Edited by

Miroslav Vysoudil · Barbara Lampič · Wolfgang Sulzer

SUSTAINABLE ENVIRONMENTAL RESEARCH

Promoting International Cooperation and Mutual Assistance in Natural Parks

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Sustainable Environmental Research: Promoting International Cooperation and Mutual Assistance in Natural Parks

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Reviews

This volume addresses several issues which in the last decades have become crucial challenges of spatial and environmental development. In the context of the enlarged and still growing European Union the most important aspects might be:

- Nature conservation: The necessity of ensuring an ecologically intact environment led to the establishment of protected areas in every European state based on a national legal framework. New paradigms have created new demands in environmental protection such as e.g. participation of the local population, international coordination of protection measures, and management of protected areas.
- Sustainability: Nature conservation can no longer be an isolated field of policy as it has frequently been in the past. According to the concept of sustainability which has become a guideline for the further development of the European Union in recent years regional planning processes have to deal not only with ecological but also with economical and social issues. In this way environmental policy now is intensively connected to a lot of other policies at all spatial scales from local to global.
- International research: These challenges forced science to create new approaches suitable for dealing with complex interactions of natural, economical and social processes which had before been studied as single systems only. To do investigations in this new way several innovations were implemented such as the internationalisation of research, the transdisciplinary cooperation of different scientific fields, and new e.g. geo-spatial technologies.

The workshop and the publication highlighted protected areas in three different Central European countries comprising a set of different ecosystems and of different legal frameworks as well. From the geographical point of view the study sites range from thermally favoured foothill regions to cold high mountain environments of the Central and Southern Alps. Considering the status and level of protection the authors give basic information on a national scale and then focus on case studies of a natural park, a proposed NATURA 2000 area, and one of the most famous national parks of the entire Alps, each with its own specific problems.

The first part of the volume shows legal and institutional conditions for the establishment of protected areas in order to achieve a common understanding of preconditions and requirements in research and planning. Despite the individual situation in each of the case study areas in the Czech Republic, Austria, and Slovenia the workshop gave room for discussion of the current state and future perspectives in cooperation. Some of the examples given can be considered as best practise both in planning and investigation design – thus the volume is an important contribution to establish a rough portfolio of data strategies, methodologies and spatial information products, founded on geo-spatial-technologies and geographical investigations. These can help especially public-sector users not only in monitoring – as an important task of managing protected areas – but also in applying policies and directives of nature conservation in general both on a local, regional, and national level.

A. Prof. Mag. Dr. Gerhard Karl Lieb
Karl-Franzens University of Graz

The protection of natural and cultural heritage has a long tradition in Central Europe. However, in the past decades individual countries of this European region managed their protected areas in a different way, developed them for the survival of inhabitants living there and protected them for the future generations. Different models and approaches to the management of protected areas have brought positive as well as negative effects. After the accession of all countries of this region to the EU a professionally-scientific challenge was posed also to geography. Namely, it was offered to cooperate in the future directing of sustainable development on the basis of a comparative analysis of different approaches to the management of protected areas in the past and the new methodological research approaches.

This is what I see as an important contribution of the international research project 'Sustainable environment research: promoting international cooperation and mutual assistance in natural parks' in which geographical research institutions from three Central European countries: the Czech Republic, Austria and Slovenia took part. Namely, each of the cooperating research groups studied in greater detail and presented the concepts of their protected areas operation (at the national level) and presented different methodological approaches to the evaluation of natural and socio-geographic features and processes in these areas on the example of a sample protected area. This can in a long run present expert bases for the planning of their sustainable development. In addition, presentations of sample protected areas and effects of the previous management and the use of space enable researchers to check methodological bases for the present and future researches. Such common researches and the confrontation of different methodological approaches can indicate a more harmonized future monitoring of processes in protected areas not only in the cooperating three countries but also wider. What should be exposed here is that at the evaluation of numerous pieces of information about individual environmental components and factors in the protected areas dealt with, the researchers were striving after the use of the most modern tools from the field of space informatics (GIS, the use of satellite shots etc).

The publication of the results of this research project cooperation will definitely have a very big applicable value and will be used among experts monitoring conditions in protected areas, planners and managers of their future development, students and also in broader public. Since the extent and the meaning of protected areas are on the increase, the breakthrough of geographic methodological approaches is even more important.

Assoc. Prof. Metka Špes
University of Ljubljana

Over the last few decades, the protection and management of protected areas have been drawing growing attention from research as well as practical perspectives. Today, the issues in question concern not only biologists and ecologists, but other professions as well, including geographers. The same applies to an international project which was carried out in the territories of the Czech Republic, Austria and Slovenia. The aim of the project was to exchange ideas and practical experience in the field of environmental geography with special regard to a range of concepts and methodology.

The published conclusions of the project, well arranged in the monograph, summarize research concepts of nature environment protection in individual countries, comprising the first results of environmental research of model areas in the involved countries from a geographical perspective.

The text published in the monograph offers a confrontation of different research methodologies used in the countries involved in the project. I am convinced that the achievements of the project will not only enhance mutual cooperation among the participating institutions, but it will also provide useful information for students working on their own research projects (seminar papers, diploma thesis, etc.) which are related to sensitive land utilization in the participating countries.

Prof. Bořivoj Šarapatka
Palacký University of Olomouc

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Introduction

Miroslav Vysoudil

Current research is expected to follow international and trans-disciplinary approaches to participate in the modern scientific community. Interdisciplinary environmental investigations of natural parks by means of physical geography techniques, geo-spatial technologies (GIS / remote sensing / cartography) and regional planning tools can meaningfully contribute to sustainable development of those regions.

An effort to improve environmental research brought together specialists from the Czech Republic, Austria and Slovenia to work up a joint project *Sustainable environmental research: promoting international cooperation and mutual assistance in natural parks*.

Each participating country and institution uses different approaches to solve the defined demands. This joint project should increase and strengthen existing cooperation and networking between Austrian, Czech and Slovene researchers. Methods of research will be exchanged and mutually evaluated and special efforts will be integrated into institutions' research schedules.

The project focused on exchange and integration of different interdisciplinary approaches and methodologies in environmental investigations of natural parks in the Czech Republic, Austria and Slovenia. The Natura 2000 area "Hohentauern" in Styria/Austria, "Triglav National Park" in Slovenia, and Natural Park "Bystřice River Valley" in the Olomouc district/Czech Republic have been investigated for a long time. Regional planning aspects as well as intensive sharing of nature and human activities (housing, economy and tourism) are well known in each of the investigated areas.

The objectives and methodology of the project were the following:

- Exchange of knowledge/state of the art investigations and results of existing projects concerning environmental research with focus on geospatial data (GIS, Remote Sensing, Cartography) implementation/handling/analyses and integration into planning purposes
- Analyses, mutual discussion and demonstration of different and similar approaches and methodologies (also with respect to other projects)
- Exchange in knowledge on methodology of evaluation of natural conditions in natural parks concerning different economic use of the areas (e.g. alpine pasturing, ecological tourism, sport and recreation, second homes).
- Knowledge exchange in regional planning in natural parks.
- Compiling and mutual implementation of methodology into the institutions' project schedules.

- Feasibility study of ongoing cooperation (research exchange, student exchange, mutual assistance in sharing workload and topics, networking with other partners in ASO countries, applying for EU Framework programmes, e.g. Socrates/Erasmus, CEEPUS, Marie Curie).

The scientific relevance of the project

At present there are no larger projects and governmental funding for broadening research of small natural parks with an international scale in evaluation of methodology. The project opened a chance to bring its methodology into international discussion and to implement new approaches into the work of institutions.

The joint publication is also intended to serve as a handbook/field guide for analogical investigations in other similar protected areas. Useful appears to be the exchange in knowledge on methodology of evaluation of natural conditions in natural parks concerning different economic use of the areas and knowledge exchange in regional planning in natural parks.

Concepts of Nature Conservation in the Czech Republic, Austria and Slovenia

Nature conservation in the Czech Republic

Martin Jurek

Conservation of nature and landscape in the Czech Republic has a considerably long history. The first steps towards purposeful nature protection trace back to medieval landowners who aimed to prevent degradation of their property, mainly by regulations on logging wood and hunting. King Charles IV in his code Majestas Carolina (1355 AD) appreciated the value of forests, called for reduction in the logging volumes and encouraged reforestation. The protective approach was carried on by part of the aristocracy through centuries and, in combination with advanced forest laws issued by Maria Theresia in the 18th century, enabled reasonable conservation of large forest areas.

The oldest specifically protected areas are the virgin forest reserves Žofínský prales and Hojná Voda, both located in the Novohradské Mts. in southern Bohemia (proclaimed 1838 AD). During the latter half of the 19th century and in the first half of the 20th century, several other reserves were proclaimed in the country. The modern era of nature conservation started in former Czechoslovakia in the 1950s with the adoption of appropriate state legislation, namely of Act No. 40/1956 Coll. on state protection of nature, which set the framework for establishing national parks (NP), protected landscape areas (PLA) and small-scale protected areas (state nature reserves, protected sites, protected parks and gardens, protected study areas, protected natural formations, protected natural monuments). Since 1973, the so-called rest areas were also defined as relatively valuable parts of landscape suitable for recreation because of their natural and aesthetic qualities.

The Czech legislation on nature conservation was distinctively adjusted by the adoption of Act No. 114/1992 Coll. on nature and landscape protection. The categories of large-scale protected areas remained the same (national parks, protected landscape areas), while the small-scale protected areas were redefined into the following categories: national nature reserve, national nature monument, nature reserve, and nature monument.

National parks are unique on either national or international level. They consist of natural ecosystems or ecosystems little influenced by man, whose fauna, flora and abiotic nature are of exceptional scientific and educational significance. All activities in the national parks should be directed towards preservation and improvement of the natural environment. The area of national parks is divided into three zones and public access to these zones is restricted. As of 2007, there are four national parks in the Czech Republic, together taking up 1.5% (1,195 sq km) of the state territory (see Table 1).

Protected landscape areas are large territories of landscape formed in a balanced way, with characteristic relief, a significant portion of natural forest and permanent grassland ecosystems, in some cases with conserved historical settlement monuments. Economic exploitation of these areas is permitted in accordance with their protected status to the extent that it contributes to and improves their natural state and assures the preservation of optimal ecological conditions. Recreational use is permissible if it does not harm natural values. As of 2007, there are a total of 25 PLAs in the Czech Republic (a total of 10,887 sq km).

National nature reserves are small-scale areas of exceptional value, unique ecosystems of national or international significance in combination with natural relief and typical geological features. Natural reserves are small-scale areas where natural rarities are concentrated and a typical and significant ecosystem of the geographical area is present.

National nature monuments and nature monuments are defined as small-scale natural features. They are especially landforms or geological features, mineral resource localities or areas where rare or vulnerable species occur in the remnants of ecosystems. Where there is an ecological, scientific or aesthetic significance on either a national or international level, the area (even an area formed by man) is designated a national nature monument.

Small-scale protected areas represent spots of strict protection within national parks and protected landscape areas as well as outside of these large-scale protected areas, protecting distinct natural features that have been conserved in an otherwise culturally transformed landscape. As of January 1, 2007, there were 112 national nature reserves, 779 nature reserves, 104 national nature monuments, and 1,191 nature monuments in the Czech Republic.

Apart from large-scale and small-scale specially protected areas, Act No. 114/1192 Coll. defines a category of *monument trees* as protected trees of significant age, biological or aesthetical importance. Also *natural parks* are defined as areas intended to protect concentrated aesthetic and natural values of landscape by restricting the extent of human activities that would be likely to degrade the natural values of the landscape. The former “rest areas” were turned into natural parks, and also new natural parks were established where suitable.

