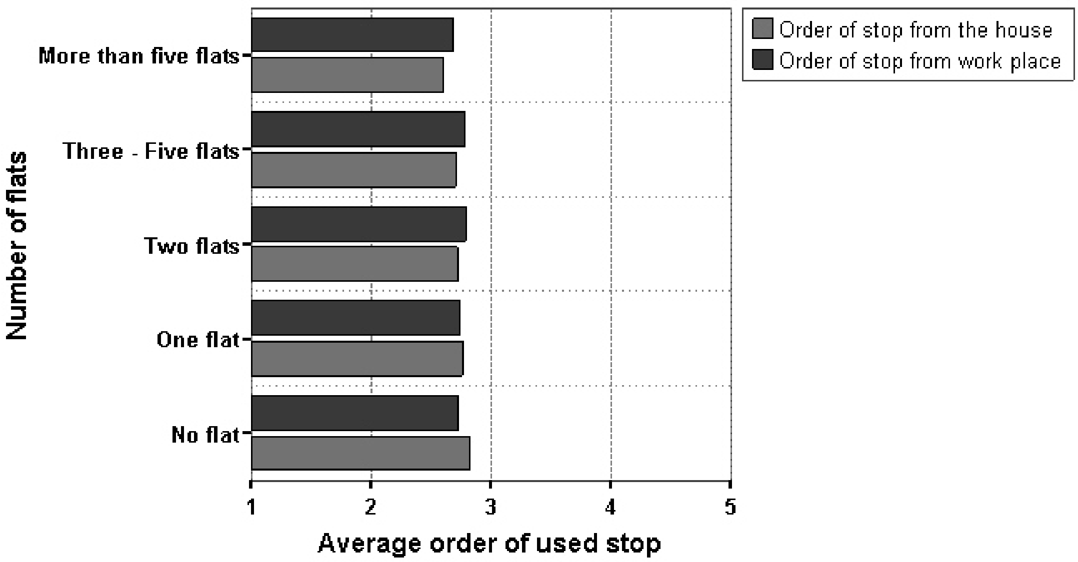
Other interesting attribute from register of buildings is number of flats inside the building. Buildings without any flat are farther from usable stop and commuters from these buildings should walk more than 18 minutes. With rising count of flats fall the averages of walking times. Commuters from buildings with two flats should walk more than 12 minutes. The least walking time is in case of buildings with more than five flats, from where is average walking time almost 8.5 minutes. The same progress is in case of standard deviation or maximum.

In average order of used stop is not any significant difference based on number of flats inside the buildings. Commuters from buildings without any flats or with only one flat should prefer closer stop to work place than from their home.

Tab. 9 Average walking time to and from the most useable stop in accordance to number of flats. (source: author)

Number of flats	**Mean***		**Std. Deviation***		**Maximum***	
	to stop	from stop	to stop	from stop	to stop	from stop
No flat	18.09	11.84	12.29	6.82	62.49	26.89
One flat	13.30	9.02	9.09	5.76	62.45	26.89
Two flats	12.34	8.72	8.25	4.97	62.32	26.89
Three - five flats	10.52	8.97	7.17	5.27	57.76	26.89
More than five flats	8.42	7.93	5.20	4.96	59.34	26.89

Fig. 9 Average order of stop to use in accordance to number of flats. (source: author)



4.6 Influence of walking times on door-to-door journey via public transport

In the **tab. 10** are displayed values for each employer. In first column are names of employers. The second column contains average walking times to home stop. The longest walk to home stop is by Město Třinec in Třinec region, Osram Bruntál, RD Rýmařov a AL Inv. Břidličná (all in Bruntál region). The walking time here is bigger than 16 minutes. The smallest walking time (about 12 minutes) time is by commuting to ArcelorMittal in Ostrava region or Brano in Opava region. The bigest walking times from target stop to work place are in cases of KVS Ekodivize or Osram Bruntál, both in Bruntál region with more than 20 minutes of walk. It is naturally, that the longest journey to work will be in the largest regions – Bruntál, Ostrava or Opava region. Better for understanding of door-to-door approach importance is the influence of both walking times on the whole journey to work. In some cases (7 employers from 35) the walking process doubles the whole journey. Commuters who want to commute to companies Osram Bruntál or Slezan Frýdek-Místek have to commute thanks to walking to stop and from stop about more than 130% longer time. The commuting time will be extended about less than 50% by walking times in case of 10 companies. At least than in case of Biocel Paskov, Jäkl Karviná or ŽDB Group Bohumín, where is the extension caused by door-to-door approach only 35%. The column with prizes is only orientation, because not every transporter got the prize rates to traffic order provider.

Tab. 10 Average walking time and influence of walking times on journey to each employer. (source: author)

Employer	Walking time to home stop	Time of travel	Walking time from work stop	Influence of walking times on journey	Time of door-to-door travel	Prize
GDX Automotive	13.34	58.66	11.03	41.55%	83.03	13 Kč
KVS Ekodivize	15.52	41.02	23.34	94.75%	79.88	16 Kč
Technomont	15.57	41.62	20.26	86.09%	77.44	16 Kč
Slezská nem.	16.11	55.00	5.91	40.03%	77.02	16 Kč
Jäkl Karviná	11.43	56.19	8.55	35.56%	76.18	11 Kč
Siemens aut. sys.	13.53	52.82	7.44	39.71%	73.79	14 Kč
Iktus	14.06	44.92	13.78	61.96%	72.76	14 Kč
Autopal	13.38	48.18	9.25	46.95%	70.81	13 Kč
MSA, a.s.	11.62	43.43	13.81	58.54%	68.86	12 Kč
Adv. Plastics	15.50	41.95	9.82	60.36%	67.27	15 Kč
AL Inv. Břidličná	16.47	38.50	11.95	73.79%	66.92	16 Kč
Osram Bruntál	16.59	28.57	21.69	134.00%	66.85	17 Kč
Biocel Paskov	12.09	48.79	5.41	35.87%	66.29	12 Kč
Fakultní nem.	11.16	45.28	8.41	43.22%	64.85	11 Kč
Vúhž, a.s.	15.53	27.87	19.55	125.85%	62.95	16 Kč
ŽDB Group, a.s.	12.23	45.27	3.64	35.07%	61.15	12 Kč
Nemocn. Třinec	15.91	27.61	17.44	120.76%	60.96	16 Kč
RD Rýmařov	16.54	39.11	5.06	55.21%	60.71	17 Kč
Msem, a.s.	15.52	38.31	6.36	57.13%	60.19	16 Kč
Primus CE	12.83	33.73	11.90	73.33%	58.46	13 Kč
Ivax Pharmac.	11.95	37.93	8.16	53.04%	58.04	12 Kč
Lanex, a.s.	10.73	37.09	9.97	55.81%	57.79	11 Kč
Slezan F - M	15.58	23.91	17.45	138.12%	56.94	16 Kč

Finidr, s.r.o.	15.74	24.38	15.30	127.36%	55.42	16 Kč
Město Třinec	18.32	33.11	3.76	66.70%	55.19	18 Kč
Tatra, a.s.	13.21	33.62	7.56	61.78%	54.39	13 Kč
Brano, a.s.	12.33	29.72	12.06	82.06%	54.11	12 Kč
Těšínská tiskárna	15.55	26.83	10.55	97.26%	52.93	16 Kč
Dakon, s.r.o.	12.57	23.57	16.09	121.57%	52.22	13 Kč
Strojírny Třinec	15.91	27.98	7.76	84.60%	51.64	16 Kč
Nem. ve F - M	15.40	34.25	1.48	49.26%	51.12	15 Kč
ArcelorMittal	11.32	34.14	5.07	48.01%	50.53	11 Kč
Krn. opravny	12.92	27.42	9.90	83.22%	50.24	13 Kč
Pega	12.51	20.92	11.22	113.41%	44.65	13 Kč

5. Conclusions

The main goal of this project is to prove the importance of door-to-door approach by commuting analysis. Calculated service regions showed the existence of very large areas, where this approach is very useful and can change the results very significantly. Service areas cover on the average 2.4 square kilometers, but the maximum is even 33 square kilometers. But not all stops have some bigger importance, there are local stops, which were located and without these stops are the service areas on the average 3.1 (first condition) or 2.6 (second condition) square kilometers big. The maximal area is then even bigger than 100 square kilometers.