NATURA 2000

With the accession of the Czech Republic to the European Union, NATURA 2000 was to be implemented through adopting the Bird and Habitat Directives into the national system of nature conservation. The total extent of protected areas in the Czech Republic has risen from 15% to 18.5% due to NATURA 2000. A total of 41 Special Protection Areas (SPA) were proposed in the first stage, but one was rejected (Heřmanský stav–Odra–Poolzí) and two other postponed (Dehtář and České Budějovice Ponds), therefore the number of finally declared SPAs has dropped to 38. Individual areas are distinctive as for their acreage and number of bird species. The largest is Šumava (968.4 sq km), while nine other are larger than 300 sq km (Křivoklátsko, Doupovské hory, Labské pískovce, Krkonoše, Králický Sněžník, Jeseníky, Libavá, Beskydy, and Třeboňsko). The smallest SPA (3 sq km) is the Bohdaneč Pond in the Pardubice region. As to the Habitat Directive, 863 Sites of Community Importance (SCI) were put on the National List in 2004.

UNESCO biosphere reserves

Biosphere reserves are declared by UNESCO within the programme Man and the Biosphere. At present there are six biosphere reserves in the Czech Republic: Bílé Karpaty, Krkonoše, Křivoklátsko, Pálava, Šumava, and Třeboňsko. All of them coincide with large-scale protected areas.

Wetlands and peat bogs

In the Czech Republic, peat bogs represent a Quaternary relic. These vulnerable biotopes regulate outflow and storage of ground water, thus being of great importance in the landscape. Peat bogs, marshes and wetlands are protected by law, most of them as small-scale protected areas. Ten localities in the Czech Republic have been put on the list of the Ramsar Convention on Wetland Protection. The present area of peat bogs (some 27,000 hectares) is much smaller compared to the original natural state; large portions were converted into agricultural land, built up or inundated by ponds. Smaller peat bogs (with an area up to tens of hectares) prevail. Among the largest in the Czech Republic are Třeboňská and Borkovická Moors in the Třeboňsko region, Mrtvý luh, Rokytecká and Rybárenská Marsh in the Šumava Mts., Boží Dar Peat Bog in the Krušné Mts., Dářko Peat Bog in Ždárské vrchy and Rejvíz Peat Bog in the Jeseníky Mts. Marshes are frequent in Polabí, Máchovo jezero surroundings, an the vales of Hornomoravský úval and Dolnomoravský úval.

Table 1 National parks and protected landscape areas in the Czech Republic (as of January 1, 2007)

protected area	area (sq km)	year of declaration	description
National Parks			
České Švýcarsko	79	2000	rock cities with the largest rock arch in the Czech Republic
Krkonošský	363	1963	the highest Hercynian mountain range in Europe, glacial and periglacial landforms, peat bogs, waterfalls, endemic species
Podyjí	63	1991	deep Dyje River canyon with numerous meanders, cryogenic landforms, vegetation and climatic inversion
Šumava	690	1991	vast forest complexes, peat bogs and wetlands, glacial lakes, cryogenic landforms
PLA			
Beskydy	1,160	1973	the highest part of the Czech Carpathian range
Bílé Karpaty	715	1980	Carpathian meadows, harmonic cultural landscape
Blaník	40	1981	preserved cultural landscape
Blanský les	212	1989	forested mountain massive
Broumovsko	410	1991	sandstone rock cities (largest in central Europe)

České středohoří	1,070	1976	neo-volcanic stubs, canyon Porta Bohemica
Český kras	132	1972	karst area (Koněpruské Caves)
Český les	473	2005	natural forest complexes, peat bogs
Český ráj [1)]	182	1955	sandstone rock cities, neo-volcanic stubs
Jeseníky	743	1969	periglacial landforms, peat bogs
Jizerské hory	350	1967	peat bogs, beech forests, elevated etchplain
Kokořínsko	270	1976	sandstone rock city (rock lids)
Křivoklátsko	630	1978	preserved original species composition of forest
Labské pískovce [2)]	245	1972	sandstone rock cities
Litovelské Pomoraví	96	1990	floodplain forests, wetland biotopes
Lužické hory	270	1976	harmonic forested landscape, folk architecture
Moravský kras	92	1956	the largest karst area in the Czech Republic
Orlické hory	200	1969	vast forest complexes, peat bogs
Pálava	86	1976	Jurassic klippe, karst landforms
Poodří	82	1991	floodplain forests, Odra River bends, ponds
Slavkovský les	640	1974	neo-vulcanites, forest complexes
Šumava [3)]	994	1963	glacial relics, peat bogs
Třeboňsko	700	1979	ponds, wetlands
Žďárské vrchy	715	1970	numerous weathering landforms, cryogenic landforms
Železné hory	380	1991	wedge block, limestone islands

Notes: 1) enlarged in 2002;
2) part of this area became the České Švýcarsko National Park (declared in 2000);
3) enlarged in 1991, Šumava National Park declared in part of PLA.

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Nature conservation in Styria in the national context

Josef Gspurning

The background of conserving the Styrian nature in the national context

Following the more “EU-conform” attempt of structuring community’s member states (Vandenbroucke and Peedell, 2002) Austria (covering in total about 84,000 sq km) has part of the Continental, the Alpine and the Pannonian biogeographical region; but specified in more detail it should be divided into five major landscapes; the Austrian part of the granite-gneiss plateau (8,500 sq km, 10.1%) forms the country’s most northern provinces. In southward direction, this low mountain range is followed by the Alpine and Carpathian Forelands (9,500 sq km, 11.3%), Eastern Alps (52,600 sq km, 62.8%) and Viennese Basin (3,700 sq km, 4.4%). The Foreland in the East (9,500 sq km, 11.3%) consists of the Austrian part of the surrounding areas of the Pannonian lowlands. This rough macro-scale sequence is interrupted by many intra-alpine valleys and basins.

In addition to these and several other influences the national territory of Austria is superposed by four climate spheres: the Pannonian and Illyric climate Province in the east, the Transition climate province covering the lower parts of the Danube Valley and the Alpine Foreland and – last but not least – the Alpine/Subalpine climate province with its regional/local variations. This texture additionally is vertically differentiated producing a manifold natural environment as basement of a wide variety of different habitats. Compared to other central European countries Austria’s flora and fauna is very rich in species, a richness which is still going to get reduced by an increasing land consumption (see Table 1).

In Austria as a basic principle the conservation of nature and landscape reside in the responsibility of the federal provinces. So the legal fundament for the conservation of nature and landscape is laid not by one federal law but by nine separate provincial laws taking influence on several different layers:

- The obligation to obtain permission for and to notify projects listed in corresponding laws is to be applied for the whole non-built-up area.
- The conservation of habitat types (glaciers, riparian areas, wetlands etc.)
- Areas protected by laws for nature and landscape conservation; this instrument offers a total of 17 different categories of conservation (three of them in all Austrian provinces) and affects about 25% of the Austrian federal area (see Table 2).
- Conservation of animal and plant species. On the initiative of the provincial government endangered species of flora and fauna can be taken under the protection of law.

Table 1 Number of endangered vertebrate species in Austria (Tiefenbach, 1998)

taxonomic group	number of species per category of threat						
status category	0	1	2	3	4	0–4	n. t.
vertebrates	8.6%	8.8%	7.8%	18.8%	16.3%	60.3%	39.7%
mammals	5	4	3	18	13	43	39
birds	23	24	11	22	42	122	97
reptiles	1	1	4	8	1	15	1
amphibians	0	1	6	14	0	21	0
fishes	5	5	7	13	9	39	21

0 – extinct, exterminated or disappeared; 3 – endangered;
1 – in danger of extinction; 4 – potentially endangered;
2 – highly endangered; n. t. – not threatened.

Table 2 Number and extent of selected areas protected under nature conservation laws in Austria (Tiefenbach, 1998)

category	number	area (sq km)	% of the national territory
nature reserve	356	2,809.60	3.4
protected landscape	247	14,322.75	17.0
national park	6	343.00	2.8
protected part of a landscape	337	540.86	0.6
natural park	31	1,425.48	1.7
all categories*	**946**	**21,441.75**	**23.8**

* does not include "natural parks" since this is only an additional designation for an area already protected under another category

These four legal possibilities form an effective conservation toolbox which is punctually enforced by a network woven by international obligations, especially the directives from the Council of the European Union (Directive on the conservation of wild birds and the Directive on the conservation of natural habitats and of wild fauna and flora) which set up an uniform pan-European NATURA 2000 infrastructure and whose contents had to be taken over into federal or provincial law.

Finally conservation of landscape and nature is also aided by miscellaneous international agreements (so-called conventions). The Alpine Convention, Biodiversity Convention, Bern Convention, Ramsar Convention and Washington Convention primarily scope the conservation and the restoring of natural environment/ecosystems. Contrary to that the Convention concerning the Protection of the World Cultural and Natural Heritage focuses the conservation of unique cultural and natural sites.

Conservation of nature in the federal province of Styria

In accordance with the information already mentioned above, conservation of nature and landscape in Styria is done in different ways based on the provincial law from June 30, 1976 concerning the protection of nature and landscape (Steiermärkisches Naturschutzgesetz 1976 NschG 1976); with coming into force of the conservation law 2000 the EU-conservation guidelines turned over in valid provincial regulations. Table 3 gives a short overview of the most important topics of this body of laws.

Due to the experiences gained in the meantime, also because of recent decisions of the European Court of Justice and because of the increasing experience at provincial level, there was a strong need to update parts of the wording of the law (mainly § 13). This was done by the amendment of 2004 (Naturschutz-gesetznovelle 2004, LGBl. Nr. 56/2004).

Typologically (and with respect to their importance and impact) the protected landscape areas in the province of Styria can be categorized as national parks, natural parks, nature reserves, protected landscapes, protected parts of the landscape, nature monuments and NATURA 2000 areas.

Table 3 Scope of selected paragraphs of NschG 1976

Par.	Scope/Description
§ 1	Definition of the scope: … this law regulates the protection of nature, the protection and the maintenance of the landscape as well as the preservation and designing of the environment as a basic fundament of the living conditions for people, plants and animals …
§ 3	Definition and handling of **projects to notify** (i.e. cable cars, ski elevators, ski runs, high voltage overland cables, dams and dam walls, motocross and autocross sites, …)
§ 5	Definition and handling of **nature reserves** as areas, which are worth the conservation by declaration of the provincial government (because of their extensive originality, the special richness and variety of its animals and plants, the rareness of species, the existence of endangered wildlife elements and their living conditions or because of scientific reasons). At this stage this paragraph mainly affects alpine landscapes, mountain regions, lakes and riversides, rests of virgin forest, swamp or marshes
§ 6	**Protected landscapes** are defined and handled as areas of a characteristic inherent natural beauty or peculiarities (e.g. flood plains or mountainous landscapes) or areas which show an extraordinary recreational value.
§ 7 (1)	Concerns the **protection of standing and running water bodies** (protection of rivers, lakes and their shores including brackish water and waterfowl). This section especially controls the construction of hydroelectric power plants or lumbering of trees and bushes of the riverine vegetation belts.
§ 8	Definition and handling of **natural parks** as generally accessible parts of the landscape; a unique kind of interaction of natural factors makes them predestinated for the mediation of (scientific) knowledge about nature and for recreation purposes.
§ 10	Definition and handling of **natural monuments** as outstanding individual creation of nature (because of their scientific or cultural meaning, their peculiarity, beauty and rareness or because the monument is crucial for the landscape’s special character and appearance. Typically single trees, waterfalls, rock formations, glacier traces, gorges, natural caves, occurrences of unique rocks as well as fossil animal and plant occurrences are classified as natural monuments.

§ 11	Definition and handling of **protected parts of the landscape** as a section of the landscape, which revives landscape and/or the view of a place, as landscape components considered to be a nature or cultural monument, or as buildings or facilities that form units with the landscape (e.g. ponds, watercourses, meadows, hedges, corridor copses, avenues, parks and gardens, etc.).
§ 13	§ 13 provide the realization of a coherent European ecological network to enforce the protection of species (**NATURA 2000**). § 13a and §13b refer to the conservation of areas with EU-wide relevance and bird reserves § 13c, § 13d and § 13e ensure the protection and the care of the wildlife and species of plants in their natural and historically grown variety. Additionally a legally binding definition of the following terms is given. 1) Fauna Flora Habitat-Directive 2) Birds-Directive 3) Areas of EU-wide relevance 4) European areas for the protection of wild birds 5) Intentions of European protection areas 6) Protection of species 7) Priority habitats 8) Priority species

National parks

Until now only one of the protected areas resides in this highest-ranking category. After the completion of the feasibility study in July 1997, the National Park Gesäuse in the northern part of Styria (11,054 ha) has been established between June 2002 (Nationalparkgesetz, LGBl. Nr. 61/2002) and October 2003 (Nationalparkorganegesetz, LGBl. Nr. 69/2003). Within the borders of the national park there exist two usage-defined area types: In the conservation zone (1,510 ha) utilization in accordance to the goals of the national park is allowed without any time limit. In the nature zone (9,544 ha) this utilization is only temporary. Currently the major part of the national park is classified as NATURA 2000 area too.

Nature reserves

In Styria nature reserves can be divided into three groups: Nature reserves (lit.a) comprehend alpine landscapes, mountain massifs, lakes, ponds and fluvial landscapes. Most of these (currently 18) reserves (NSG a01 – NSG a18) are located in the alpine parts of Styria, ten of them in the district of Liezen, only three of them reside in the extra-alpine districts Weiz, Graz-Umgebung and Deutschlandsberg. The eight nature reserves (lit.b) are relicts of virgin forests, moors, swampy areas or swamp located on plateaus and at the bottom of the valleys in the mountainous parts of the province (NSG b01 – NSG b08). NSG c01 – NSG c96 describe sites and well defined habitats of endangered wildlife or species to protect can be summarized under nature reserves (lit.c). They appear uniformly distributed over the whole province.

Natural parks

At the present time there exist six natural parks, three of them in upper Styria (Eisenwurzen, Sölktäler, Mürzer Oberland), one at the border to Carinthia (Grebenzen), one in southern Styria (Südsteirisches Weinland) and one more in the eastern part of the country (Pöllauer Tal). Another natural park (Almenland) is still in an advanced phase of development and will be established in the central region of Styria (see Table 4).

Table 4 Existing natural parks in Styria

Name	Location	Attractions
Eisenwurzen	In the central part of upper Styria (congruent with the historical centre of iron workmanship	Hochschwab-massif, canyons of Enns and Salza, steep cliffs, alpine meadows
Grebenzen	At the border between Styria and Carinthia nearby the upper reaches of the river Mur (district of Murau)	Glacial shaped morphology, cultivated landscape with many ponds, Neumarkt pass
Pöllauer Tal	In the centre of eastern Styria	Rolling hills, mixture of meadows, fruit orchards, vineyards, acres and therefore paradigm for a well running cultivated landscape
Sölktäler	In the Dachstein-Tauern-Region (northwestern part of the province)	Mountain pastures, mountain lakes (1997 awarded as Austrian natural park of the year)
Südsteirisches Weinland	Southern part of Styria	Hilly landscape with widespread vineyards
Mürzer Oberland	Upper part of the Mürz Valley (northeastern part of Styria)	Mixture of alpine landscape, historic buildings and sites, museum of hunting, mining and nature

Protected landscapes and other types of protection

In addition to the characteristics mentioned above the protection scheme “protected landscapes” (49 representatives; LSG 01 – LSG 49) also covers all natural standing and flowing water bodies including a 150 meters upcountry buffer around it.

Unlike the other types the schemes “protected parts of the landscape” and “nature monuments” are typically characterized by a small geographical coverage (that means also a minor fraction of the whole protected area sum). Nevertheless the province of Styria shows a total of about 1,100 cases of protection (188 protected parts of the landscape and 918 nature monuments).

NATURA 2000 areas

Although most of the 47 designated protection areas became legally operative in the years between 2002 and 2006 (see Table 5), the roots go back into the last decades of the previous century. Bird Directive (1979) and Habitat Directive (1992) as important European conservation documents have been the predecessors of the national/provincial laws.

Table 5 NATURA 2000 areas in Styria

Nr.	Name of NATURA 2000 area	operative	site code	BD	HD
1	Feistritzklamm / Herberstein	17 07 2002	AT2218000	×	×
2	Steirisches Jogl- und Wechselland (parts)	17 07 2002	AT2229000	×	
3	Schwarze und Weiße Sulm	01 03 2003	AT2242000		×
4	Wörschacher Moos	01 03 2003	AT2212000	×	×
5	Ober- und Mittellauf of Mur	23 05 2006	AT2236000		×
6	Pürgschachen-Moos	23 06 2006	AT2205000	×	×
7	Ennsaltarme at Niederstuttern	p. a.	AT2240000		×
8	Gersdorfer Altarm	23 06 2006	AT2238000		×
9	Raabklamm	11 02 2006	AT2233000	×	×
10	Hörfeld, Steiermark	08 02 2006	AT2207000	×	×
11	Patzenkar	11 02 2006	AT2209002		×
12	Flaumeichenwälder in the Grazer Bergland	08 02 2006	AT2244000		×
13	Kirchkogel / Pernegg	02 03 2006	AT2216000		×
14	Südoststeirisches Hügelland (parts)	26 07 2005	AT2230000	×	×
15	Steirische Grenzmur, Gamlitz & Gnas	30 08 2005	AT2213000	×	×
16	Demmerkogel (S slopes), Wellinggraben	p. a.	AT2225000	×	×
17	Ennstaler Alpen / Gesäuse	p. a.	AT2210000	×	×
18	Zlaimmöser-Moore / Weissenbachalm	08 02 2006	AT2224000		×
19	Steirisches Dachstein-Plateau	23 05 2006	AT2204000		×
20	Ödensee	19 05 2006	AT2206000		×
21	Gamperlacke	p. a.	AT2221000		×
22	Pinkatal (upper part)	26 07 2005	AT2229001		×
23	Ramsauer Torf	02 03 2006	AT2228000		×
24	Hartberger-Gmoos	11 06 2005	AT2211000	×	×
25	Pölshof / Pöls	30 08 2005	AT2223000		×
26	Peggauer Wand	11 02 2006	AT2217000	×	×
27	Lafnitztal-Neudauer Teiche	30 08 2005	AT2208000	×	×
28	Furtner Teich-Dürnberger Moor	19 05 2006	AT2226000	×	
29	Dürnberger Moor	08 02 2006	AT2226001		×
30	Furtner Teich	08 02 2006	AT2226002		×
31	Zirbitzkogel	14 02 2006	AT2220000	×	
32	Steirisches Nockgebiet (parts)	p. a.	AT2219000		×
33	Deutschlandsberger Klause	14 06 2006	AT2214000		×
34	Eisenerzer Alpen (parts)	02 03 2006	AT2215000		×

35	Totes Gebirge & Altausseer See	23 05 2006	AT2243000	×	×
36	Gorge forest at Gulling	02 03 2006	AT2227000		×
37	Steilhangmoor in Untertal	11 02 2006	AT2209001		×
38	Niedere Tauern	23 06 2006	AT2209000	×	
39	Wölzer & Seckauer Tauern (higher parts)	14 06 2006	AT2209004		×
40	SE Schladminger Tauern (higher parts)	19 05 2006	AT2209003		×
41	Ennstal (Liezen-Niederstuttern)	p. a.	AT2229002	×	

BD – Birds Directive
HD – Habitat Directive
p. a. – pending action

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Nature conservation in Slovenia

Barbara Lampič, Irena Mrak

Slovenia has the reputation of being one of the geographically most variegated countries in Europe. The consequences of this fact are five major landscape units: Alpine, Subalpine, Subpanonian, Karst-dinaric and Submediteranean. The landscape variegation is shown in:

- very high level of biodiversity,
- numerous nature values,
- large ecologically important areas,
- numerous protected areas,
- large areas of NATURA 2000.

Slovenia has a significant share of protected areas (11% of state territory) and areas of NATURA 2000 (over 36%), forested areas (over 60%) and rural areas: some typologies encounter as much as 90% of rural landscape with 60% of total population.

Respecting OECD and EUROSTAT qualitative indicators (population density less than 100 inhabitants per sq km) almost complete Slovene territory is enlisted as rural area. Taking into account the urbanization stage Slovenia with a relatively low degree of urbanization (51%) ranks among the most rural areas in Europe (Lampič, Potočnik Slavič, 2006).

We were able to preserve the unique settled rural areas (altogether approx. 6,000 settlements) but from the demographic perspective, nearly half of settlements (approx. 3,000) face with population decline; almost 700 settlements are endangered by very fast tendencies (Kladnik, Ravbar, 2003).

It is the high landscape variegation and biodiversity that present the unique and not yet well activated development opportunity of Slovenia.

A brief history of nature protection in Slovenia

Until 1918 nature protection in the area of Slovenia was limited to rare individuals, tourism and hunters clubs taking care of special natural values, building visitors' trails enabling the first tourism development and also protecting nature. The count Auersperg was one of the first to emphasize the importance of natural values of Slovenia. In 1888 he decided to exclude from economic use 305 ha of natural forests in the region of Kočevje in order to protect them for future generations. The first initiative for the special law on nature protection was given by dr. L. Dimitz, the forest expert, in 1909. In 1920 the Nature Protection

Section of the Museological Society of Ljubljana addressed a memorandum to the regional government for the:

- establishment of alpine, mountain and marsh protected areas,
- law on ban of the destruction of rare and typical, scientifically important animals and plants,
- the survey and protection of underground caves with interesting flora and fauna,
- to encourage the wider public interest for nature protection in general.

This memorandum was the basis for the “Ordinance on rare and typical scientifically important animals and plants, and cave protection in Slovenia”.

Seismologist Albin Belar gave the first initiative for the establishment of a national park in 1908. He suggested the protection of Valley of Triglav lakes in Julian Alps but due to the World War I all the actions were stopped. In 1924 the headquarters of state forests excluded 1,600 ha of the area around Triglav Mountain and proclaimed it as an “Alpine protection park” for the period of 20 years. From the legislation point of view the nature protection was a part of Act on Forests from 1929 and the Construction Act from 1931 In 1938 the Ordinance on national parks enabled the protection of special nature values of scientific and historical importance and those that were important for tourism development as well as for nature enjoyment and were physically and psychologically important for citizens (Piskernik, 1964).

After the World War II the new protected areas were proclaimed and in 1944 the contract of the “Alpine protection park” expired. It was only in 1961 that the decree on the new national park was accepted. The Valley of Triglav lakes was proclaimed as a Triglav National Park. The protected area encountered 2,000 ha. In 1981, twenty years after the proclamation the protected area was enlarged and the special Act on Triglav National Park recently covers 83,807 ha (Šolar, 2001).

Recent situation of protected areas in Slovenia

According to the Act on Nature Protection the wider protected areas (national park, regional parks and landscape parks) recently cover approximately 1,900 sq km or around 9%, together with nature reserves and natural monuments protected areas cover almost 11% of the territory of Slovenia. The percentage of protected areas in comparison to other European countries ranks Slovenia at the bottom part of the international scale (Berginc, 2006).

Nature protection is defined through the Act on Nature Protection from 1999 (Zakon o ohranjanju narave, Ur.l. R.S., 56/99) and protection of cultural heritage through the Act on Cultural Heritage Protection from 1999 (Zakon o varstvu kulturne dediščine, Ur.l. R.S., 7/99). Triglav National Park has its own Act whereas other wider protected areas such as landscape parks and regional parks as well natural monuments and natural reserves have their own special decrees.

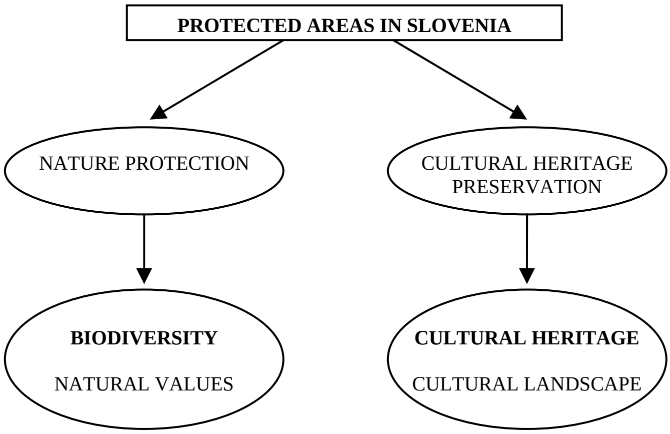

Figure 1 Protected areas in Slovenia are the result of historical nature protection development as well as the culture heritage preservation.