In all previous chapters is evident the existence of areas with longer walking distance. The Moravian-Silesian Region was split in seven working regions. For the whole Region and all smaller working regions was calculated weighted average walking time. As weights were stated percentages of flats or houses in one of 4 distance intervals. For all flats in the Region is the average walking time almost 6.5 minutes and from houses about one minute longer.

As chosen employers were selected 35 companies, in every working region 5 companies. Door-to-door commuting time from every house to each employer was computed. Every commuter has possibility to choose the best stop in the neighborhood, so from results was analyzed the most used stop, not only the closest one. Almost 40% of commuters should use the closest stop in region Ostrava, but in region Bruntál is the ratio only 27%. Second best stop to use is the third or the fifth. Difference in preferred stop can be found by walk to stop from home and from stop to work place. Average walking time is quite longer, if we analyzed the journeys to real employers and with possibility of choice of the best stop instead of previous condition of the closest stop. The average walking time is in this case about 14 minutes, but the situation is different in each working regions.

On walking time or preferred stop have some influence many factors, some of these were analyzed too. Altitude has a big influence, with higher altitude are higher walking times to stop as well. In altitude higher than 600 meters is the walking time bigger than 25 minutes. So the usage of buildings shows interesting conclusions. Commuters from weekend houses or forester buildings have to walk more 19 minutes. The smallest walking times are from transport or amenity buildings (only 9 minutes). The last analyzed influence was the number of flats in buildings. With rising count of flats fall the averages of walking times.

All these numbers can prove the importance of commuting, because the walking time can have in some cases the same or even longer duration as the journey in public vehicle itself. These prove the situation of some cases (7 employers from 35), where the walking process doubles the whole journey.

Appendix

A) Accessibility of the chosen stops in LAU centers

Stop of origin	Accessible from stops		Inaccessible from stops	
	for 8 o'clock	for 14 o'clock	for 8 o'clock	for 14 o'clock
Bruntál,žel.st.*	313	325	3 585	3 573
Bruntál**	154	180	3 744	3 718
Frýdek-Místek,Frýdek, aut. nádr.*	1 954	1 957	1 944	1 941
Frýdek-Místek**	1 787	1 551	2 111	2 347
Karviná hl.n.**	1 369	1 354	2 529	2 544
Karviná,Fryštát, aut. nádr.*	1 742	1 345	2 156	2 553
Nový Jičín město**	800	710	3 098	3 188
Nový Jičín, aut .nádr.*	1 136	828	2 762	3 070
Opava východ**	839	912	3 059	2 986
Opava ,nemocnice*	935	267	2 963	3 631
Ostrava-Svinov**	2 195	1 990	1 703	1 908
Ostrava hl.n.**	1 980	1 894	1 918	2 004
Ostrava ,ÚAN*	2 184	1 816	1 714	2 082

Note: * bus stops, ** train station.

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Role of public spaces in old urban texture

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Abstract

In the world, every object requires preserver and reinforcement in order to survive. Every article which stops movement is condemned to die. So, one of the best and simple ways of survival is sustaining to movement. The best solution for survival of an object is the preservation of its movement.

The main solution for survival of an urban texture is continuity of important urban public and comprehensive places. In this article, public spaces such as cultural, religious, governmental, and scientific centers are introduced as important urban centers and their roles in stability and survival of the city are expressed. For an instance, it will be referred to some religious and cultural spaces in Islamic countries. In simple words, the hypothesis of the research is defined as follows.

Public spaces are hearts of cities. A way of their stability is the preservation of continuity and updating the survival of them.

Keywords: sustainability; public spaces; urban design; architecture

1. Introduction

The beginning and end of the life cycle of a plant involve a core and its central part that indicate the name and identity of total plant.

It is possible to forget previous name of a plant, when it is dried, but its seed preserves it and it can revival the plant's identity after passing special phases.

If there are proper seeds developing in proportionate condition, the result will be a defect plant the fact is that incorrect selection of seed lead to unusable plant in spite of correct planting stages. The name and identity of a person is determined by his/her ancestor's identity, when he/she obtains new personality; it is dominated, so the firm and strong part of a person's identity is his/her family's eternal part.