At present there are still two landscape parks and seven regional parks yet to be proclaimed. In the National Program of Environmental Protection 2006-2012 (UL 2/2006) the enlargement of protected areas to 15% by 2008 and to 20% by 2014 is expected.

Due to the EU requirements, Slovenia introduced NATURA 2000 as a mechanism for the Council Directive 92/43/EEC on conservation of natural habitats and of wild fauna and flora and of the Council Directive 79/409/EEC on the conservation of wild birds. The average percentage of NATURA 2000 in EU countries is 15% whereas in Slovenia it is much higher, over 36%. The very high percentage is a consequence of relatively preserved natural environment in our country.

According to SPA (Special Protected Areas) Slovenia has protected 26 areas or 22.8% of the state territory and according to SCI (Sites of Community Interest) 260 areas are protected, covering 31.5% of Slovenia. 9% of NATURA 2000 are areas above 900 m a. s. l. and 70% of the total represent forests (Source: Ministry of Environment and Spatial Planning, 2006).

Table 1 Types, numbers and size of protected areas in Slovenia according to IUCN categories

category	number	area (sq km)	% of state territory
wider protected areas			
national park	1	838	4.1
regional park	3	418	2.1
landscape park	42	646	3.2
smaller protected areas			
Strict Nature Reserve/ Wilderness Area	–	.	.
Nature reserve	52	.	.
Natural monument	1217	.	.

Source: Ministry of Environment and Spatial Planning, 2007.

Table 2 National park, regional parks and landscape parks in Slovenia

Protected area		IUCN category	Area (ha)	Year of declaration
National park				
1	Triglavski Narodni park	II/V	83808	1981
Regional parks				
1	Kozjanski regijski park	V	20760	1981
2	Škocjanske jame	III	406	1996
3	Notranjski regijski park	V	21000	2002
Landscape parks				
1	Beka	V	244	1992
2	Boč, Plešivec		873	1990
3	Boč - Donačka gora, Plešivec	V	2151	1992
4	Drava	V	2175	1992
5	Golte	V	1225	1987
6	Jareninski dol	V	469	1992
7	Nanos - južna in zahodna pobočja z vrhovi Pleše, Grmade in Ture	V	1008	1984
8	Južni in zahodni obronki Nanosa	V	2158	1987
9	Južni obronki Trnovskega gozda	V	4833	1985, 1987
10	Kamenščak-Hrastovec	V	854	1992
11	Kolpa	V	4270	1998
12	Kum	V	2232	1996
13	Lahinja	V	259	1988, 1998
14	Ljutomerski ribniki in Jeruzalemske gorice	V	1346	1976
15	Logarska dolina	V	2438	1987
16	Mariborsko jezero	V	200	1992
17	Mašun	V	88	1969
18	Mrzlica	V	141	1996
19	Negova in Negovsko jezero	V	175	1967
20	Planinsko polje	V	668	1984
21	Ponikovski kras	V	1717	1998
22	Rački ribniki-Požeg	V	459	1992
23	Rakova kotlina pri Rakeku	V	124	1949
24	Robanov kot	V	1436	1950, 1987
25	Sečoveljske soline	V	724	1990
26	Spominski park revolucionarnih tradicij občine Domžale	V	444	1984
27	Strunjan	V	470	1990
28	Štanjel	V	16	1992
29	Štatenberg	V	273	1992
30	Šturmovci	V	215	1979
31	Tivoli - Rožnik - Šišenski hrib	V	509	1984
32	Topla	V	1529	1966
33	Udin Boršt	V	1736	1985
34	Zgornja Idrijca	V	4427	1993
35	Žabljek	V	171	1992
36	Jeruzalemsko - ormoške gorice	V	1911	1992
37	Kopališče Banovci	V	-	1976

38	Vrtine in kopališča v Moravcih	V	-	1976
39	Polhograjski Dolomiti	V	13938	1974
40	Goričko	V	46268	2003
41	Zajčja dobrava	V	66	1972

Source: Ministry of Environment and Spatial Planning, 2007.

Conflict of interests

At the state level the Environmental Agency of Slovenia, the Sector for nature conservation is in charge of biodiversity conservation and of the conservation of nature values on the basis of European and Slovene legislation as well as the international conventions. Their role is to follow legislation, to define protected areas, to survey them and to stimulate development activities. On the other hand the majority of protected areas are being proclaimed as of “local” importance and therefore they are the concern of local communities – mainly municipalities, where budget for the protected areas is limited and protected areas among the local population are understood as a development restriction. They are being disturbed by the protection regimes and due to the lack of knowledge on nature protection they are against proclamation of new protected areas (Mrak, Potočnik Slavič, 2004).

Some facts and dilemmas of protected areas in Slovenia

Comparing to other EU countries Slovenia has relatively well-preserved natural environment and a high percentage of NATURA 2000 areas is the coincidental consequence of past spatial planning and development. Along with rapid economic development the pressures and impacts on natural environment are rapidly intensifying, threatening especially in the negative way. The state inspection service is poorly efficient in different negative actions in protected areas as well as in the areas of NATURA 2000.

The new protected areas proclamation fully depends on political will and since protected areas are widely recognized as a development burden the chances for new protected areas or at least keeping the recent percentage is highly questionable. The main reason for present situation is in the introduced approach on proclaiming the protected areas which was happening in the “top down“ manner. One of the crucial development obstacles is the lack of the management of protected areas which is not established yet. The “bottom up” approach is crucial since protected areas as well as the areas of NATURA 2000 should be recognized as one of the major Slovenian sustainable development opportunities.

Figure 2 Valley of Triglav lakes in Julian Alps is in the core area of Triglav National Park. Photo: I. Mrak.

Figure 3 Cultural landscape in Bohinj area of Triglav National Park. Photo: I. Mrak.

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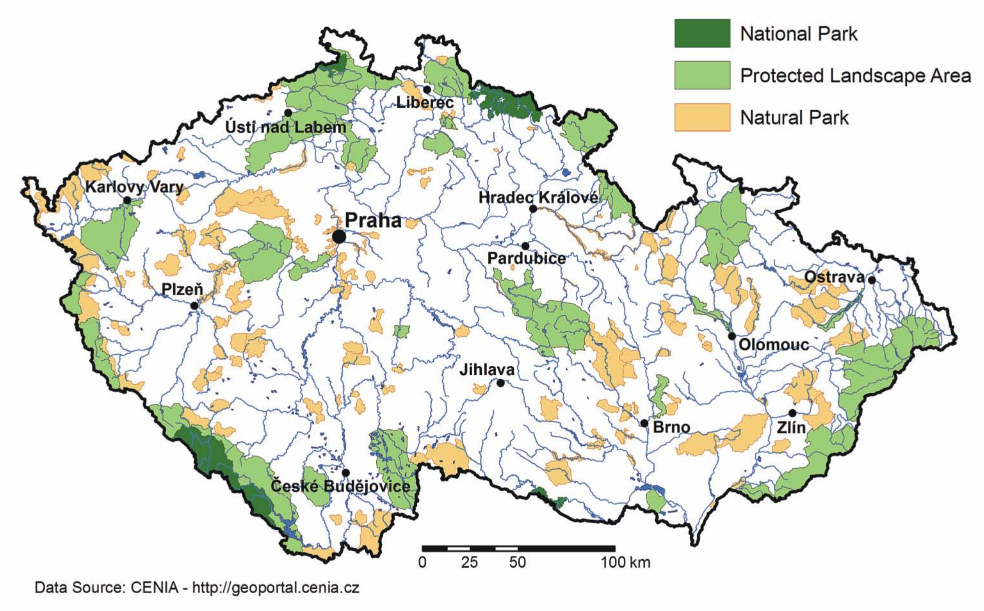

Plate A Protected areas in the Czech Republic.

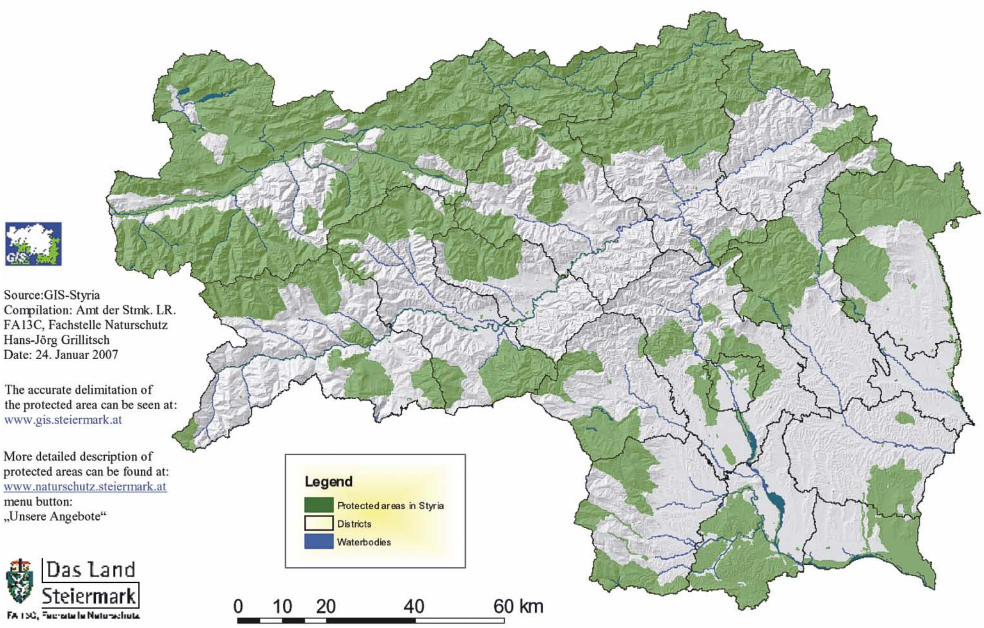

Plate B Protected areas in Styria.

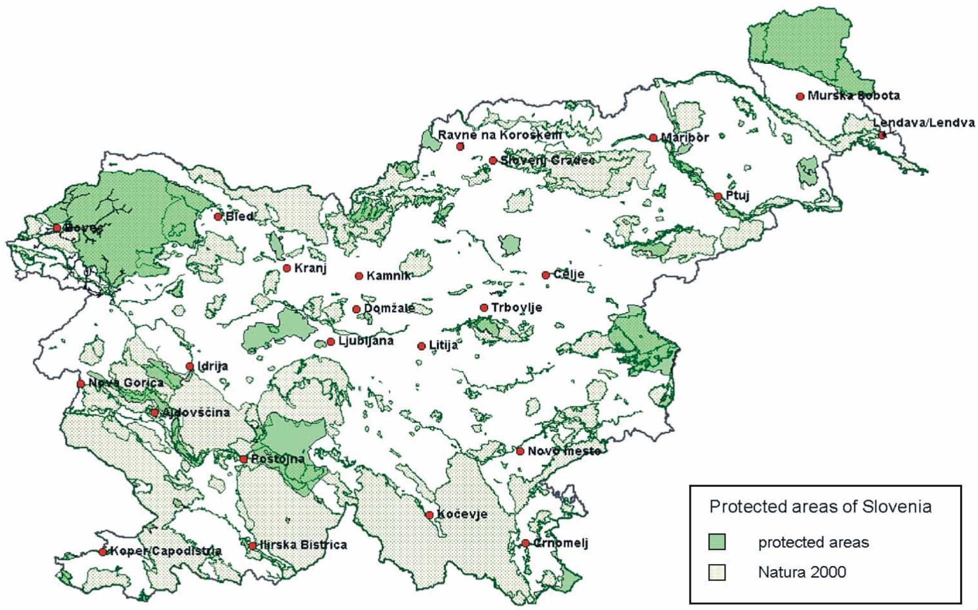

Plate C Protected areas and NATURA 2000 areas in Slovenia. Source: Ministry of Environment and Spatial Planning, 2006.