A residential texture is a complete of adjacent units; these residential units are gathering together in order to develop a texture. The identity of a place, a village or a city is the name that it is known from early days and it is fixed section of a texture which indicates current history. It is impossible to extract the identity from the appearance but the importance of a result urban complete is observable.

The aim of authors to introduce public and governmental places as main parts of an urban texture and its identity in order is propose new solutions.

Surely, we have asked about our identity and the relationship between our tasks with our personalities the best answer to these questions in scientific, religious and philosophical texts is that our behavior, environment and persons who I have Relationship with them create my personality then I am distinguished accordingly even my appurtenance is firmed. So an alive creature is recognized by his/her surrounding.

We want to consider this creature larger than a human, an animal or a plant. We propose the author's opinions about investigation about old and traditional residential texture in old cities of Iran.

2. The parish as an alive creature

A parish is a complete of neighborhood units, residential, public, and commercial and service units, their residents can meet their daily requirement in this limitation so these units can act as a group and participate in some activities as a co-group. The formation of cultural and sport groups is different from other daily behavior with neighbors by passing the time and more relationship with people. So, the parish and its physical limitation change to parish behavioral meeting place and related activities lead to active and stable place.

3. Place-parish Behavior

The main subject of the article is place-parish behavior that is the main reason for importance of parish special places and as a consequences parish identity and behavior.

The public place that can service the special individuals of a society in small scale lead to attendance of population in these places . They related to vacant space but in this case they are affected by natural and unnatural surrounding.

So, a humanistic environment creates place for group activities. A behavior is shaped gradually and then it is established by residents, space is a new identity proportionate with individual's performance in space. The good or bad value of place-behavior relate to behavior value, but this issue is not One-way-for example, anti-behavior is not shaped around religious place of teenagers do not gather around adult service offering places. In order to establish such a meeting place it should create required place for majority of population. The experience showed that the changes in places lead to changes in environmental behavior and as a result changes in identity of parish even it have symbolic aspect it can resist against new activities.

The studies in Tabriz indicated that small changes in behavior of old parish cause to demolition of identity and create parish with new identity. Sensible changes do not lead to renewal of parish structure with strong center.

In 70 to and 80 decades the urban designer did not care about the identity of cities in demolition of valuable parishes. In explanation of results, it can be referred to followings:

- The parishes with valuable masques with centrality around mosque have been recognized as parishes with Islamic and religious believes in daily activities and behavior.

- If the mosque and its surrounding preserve its old shape, similar behaviors are observable and the identity of parish does not change.

- In parish that its main place-behavior was a Bazar or square, the attendance of population shaped its fundamental identity.

- Unfortunately this identity has been loosed because of demolition of majority of these places or changes in identity. Poets and authors have been growth in these places.

- In some parishes, there is no special monument and place-behavior because of lack of unity in complexes and diversity of culture and personalities.

In large scale, it can be said that these places create a city depend on strength and level of different activities in important urban centers with strong characteristics, the city have had identity. Some of these identical centers and symbols are observable because of public and social value. They are recognized as civic elements. So a city with more parish centers has high architectural and social value in case of admission this theory, it can be used in three sections as a recognition tool:

a) Past: they are categorized as identical cities with historical and cultural precedence that main activities are conducted there.

b) Present: by recognition of important centers, it can be programmed in order to strengthening of parish and residential textures identity and eternal value.

It should be noted that these activities do not weaken these centers and reduce place-behavior.

c) Future: the investigation in Gheshm Island showed that new parishes have been built around mosques and houses of the great persons it means that the special places with proper behavior should be constructed according to design.

4. Conclusions

The total results and the manner of their application have been explained in text. Shaping of parishes identity and their revival have been carried out in four stages:

a) First stage: building and organization of required place for proper behavior.

b) Second stage: shaping defined behaviors special for places.

c) Third stage: giving place-behavioral identity to surrounding monuments and complexes.

d) Fourth stage: changing place to district index -depend on plan scale and identity of texture.

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Geothermal potential in the area at the ridge of the Ore Mountains (Krušné hory)

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Abstract

The submitted article represents one of the partial outputs of the project called MMR No. WD-44-01-1 – „ Model Solutions of Revitalization of Industrial Regions and Abandoned Mine Areas Shown at the Example of the Landscape Under the Ridge of Krušné hory". In 2007 the inventarization of disparities in the interest area was made. Among the significant disparities of the rock environment there is the occurence of geothermal energy, too.

This year a more detailed investigation of this perspective alternative energy source has been done. This paper contains basic information about their occurrence and the methodics of investigation of the relations between the geological architecture, the structure of the area and the water temperature.

Keywords: disparities; geological environment; geothermal energy; geological structure; hydro-structure; hydrotermal sources

1. Introduction

The submitted paper deals with structural geological conditions of the occurrence of geothermal energy in the area under the ridge of Krušné hory, especially in the area between the cities of Ústí n.L. and Chomutov.

This area is known – from the point of view of occurence of geothermal energy in the Czech Republic - as an anomalous one. In the last thirty years specialists have concentrated at this area, however this alternative source of energy has not been used in a larger extent.

More detailed studies and the following comparison of the character and features of geothermal energy in partial geological units has not been done in this area, as well as a more detailed search for causalities between the tectonics of the investigated area and the incidence of geothermal energy.

The processing of research outputs by utilization of the Geographic information system has brought a new view at the whole problem.

2. Regional setting

The delimitation of the investigated area of interest went through many corrections. Its boundaries were set at the base of a detailed background research of existing studies. The anomalous thermic area does not end with the eastern border of the district of Ústí, but continues till the surroundings of Děčín and Benešov nad Ploučnicí.

The research work was focused at four neighbouring units of administration – at the districts of Ústí nad Labem, Teplice, Most a Chomutov. Deciding factors therefor were the cumulation of the occurrence of thermal waters in all these districts, the amount of data about their features and differences in the character of geothermal systems, bound to three different geological environments. In this relatively small area varied hydrogeological conditions can be found. The main challenge was to compare the occurrence of thermal waters in connection with the geological and tectonic composition and to look for differences and, eventually, for continuities.

3. Materials and methods

As a unifiyng milieu for the division of objects (hydrological boreholes) the so called "groundwater zones" were chosen, that are considered to be the basic regional units for underground water balancing nowadays. Four groundwaer zones enter into the investigated area: the Basin of Most, The Chalk of the lower Elb up to Děčín – left riverside, The Chalk of the lower Elbe – right riverside and Crystalinikum in the eastern part of Krušné hory.

The character of the hydrogeological zones and the positional occurrence of the hydrological boreholes formed the base by specifying three research areas.

These areas were specified according to their dominant geological character and called hydrostructures. It concerns the hydrostructures occurring mainly in rocks of the Cretaceous period, Primary (rhyolite) and Tertiary origin. The single structures can be found approximately within the existing borders of the units of administration - the districts of Ústí nad Labem, Teplice, Most and Chomutov. Subsequently, the single structures were entitled The Hydrostructure of Ústí, The Hydrostructure of Teplice and The Hydrostructure of Most and Chomutov.

Within each hydrostructure there are partial structures, which are specified by the above mentioned groundwater zones.

By this way three expressively different environments of geothermal energy occurrence were itemized, that can be assessed and compared each other.

Their boundaries are given by their tectonic restrictions or by the basic change of leading collectors, i.e. by their different lithological composition and thereby by the change of paleofacial, filtering and hydraulic parameters.

The single structures were described according to the aspect of their extent, geological architecture, tectonics, hydrogeological charachteristics, chemism and of their temperature, of course.

The information has been worked up graphically in appropriate thematic levels.

4. Results

Characteristics and comparisons of the three hydrostructures (Ústí, Teplice and Most-Chomutov)

4.1 Geology

The majority of thermal aquifers in the Ústí Structure were cought in the rocks of Upper Cretaceous cenomanian and turonian. From the lithological point of view the sandstone alternating with claystones dominate there. The aquifers inhere in the depths of about 300 – 450 meters.

The thermal waters in the Structure of Teplice rise above in clefts in the Paleozoic rhyolite.