Plate D Project participants, field trip in Slovenia. Photo: M. Vysoudil (2006).

Sustainable Environmental Research: Case Studies

Case study for the Natural Park Bystřice River Valley, Czech Republic

Geographical description of the Natural Park Bystřice River Valley

Miroslav Vysoudil

The study area is situated mostly in the eastern part of the Olomoucký Region, with the northernmost part reaching into the Moravskoslezský Region. The Natural Park Bystřice River Valley ("Přírodní park Údolí Bystřice" in Czech) was established in 1995 by the Olomouc and Bruntál district authorities (Šafář, 2003). Its area is 99.3 sq km. The Bystřice River represents a natural axis of the area, only in the southern half it forms short sections of its eastern boundary.

Approximately 50% of the natural park area is covered with woods, mainly beech and spruce. Municipalities are concentrated either along the narrow valley of the Bystřice River or in the surrounding tablelands. Pastures prevail in the remaining sections.

Geomorphological conditions

The study area forms part of the Nízký Jeseník geomorphological unit. Four subunits (Domašovská vrchovina Highland, Bruntálská vrchovina Highland, Oderské vrchy Highland and the Tršická pahorkatina Upland) contribute their regions to the natural park area. The highest altitude here is 701 m a. s. l., the lowest 250 m a. s. l. In certain sections the slopes of the Bystřice River valley as well as of the adjacent tributary valleys are very steep.

Hydrological conditions

The vast majority of the water in the natural park is collected in the Bystřice River catchment while the Trusovický potok catchment only collects runoff from the westernmost part of the park. The Bystřice River, springing at 660 m a. s. l., presents a hydrological axis of the natural park. This 54 km long watercourse joins the Morava River near the centre of the city of Olomouc, at 212 m a. s. l. Total area of the Bystřice River catchment is 267 sq km. The average volume flow rate at the confluence with the Morava River slightly exceeds 1m^3/s (Vlček et al., 1984).

Climatic conditions

According to Quitt (1971) the area belongs to moderately warm (MT) and cold climatic (CH) regions. The moderately warm climatic region is represented by four subregions (MT10, MT9, MT7 and MT3). Only the northernmost sector of the park and the segment along the eastern boundary lie within the cold climatic region (subregion CH7). The elevation gradually increases heading north, thus the summer season duration declines in this direction. The winter season duration and the snow cover period increase correspondingly.

The macroclimatic conditions can be described using data from meteorological stations Moravský Beroun (nonexistent nowadays) and Olomouc:

- Moravský Beroun – 570 m a. s. l., 49°48′ N, 17°27′ E
- Olomouc – 215 m a. s. l., 49°36′ N, 17°16′ E

The annual mean air temperatures in Moravský Beroun (6.2°C) and in Olomouc (8.8°C) reflect variations in altitude. The highest air temperature ever recorded in Olomouc is 35.5°C (August 21 and 22, 1943). The lowest temperature ever recorded (–38.0°C) occurred on February 11, 1929 at the same station. The average annual number of tropical days in Olomouc is 9.5; the average number of summer days is 59.1; 116.0 for frost days; 35.5 for ice days, and 2.3 for arctic days.

The vegetation season lasts 198 days on average in Moravský Beroun and 218 days in Olomouc. This season begins on April 10 and March 29, respectively, and ends on October 24 and November 1, respectively.

Higher precipitation amounts were consistently recorded in Moravský Beroun. The lowest monthly precipitation amounts were measured in February both in Moravský Beroun (40 mm) and Olomouc (23 mm). The highest monthly amounts of precipitation (99 mm and 86 mm) were measured in July at both stations (Vysoudil, 1989).

During the period 1920/1921 to 1949/1950, 47.7 snow days were recorded on average in Moravský Beroun and 28.2 in Olomouc. The snow cover duration was on average 96.8 days in Moravský Beroun and 40.9 in Olomouc.

In Olomouc, the northwesterly winds prevail (15%). The calm occurrence is 25.1%. The sunshine duration in Olomouc is maximal in July (from 273 to 278 hours), the shortest in December (from 25 to 26 hours). The annual mean air relative humidity was 76% during the 1926-1950 period at the Olomouc station.

Biogeographic conditions and nature protection

Spruce and beech predominate in the forests species composition within the natural park. Meadows and pastures are typical for the western and northern parts. Several rare plant species have been preserved in the meadows, *Iris sibirica* for instance. Within the natural park region, eight Chiroptera species have been discovered (Šafář, 2003), e. g. *Rhinolophus hipposideros* and *Myotis myotis*.

Chiroptera often hibernate in local quarries and empty adits as well as another rare wildlife species worth mentioning, *Salamandra salamandra*.

Block streams of “Kamenné proudy u Domašova” were declared Natural Monument in 1974 (Šafář, 2003). Also within the natural park lies the site of “Hrubovodské sutě”, declared Nature Preserve in 2001.

Socioeconomic conditions

There are only small municipalities within the area of the Naural Park Bystřice River Valley. The largest one is Hlubočky with a population of 4,500 as of March 1, 2001 (Statistický lexikon obcí ČR, 2005). Population decreased significantly in all local municipalities in the latter half of the 20th century. The biggest settlements are found in the Bystřice River valley (Hlubočky, Dětřichov nad Bystřicí, Domašov nad Bystřicí). Moravský Beroun is outside the natural park area, and only its two urban neighborhoods, Ondrášov and Sedm Dvorů are within the natural park. Radíkov and Lošov are administrative parts of the city of Olomouc.

A vital railroad connecting Olomouc and Opava runs through the natural park. A major road connecting Olomouc and Opava cuts through the northern part of the park.

There are two major industrial sites within the park area, the Foundeik foundry plant and the Mora producing non-electric devices for private households. They are listed as a category REZZO 2 in terms of the pollution source classification. However, the home furnaces and the increasing automobile traffic present the greatest hazard to the air quality, especially during the temperature inversions.

In the highest locations of the natural park, above 600 m a. s. l., with an abundance of meadows and pastures the mountain agricultural production practiced dominated by cattle rising. In the lower altitudes potato growing, grain farming and cattle raising predominate.

Because of the natural conditions, especially the geomorphologic and the climatic ones, industrial production as well as agriculture play an insignificant role within the area. Because of the abundance of the leisure time facilities in the park land the area is frequently visited by holidaymakers from Olomouc and its surrounding areas.

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Sustainable topoclimatological research

Miroslav Vysoudil

One of the important parts of sustainable environmental research is topoclimate study. This research, in contrary to standard meteorological observations, allows detail description of local climate and its response to the local climate determinants factors, including human influence. Processes in the atmospheric boundary layer and consequently topoclimate features can be influenced negatively by changes in morphometric parameters of georelief as well as by changes in nature of the active surface. Therefore, field observation of topoclimate based on functional meteorological network is considered a powerful tool of sustainable topoclimate research. During 2006, a topoclimate research campaign was carried out in the Natural Park Bystřice River Valley.

The station network consisted of six automatic meteorological stations by Fourier Systems Ltd. Additional measurements of air temperature and humidity at other localities were also provided with the use of digital micrologs. Each station was equipped with six or seven sensors (temperature, humidity, barometric pressure, rain collector, wind speed, wind direction and also solar radiation at selected sites).

Geographical location

When choosing suitable placing for the stations, it was necessary to select representative locations for topoclimatological research. Vertical differences in the experimental area are considerable. Two stations were located at the bottom of the Bystřice River valley in places surrounded by steep slopes. Two other stations reflected conditions of summit parts of the area, and two reflected the character of a slip plane. The elevation difference was 301 metres.

The MicroLog system in the villages of Dolany and Pohořany represents meteorological conditions in the western part of the natural park.

Table 1 Fourier stations geographical location

station (abbreviation)	latitude	longitude	altitude (m a. s. l.)	location
Dětřichov nad Bystřicí (DET)	49°49.4′ N	17°23.8′ E	608	peak site
Pohořany (POH)	49°40.3′ N	17°22.6′ E	561	peak site
Moravský Beroun (MB)	49°47.3′ N	17°26.4′ E	545	slip plane
Domašov nad Bystřicí, Trout Hatchery (LIH)	49°43.3′ N	17°27.0′ E	458	bottom of valley
Radíkov (RAD)	49°38.5′ N	17°22.1′ E	425	peak site
Posluchov (POSL)	49°38.0′ N	17°23.6′ E	391	slope
Hlubočky, Retirement Home (DD)	49°39.6′ N	17°24.6′ E	307	bottom of valley

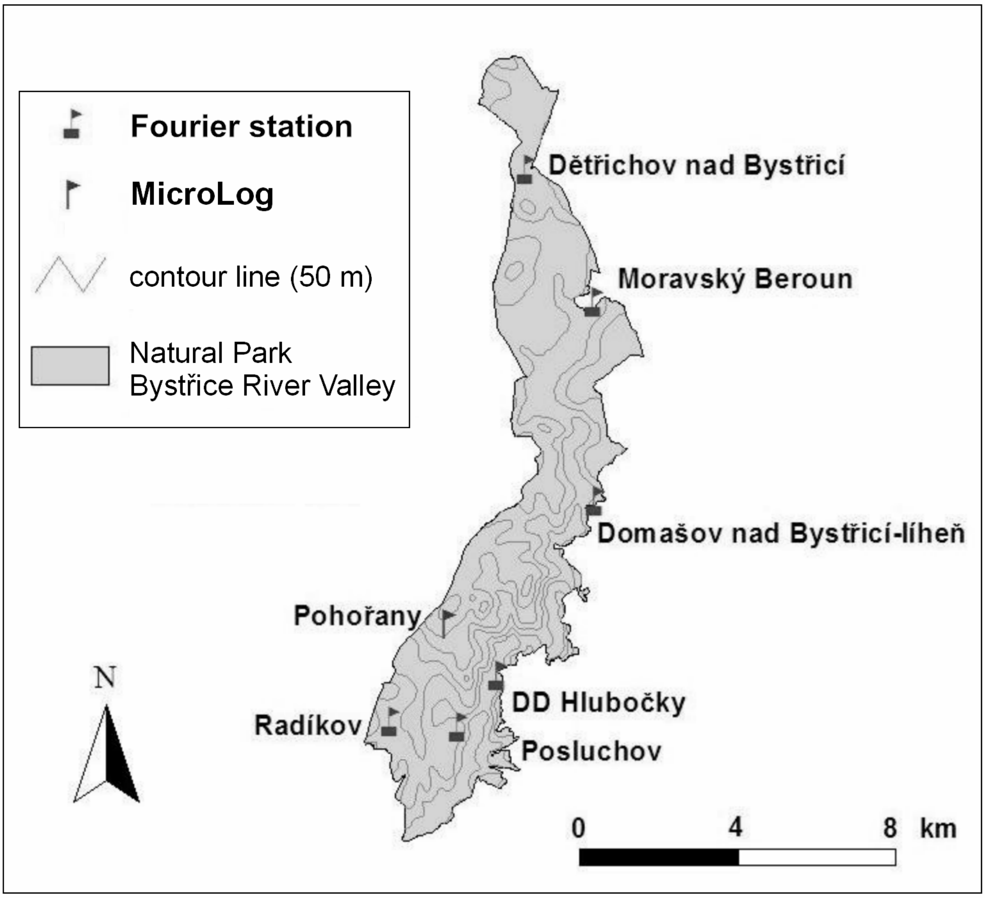

Figure 1 Geographical location of the topoclimatological stations

Stations and their surrounding features

The *Dětřichov nad Bystřicí* station is situated on a plateau in a private garden at one of the scattered houses at the end of the village. Active surface is represented by regularly mown permanent grassland and cultivated land. Low fruit trees in the garden represent the closest terrain barrier.

The *Moravský Beroun* station was situated on a slip plane, in a private orchard on the southern town border. Houses are scattered in this area and the surface blends into the hilly land. The active surface is represented by regularly mown permanent grassland. Low fruit trees in the garden represent the closest terrain barrier.