In several boreholes the thermal waters occur in the upper cretaceous rocks. It relates to the east and south-east margins and the surroundings of Teplice. In the partial structure of Háj-Osek the Paleozoic rhyolite dominates as the aquiferous environment. At the eastern margin of this group of boreholes, near Osek, the chalk was found. All waters in rhyolite are fissure waters and that is why they occur in various depths. There are big differences – from several meters up to hundreds of meters.

In the Structure of Most-Chomutov the aquiferous rocks are mostly of Miocene origin. At some places they are of unidentifiable neogéne origin.

Chalk deposits were found in the thermal water boreholes in the partial structures of ČSLA-Jezeří and Strupčice-Havraň and in single boreholes in the Bohemian Central Mountains (České středohoří).

4.2 Tectonics

The whole modeling territory is characterized not only by its various geological structures, but also by its tectonic pattern.

The main tectonic lines demarcate the area of interest in the following way: the west border is formed by the Doupovské hory and in the east it is the valley of the Elbe river.

Krušné hory (The Ore Mountains) with their picturesque chain of faults create the northern border, while in the south it is the fault of Litoměřice, a part of the Rift of Ohře.

The Structure of Teplice is afflicted with tectonics mostly. There is a row of important dip and multiple faults (towards the main tectonic line of the chain of faults of Krušné hory).

There is a markedly lower number of faults in the Structure of Ústí. The most important tectonic line is the chain of faults of Krušné hory. Another important role the faults have coming from the southeast (the fault of Malečov-Okřešice).

4.3 Chemism

It is very difficult to compare the single structures because of the different number of chemical analyses (the Structure Ústí – 16, Teplice – 157, Most-Chomutov – 29). The dominating character of hydrodynamic types, defined on the basis of chemical analyses is as follows:

There is a significant amount of alkali in all waters. Most Na+ is found in the samples from the Structure Ústí. So it is possible to mark these waters as pure, genuine alkali waters, thanks to the dominating Na+ and HCO3- ions.

A little lower in Na+ but most of HCO3- contain the waters of the Structure Teplice. They can be marked as pure alkali waters as well.

All samples with temperature above 25 degrees centigrade are additionally marked with the word “teplice” (warm water).

The waters of the Therme of Ústí have a higher rate of F- locally. Some waters in the Structure of Teplice contain a significant amount of radon.

4.4 Water Temperature

When selecting data from the hydro database (Sine 2001), the lower limit for the water temperature was set by 15° C. The main reason therefore was to get as much high quality and comparable data from the investigated area as possible, despite of the norm that denotes waters as thermal waters only when their temperature exceedes 25° C.

The group of boreholes with water temperature between 15 and 19.9°C takes nearly one third of all data. There is a danger here that the water is not warmed up by geothermal heat, but that the source of warmth is of anthropogenic origin, like in case of a near landfill. However, this has not been prooved.

The dominant position in the investigated area occupies the Structure of Teplice. Because of its extent, of the number of documentary points and of the highest temperatures it impacts the characteristics of the whole region.

The temperature of thermal waters in the Structure of Ústí moves between 15.5 and 32.7°C. The warmest water was found in the borehole northward from Ústí, in Strážky.

In the hydrothermal Structure of Teplice the temperature of thermal waters moves between 15 and 48.2°C. Waters with temperature above 35°C occur only in this structure.

The temperature of waters in the investigated boreholes in the Structure Most-Chomutov moves between 15 and 33°C. The highest temperature was found only in a single borehole in the partial structure ČSLA-Jezeří. The waters with temperatures between 15 and 19.9°C are prevailing. There is an exception - warm waters (45°C) between the localities of Březno and Droužkovice. However, there are anthropogenic impacts, it relates to the area of underground coal combustion. Another exception represents the borehole DO 332 southwards of Chomutov with temperature of 42°C. A new revision will be necessary there to confirm the acquired data (Bejšovec, Milíč 1995).

4.5 The vulnerability of hydrostructures

The risks of vulnerability of hydrothermal groundwater bodies arise from the mining activities and their following effects, from the posible contamination by industrial enterprises or by densely populated areas and from their overdrawal - which represents the most serious endangerment nowadays.

4.6 The Structure of Ústí

A significant risk is over in this area: the mining operations were stopped. However, there is a heavy fear that the quality and temerature of the water could be endangered.

The surface contamination can influence the quality of thermic wells when they are interconnected with polluted and colder waters from shallow groundwater bodies or through artificial ways, eg. test holes or exploitative holes.

The biggest issue, which is beeing solved by elaborating balances of thermal waters, is the already mentioned possibility of overdrawal of a hydrothermal source. The quantity protection is necessary because of the limited capacity of the underground body. There is a certain doubt that the demands for their exploitation are probably reaching their maximal usable limits.

4.7 The Structure of Teplice

The most significant risk of the vulnerability of the Structure of Teplice has been the coal-mining. The allotments of brown coal are reaching the very proximity of the hydrostructure. The impact of contamination from the surface is possible due to the fact that a large part of the area has a high fissure permeability.

Thanks to the spa protective zones the contamination has been minimalized. The impacts of coal-mining came to light dramatically several times in the history.

Destruction of a thermic well was caused by a wateroutbreak in the Döllinger-mine on February 10th, 1879. At that time the overflow was lost and the level of Pravřídlo (Urquell) sunk very low (in the Teplice-line), while the overflow of Horský pramen (in the Šanov-line) sunk only a little.

In the area of both lines there were 14 springs. Next wateroutbreaks followed in the years 1888, 1892 and 1897. The overflow of warm waters of Obří pramen near Lahošť disappeared in 1878, one year prior to the Döllinger wateroutbreak.

4.8 The structure of Most-Chomutov

The vulnerability of groundwater bodies in this structure is caused by the mining operations first of all. The most important groundwater body, bound to the aquifers of brown-coal groups of strata, has a free level as a result of intensive coal-mining and drainaging of allotments. The hutch water pumping causes an artificial slant of the underground water level and accelerates the water circulation at the same time. Removal of the top soils lowers the potency of the „insulator“ of thermal waters. There are allotments that were or still are exploited. Subsequent manifestations of the mining operations in form of dumps (inner dumps, outer dumps, dumps in abandoned mines) complicate the utilization of warm waters. Landfills of municipal and other waste as well as large industrial enterprises (Chemopetrol Litvínov) are potential polluters, not only of thermal groundwater bodies. This risk is lowered a little through a certain natural barrier of impermeable or low permeable rocks.

5. Discussion

The Geothermal Potential in the Area under the Ridge of Krušné hory: The perspectives of the geothermal potential in the in the surveyed area are not geologically and tectonically identic, but in spite of that it is possible to find common factors that enable or deteriorate the ascension of geothermal energy to the surface and so they increase or suppress the amount of geothermal potential.

Since this is an experimental study only, the calculations came out from the capacity of 161 investigated boreholes and their thermal and capacitance values (Sine 2001; Blažková 2002).

The energetical efficiency of the geothermal energy in the 161 measured points in all three structures is as follows:

a) The Structure of Ústí, 20 boreholes - 14.66MW

b) The Structuere of Teplice, 114 boreholes - 29.83MW

c) The Structure of Most, 27 boreholes - 2.1MW

d) Total, 161 boreholes in the area - 46.00MW

This paper has not dealt with economical relations in the course of geothermal energy utilization in a much more profound way. Nowadays this one just as other alternative sources of energy is not able to compete with the energy gained by combusting of traditional fossil fuels. The reneweable sources have two great advantages, however. They are practically of an endless perspective and they are environmentaly friendly (Myslil 1986; Blažková 2002).

6. Conclusions

a) The surveyed area was described from the viewpoint of its hydrogeological, geological and tectonic composition.

b) Three basic hydrostructures were defined in terms of hydrogeological and geological conditions in this paper: the structures of Ústí, Teplice and Most-Chomutov

c) Single hydrostructures were compared according to the occurrence of thermal waters (verified by the boreholes in the hydrodatabase) and their vulnerability was checked.

d) The geothermal potential was calculated at an experimental level, using concrete data (161 boreholes).

e) The research work will go on next year. The gained findings will be reassumed by research of other sources of geothermal potential such as the possibilities of utilization of hutch waters etc. (Myslil 1986)

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Editor´s comment

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