The *Domašov nad Bystřicí-líheň* station was located at the bottom of the Bystřice River valley in a trout hatchery area close to the Bystřice River stream and small hatchery ponds. Active surface is represented by regularly mown permanent grassland. The inversion valley and the riverbed are very narrow here.

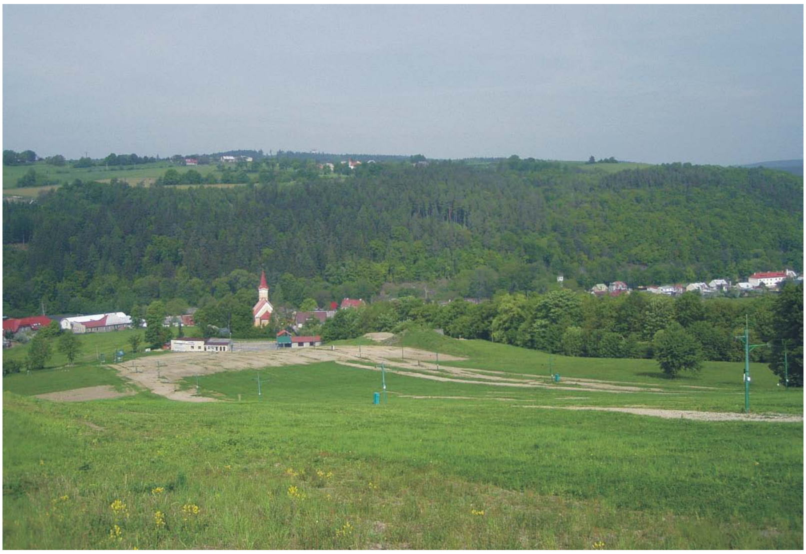

Plate E Natural Park Bystřice River Valley. Photo: M. Jurek.

Plate F Topoclimatic station Hlubočky Retirement Home.
Photo: M. Vysoudil.

The *Hlubočky Retirement Home* station was located in the vicinity of a retirement home in the Bystřice River floodplain. The watercourse flows approximately 100 m from the station location. Active surface is represented by regularly mown permanent grassland. The station was situated in the southern part of the area where the valley is wider in comparison with the northern part.

The *Posluchov* station was situated on slip plane, in a private garden. Houses are scattered in this area. Active surface is represented by cultivated land. Low fruit trees in the garden form the closest terrain barrier.

The *Radíkov* station was placed near the Radíkov settlement in the summit part of Nízký Jeseník Hillyland. Active surface is represented by wild growing permanment grassland, but also forest surrounding the station location must be taken into account. In addition, the wind speed and/or wind direction can be influenced by the proximity of a 35 m tall telecommunication tower.

The *Pohořany* station (the only one equipped with MicroLog EC650 for temperature and humidity recording) was placed in a garden on the southern village border, about 800 m from the summit of Jedová (633 m a. s. l.). The elevation is 561 m a. s. l. Active surface is represented by regularly mown permanent grassland.

Observation methods

The sensor height above active surface respected the principles and needs of topoclimate research.

Air temperature and humidity: the level of 150 cm is a compromise value between the standard level and levels used in microclimatology. This height sufficiently reflects influences of the active surface.

Precipitation: the upper edge of the rain collector was installed 150 cm above the active surface. This is consistent with the standard for meteorological stations.

Wind speed and wind direction: placement of the wind sensor is determined by the station construction. Influences of georelief roughness on wind parameters are significantly expressed, yet this is desirable for the study of topoclimate features.

Solar radiation: a radiation sensor placement is also determined by the station construction.

Table 2 Location of sensors above the active surface (in cm; × – not registered)

station	air temperature	humidity	wind speed	wind direction	solar radiation	rain collector
Fourier	100	100	200	200	200	150
MicroLog	100	100	×	×	×	×

Station measurement

Applied observation methods are based on general principles for topoclimatic measurement described e.g. by Vysoudil (1998). They involve continuous observation lasting several months. The best time for observations is the warm half of the year when frequent occurrence of days with radiative anticyclonic weather is expected (cloudless, wind speed $\leq 2 m.s^{-1}$).

The influence of the georelief on forming of stable atmospheric stratification, i. e. radiative inversions is enormous in deep and narrow valleys. The probability of their occurrence in the natural park is extremely high.

The modification of wind speed/wind direction in deep and narrow, from north to south oriented Bystřice Rriver valley, is presumable. The time of calm also plays a significant role when topoclimate is formed and demonstrated.

The deep Bystřice River valley quite transparently influences solar radiation and air humidity. There is more or less non-predictable atmospheric precipitation regime due terrain architecture.

Above facts underline needs of representative stations spatial distribution to be able describe topoclimate and distinguish its differences place to place with accent to altitude.

All stations record air temperature, humidity, wind speed, wind direction, and the precipitation. The Domašov nad Bystřicí-líheň, Moravský Beroun a Hlubočky Retirement Home were also equipped with a solar radiation registration sensor. The sampling interval for all registered characteristics was 30 minutes.

Cross-section measurement

Cross-section monitoring, continual stationary as well as mobile, is an important part of topoclimatological research. This method is desirable when the need of detail topoclimate description is required. Mobile cross-section measurements provide mostly precise information about air temperature and humidity regime. Therefore methodology by Quitt (1972) is suggested for the improving of sustainable topoclimatological research in the Natural Park Bystřice River Valley.

The methodology is relatively standard and in fact offers two alternatives:

- record values and a time at pre-set points from a vehicle moving at a constant speed,
- record values at set time intervals from a vehicle moving at a constant speed.

The measurements must be taken either on a closed, circular route or on a two directional, return route (there and back). The next step requires correction of values based on the time difference between the start and the end measurement.

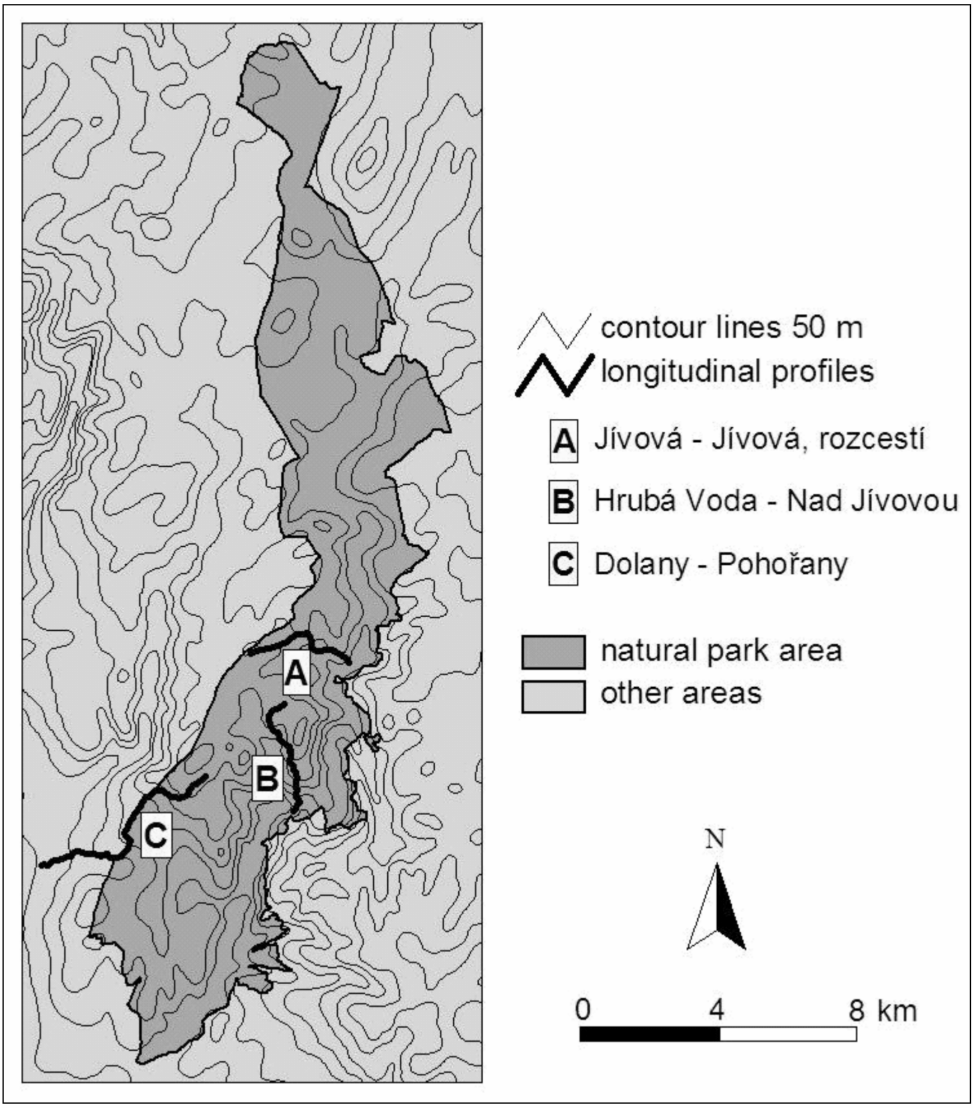

Figure 2 Longitudinal profiles in the Natural Park Bystřice River Valley.

Three profiles (see Figure 2) were marked in the natural park using GPS to satisfy the need for the mobile cross section measuring. The profiles have a relatively great elevation differences. As an example is presented the most distinctive one, cross section Dolany–Pohořany (Figure 3). This is the longest cross section (6,600 m), and its elevation rise (312 m) is the largest of all. The lowest elevation point is 250 m a. s. l., the highest elevation is 562 m a. s. l. While the upper part of cross section is within the natural park, its lower part is outside the boundaries.

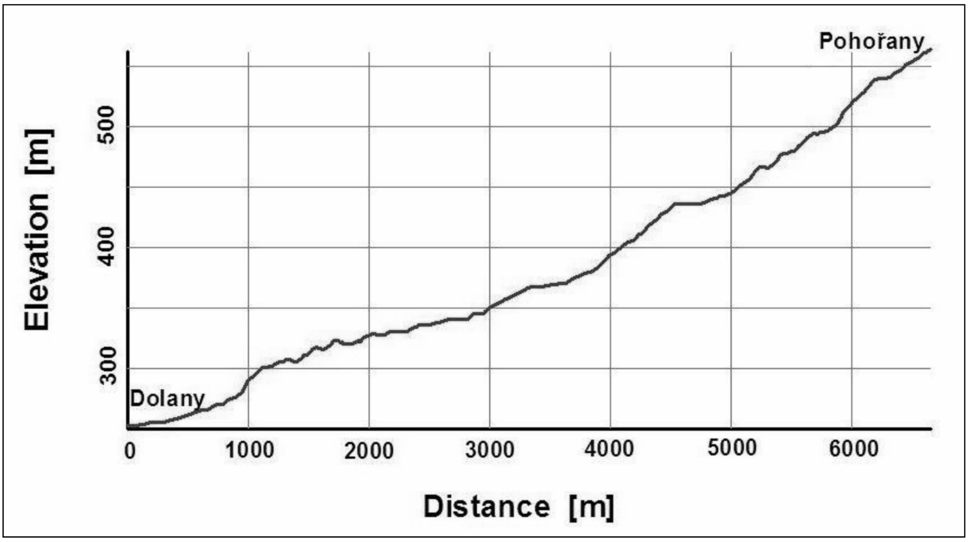

Figure 3 Longitudinal profile Dolany–Pohořany

Temperature Inversion Study in Natural Park Bystřice River Valley

Temperature inversion monitoring in the Natural Park Bystřice River Valley plays one of important part during sustainable topoclimatological research. High probability of their occurrence represents hazard of deterioration in air quality. It is in virtue of morphography of georelief and human activities here worked.

The meteorological data obtained during field measurement together with knowledge of unfavourable synoptic situation occurrence (anticyclone weather) which determine origin of radiative weather represent proper database.

As an example, here is presented overview of temperature inversion occurrence in Natural Park during June, 2006. In this month, 15 days with anticyclone weather and thus with presumption of radiative weather demonstration was classified by use preliminary version of "Katalog povětrnostních situací pro území ČR v roce 2006". This kind of weather usually involves marked radiative inversion origin that in consequence influent immediately air quality, and long-term both population and vegetation health, origin of vegetation inversion etc.

Figure 4 Moravský Beroun, situation before (left) and during (right) surface inversion. Photo: M. Vysoudil.

In accordance with geographical position of topoclimatological stations occurrence of strong temperature inversion was supposed mainly between by those stations:

DET–MB, DET–LIH, DET–RAD, DET–POSL, DET–DD, DET–POH

RAD–DD, RAD–POSL, RAD–LIH

POH–RAD, POH–LIH

MB–LIH, MB–DD

POSL–DD, POSL–LIH

LIH–DD

The temperature difference between mentioned stations at 05 a.m. CET (Central European time) was decisive reason for further analyses. Consequently the curves of 30min. temperature values were constructed for separated pairs of stations. As the end of inversion standing, resp. surface atmosphere layer warming, 02 p.m. CET was determined.

The most frequently number of temperature inversion in the days with anticyclone weather in June 2006 was registered among pairs of stations DET–POH (13), RAD–DD (6), POSL–DD (11), RAD–LIH (12), POSL–LIH (14), MB–LIH (12) and MB–DD (11).

According to classification of temperature inversion by intensity (Petrovič 1960) belong most of inversion cases to the class “slight” when temperature difference between stations is 0.1-3.0ºC. Less frequently were temperature inversion of class “middle strong” (temperature difference between stations is 3.1-6.0ºC), and sporadically “strong” (temperature difference is 6.1-9.0ºC). At all, the highest temperature difference refer to the class “strong” (6,4ºC) was detected on June 15, 2006 (synoptic situation Wal) between stations pair MB–DD. The longest continual period with detected inversion at 06 a.m. CET persisted 8 days (from June 6 to June 15). It is related to pairs of stations DET– POH and POSL–LIH.

Temporal behaviour of inversion, resp. surface atmosphere layer warming in the morning on selected stations are presented in Figures 5 and 6.

Here presented way of temperature inversion analysis will be used for the whole observation period. The outcomes appear to be helpful as one of many form sustainable topoclimatological research, and also for detail understanding of georelief influences on local climate and its rarity in Natural Park Bystřice River Valley.

Table 3 Temperature difference on topoclimatological stations in Natural Park Bystřice RiverValley at 06 a.m. CET, June 2006 (positive value = temperature inversion)

DAY	W.S.	DET-MB	DET-LIH	DET-RAD	DET-POSL	DET-DD	DET-POH	RAD-DD	POSL-DD	RAD POSL	RAD-LIH	POSL-LIH	LIH-DD	POH-RAD	POH-LIH	MB-LIH	MB-DD
June 8	NEa	-2,1	-0,7	0,3	-3,9	-1,7	**0,6**	0,0	**2,3**	-2,3	**0,9**	**3,2**	-0,9	-2,3	-1,3	**1,4**	**0,5**
June 9	NEa	-3,1	-0,1	-1,1	-2,8	2,3	**1,1**	**3,0**	**5,2**	-2,2	**0,5**	**2,7**	**2,4**	-1,8	-1,2	**3,0**	**5,4**
June 10	NEa	-1,8	-2,0	-10,6	-3,4	-6,2	**0,3**	-3,4	-2,8	-0,7	**0,7**	**1,4**	-4,2	-3,1	-2,3	-0,2	-4,4
June 11	NEa	-1,2	-2,1	-6,2	-3,4	**1,7**	**1,5**	**3,0**	**5,1**	-2,2	-0,9	**1,3**	**3,8**	-2,8	-3,6	-0,9	**3,0**
June 12	NEa	-1,3	1,4	-0,8	-4,0	**1,7**	**1,7**	**3,0**	**5,7**	-2,7	**2,7**	**5,4**	**0,3**	-2,9	-0,2	**2,7**	**3,0**
June 13	NEa	-2,1	-1,0	-1,1	-3,4	-1,1	**1,3**	0,0	**2,4**	-2,4	**0,1**	**2,4**	-0,1	-2,3	-2,3	**1,1**	**1,0**
June 14	Sa	-1,9	-1,3	0,1	-3,3	-1,4	**1,1**	0,0	**1,9**	-1,9	**0,1**	**2,0**	-0,1	-2,5	-2,4	**0,6**	**0,5**
June 15	Sa	-2,2	**2,0**	-1,3	-4,3	**0,2**	**2,1**	**0,5**	**4,5**	-4,0	**2,3**	**6,2**	-1,8	-2,3	-0,1	**4,2**	**2,5**
June 18	Wal	-1,5	0,0	-5,0	-1,4	-1,5	**2,2**	-2,0	-0,1	-1,9	-0,5	**1,4**	-1,5	-1,7	-2,2	**1,5**	0,0
June 19	Wal	-1,3	**1,3**	**0,2**	-2,3	0,7	**5,0**	0,0	**3,0**	-3,0	**0,6**	**3,7**	-0,6	-4,3	-3,7	**2,6**	**2,0**
June 20	Wal	-0,3	**0,2**	**5,1**	-2,8	0,2	**3,5**	**0,5**	**3,0**	-2,5	**0,5**	**3,0**	0,0	-3,8	-3,3	**0,5**	**0,5**
June 21	Wal	-0,8	**0,6**	**5,6**	1,6	5,6	**3,6**	**2,5**	**4,0**	-1,5	-2,5	-1,0	**5,0**	-0,5	-3,0	**1,4**	**6,4**
June 22	Wal	-0,8	-0,4	-2,3	-0,8	-1,3	**0,6**	-0,5	-0,5	0,0	**0,5**	**0,5**	-1,0	-1,5	-1,0	**0,5**	-0,5
June 23	Ap_2	-1,7	-1,7	-2,5	-3,9	-4,1	-1,6	-0,5	-0,2	-0,3	**2,0**	**2,3**	-2,5	-2,0	0,0	0,0	-2,5
June 24	Ap_2	-2,5	1,8	-5,9	-4,5	-2,0	-0,1	0,0	**2,5**	-2,5	**3,7**	**6,3**	-3,7	-1,9	**1,9**	**4,2**	**0,5**

Note: W.S. – Weather situation

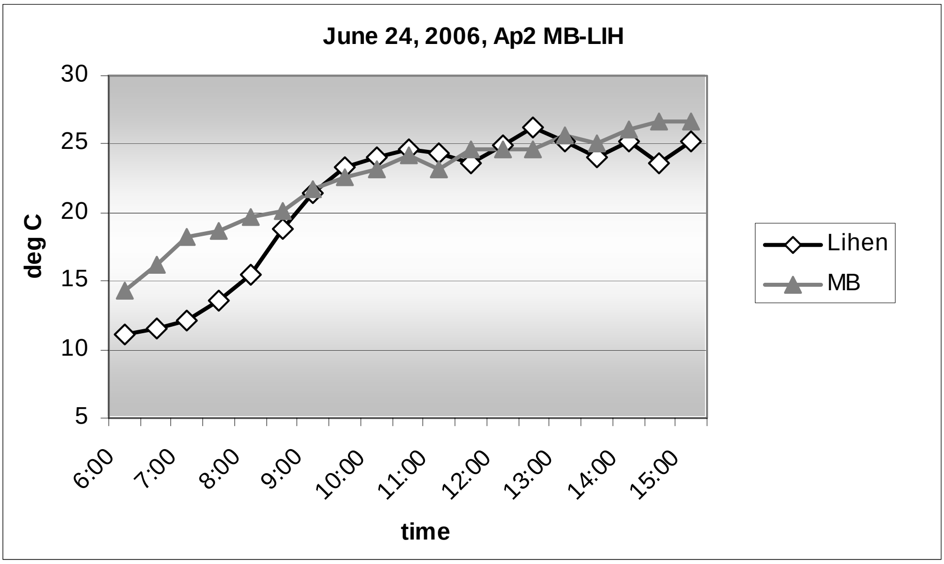

Figure 5 Surface atmosphere layer warming, stations MB–LIH, June 24, 2006, situation Ap_2.

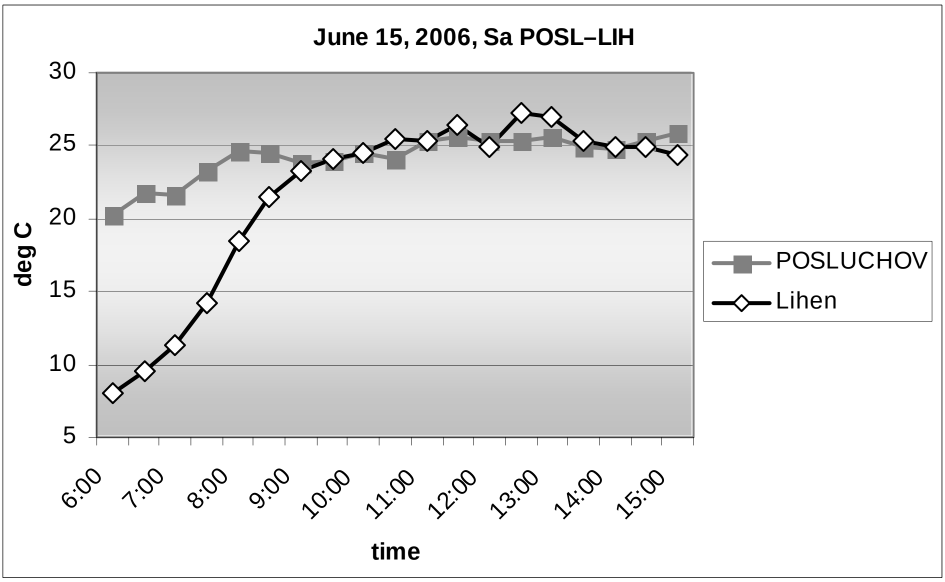

Figure 6 Surface atmosphere layer warming, stations POSL–LIH, June 15, 2006, situation Sa.

Conclusion

The start of the experimental topoclimatological measurements in the Natural Park Bystřice River Valley in 2006 formed a valuable groundwork for a continuous experiment. The representative meteorological data time series achieve is fundamental for the sustainable topoclimate as well as for sustainable environmental research.

Results and applicability

Results:

- theoretical knowledge about topoclimate study were used in praxis,
- obtained time-series of meteorological elements constitute the database for study of sustainable topoclimate, local climate effects, and possible environmental consequences,
- methodology of topoclimatological field experiment was tested.

Applicability:

- experience with organization of topoclimatological field observation can be transferred in the natural park with different geographical conditions (tract, vertical variability etc.),
- used methodology of topoclimate study can be apply as a template for similar research in different geographical territories.

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Application of GIS in sustainable environmental research

Aleš Létal

This chapter describes possibilities of free internet access to GIS data maintained and provided by Czech public institutions. Among the essential benefits of this kind of service is raising effectiveness of public funding of research activities. Providing GIS data via internet has recently become widespread practice, with rapid development especially in Map Server Technology. Various data sources are accessible using WMS (Web Map Service) or WFS (Web Feature Service) (Beaujardiere 2006, Tyler 2005). The following pages give a basic overview of useful digital data services related to environmental research in the Czech Republic.

Relevant data for environmental studies in the Czech Republic

The Czech Republic has a long history of landscape protection. We can sorts the data for it to several branches. Firstly we need precise topographic information after that other information about landscape abiotic elements (geology, geomorphology, soils, hydrology, and biota); finally we need information about living organisms and human influence. In 2005 there was transferred a new state-subsidised organisation under the Ministry of the Environment – CENIA: Czech Environmental Information Agency (http://www.cenia.cz). This organization is focused to share and cover all environmental data/information, first of all for the state municipalities, local governments and other state institutions.

Topographic information

Topographic information is necessary for representation of spatial (regional, local) ties and made the base platform for documentation of studying phenomena. There are several sources for taking detailed topographic information or detailed data about landscape topography.

Topographic maps (scale 1:10,000; 1:25,000)

In the Czech Republic there are two main sources for topographic maps (Miklošík 1997). For civil purpose there are materials from COSMC "Czech Office For Surveying, Mapping And Cadastre" (http://www.cuzk.cz). These maps are used as a thematic state map series for all state institutes. The maps are printed (in scales 1:10,000; 1:25,000; 1:50,000; 1:100,000; 1:200,000) or in vector ZABAGED (Elementary base of Geographical Data) in 1:10,000 scale and raster format (all scales). Maps in digital format are not free of charge, for students works are free (area and map sheet limited). Used for state institutions and municipal government.

For Czech Army needs there exists “Military Topographic Institute”. The institute has a long tradition, activities was strictly oriented for Army purposes, partially for civil using (state service), but with restrictions for normal people usage. After 1989 the materials are used for civil aims too (touristic topographic maps 1:50, 000). The topographic information are in digital format (vector format with catalogue of attributes), basically in 1:25,000 scale, commercial name DMÚ 25 (Digital Topographic Model, Digital model of territory). It is more detailed in case of topographic information (type of bridges, vegetation cover specification, roads differentiation, orientation points, etc.). There exist other equivalents in scale: DMÚ 50, 100, 200 (scale 1:200,000) used for army primary, then for state institutions and municipal government exigencies. Public version of topographic geodatabase can be found in Czech Army “IZGARD application” - Digital Atlas of Czech Republic (Figure 1).

Remote sensing, photogrammetry

Before 1989 (especially to 1980), materials like airborne photo or other remote sensing data was strictly protected by law “top secret” for normal usage. Only institutions could use them. The main activity was made by VTOPU. There exists big range of analog airborne photo scenes for whole Czech Republic. It started regularly from 1936. Airborne photo was made for preparing topographic maps for army purposes, after 1946 the technology was used for preparing topographic map for civil usage. Every 5-10 years there the whole country photo campaign. These materials are not rectified (photos, films). User must specify area and period, VTOPU make a copy of photos (photo paper, scanner). After 1989 was founded many companies that are able to made airborne photo. Only few of them made the larger part of country. The bigger one is GEODIS (http://www.geodis.cz) that has it own datasets and databases covering the whole country. Data from the satellites are offered normally by several companies and some of them are free. There exists project at Charles University that links directly to Meteosat satellite and save the scenes for the students or university needs.

Services for detailed measuring in field

There exist new services that help scientists and companies to measure more effectively in field. There are two projects in the Czech Office for Surveying, Mapping and Cadastre. For the first users can used an Internet portal with database of triangulation and net desification points. There the information about geodetic objects - points (coordinates, documentation map) can be downloaded and used in field work (DGPS, total station measurements). For those purposes there is a www portal of the database DATAZ (http://cuzk.dataz.cz).

The new service that starts 2 years ago is named CZEPOS (http://czepos.cuzk.cz). It is network of permanent GPS stations regularly disposed about 60 km spacing each other. Each station observes 24 hours and registry every second. Safed data are processed promptly and able for everyone (payed service). The service covers the problem with DGPS measurements. Users can measure with one station and the base data download from CZEPOS Network Service – Virtual DGPS base (Figure 2).

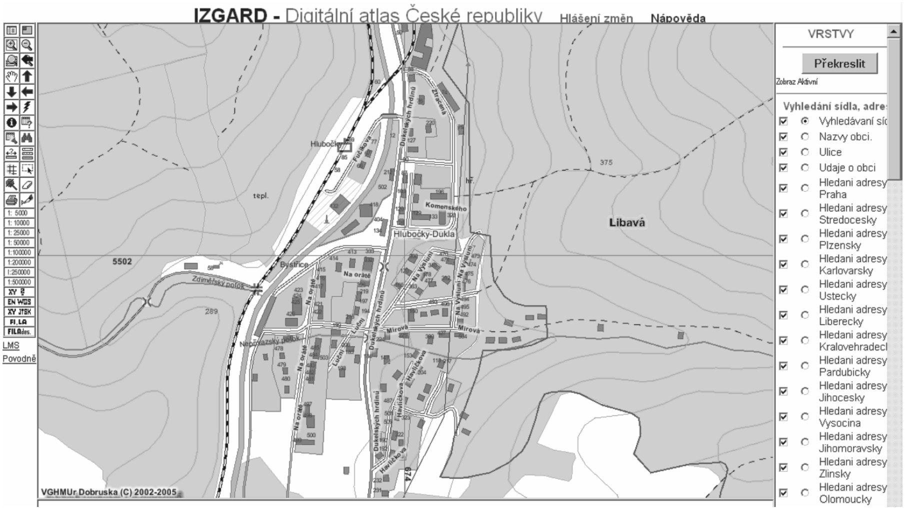

Figure 1 User interface in IZGARD application – Digital Atlas of Czech Republic. Source: http://izgard.cenia.cz/dmu/viewer.htm.

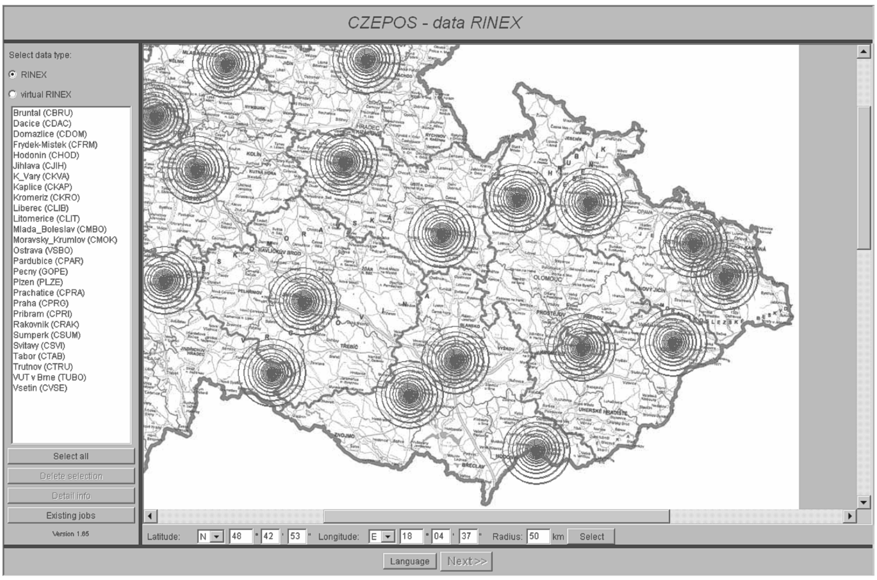

Figure 2 Java Application for downloading DGPS data from CZEPOS Network Service. Source: http://czeposp.cuzk.cz/geopp_gnweb/gnweb.html.

Thematical information

There exist several sources for environmental data sources. The best source for it is Ministry of the Environment. This organisation has a special programme that collects and compiles informations about environment and makes it accessible for all. For that purposes it use the modern technology – webmap application (http://geoportal.cenia.cz). Map server consists of more than 40 thematic layers that can be sorted to several spheres of interest:

- nature environment data (nature protection areas, data from abiotic sphere, lancover, landscape typology, etc.)
- registry of contaminators
- territorial and administrative state structure
- population data
- traffic
- historical maps (military mapping)

Webmap technology (WMS, WFS) is used in other institutions that manage or study some part of the Czech environment.

Forests cover about 34% of the Czech land and there exists special “Forest Management Institute” (http://www.uhul.cz) that solves the problem with forest inventory, compilation and administration of Regional Plans of Forest Development and administers Informational and Data Centre for forests and game management. Their map server covers the data about forest development, forest health quality, hounting districts, soil erosion, potential soil erosion, etc.

Important component of landscape is hydrology. T. G. Masaryk Water Research Institute *(http://www.vuv.cz)* covers all activities connected with water management (water quality and pollution, evidence of contaminants, floods etc.). It manages “Hydroecological Informational System” *(http://heis.vuv.cz)* based on the same technology like previous expamples (webmap server and databases). Other institutes that cover the problems with water management in regional scale – main watersheds (Elbe, Morava, Odra, Ohre, Vltava) are organized by Ministry of Agriculture and share the “Water Management Information Portal” (, there exists so called “floods warning system” with actual informations about flood levels and actual water level (Figure 3).

Other thematic data share institute “Czech Geological Survey” *(http://www.cgu.cz).* You can use geological mapserver (geological map of the Czech Republic, radon risc map, etc.).

Finally there must be mentioned notable application founded on Geoinformatics Laboratory at University of Ústí nad Labem *(http://oldmaps.geolab.cz).* Portal of historical maps (Figure 4) shares Military Survey Maps (1st, 2nd, 3rd Survey of Austro-Hungarian Monarchy), Muller´s Survey maps or maps of Stabile Cadaster. Unique historical map sources cover whole state and are essencial study material for longtime landscape changes.

Previous data sources can be mostly used without restrictions for scientific intentions most of the mapserver interfaces have the English version. The user can ask about raw data (vector format). Most of the thematic maps are in 1:50000 scale, or cover regional scope (1:200,000; 1:500,000). Exceptionally the map sources can be distributed in 1:10,000; 1:25,000 scale (forest matter, some geological maps, historical maps), some data are in non-spatial format (texts, databases, diagrams, etc.)

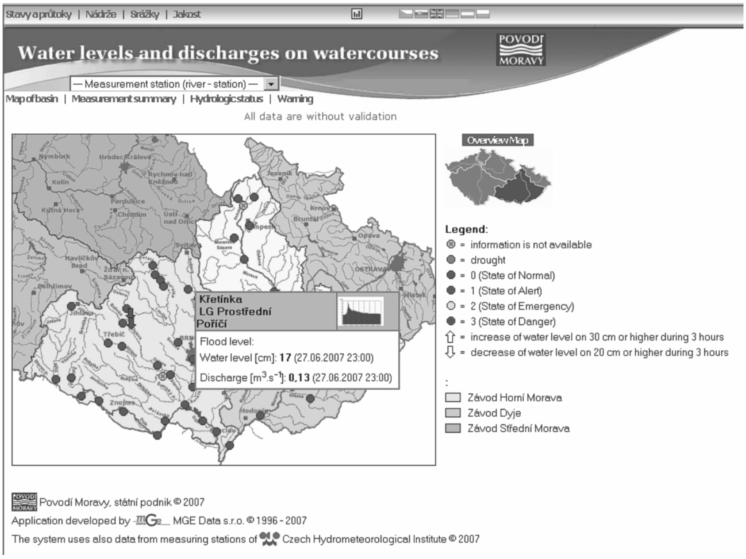

Figure 3 Water Management Informational Portal – flood warning system page. Source: http://www.pmo.cz/portal/sap/en/index.htm.

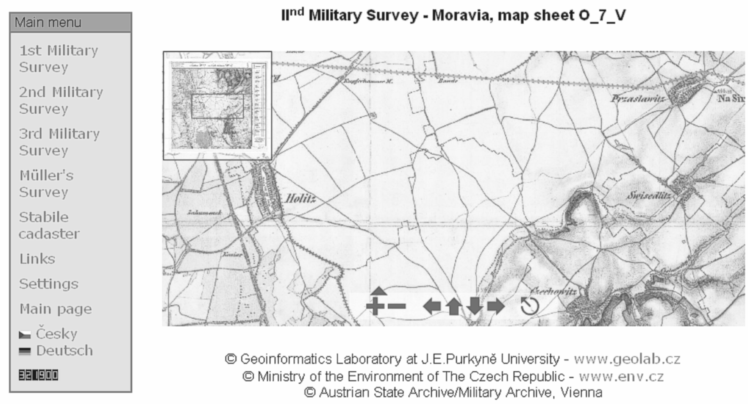

Figure 4 Internet application for historical map presentations, 2nd Military Survey Maps (http://oldmaps.geolab.cz)

We presume to affirm that Czech Republic is a leader country in central European region with environmental data sharing for public use. Extent and number of environmetal data sources that are available help to people find relevant information about our nature and recent problems with it.

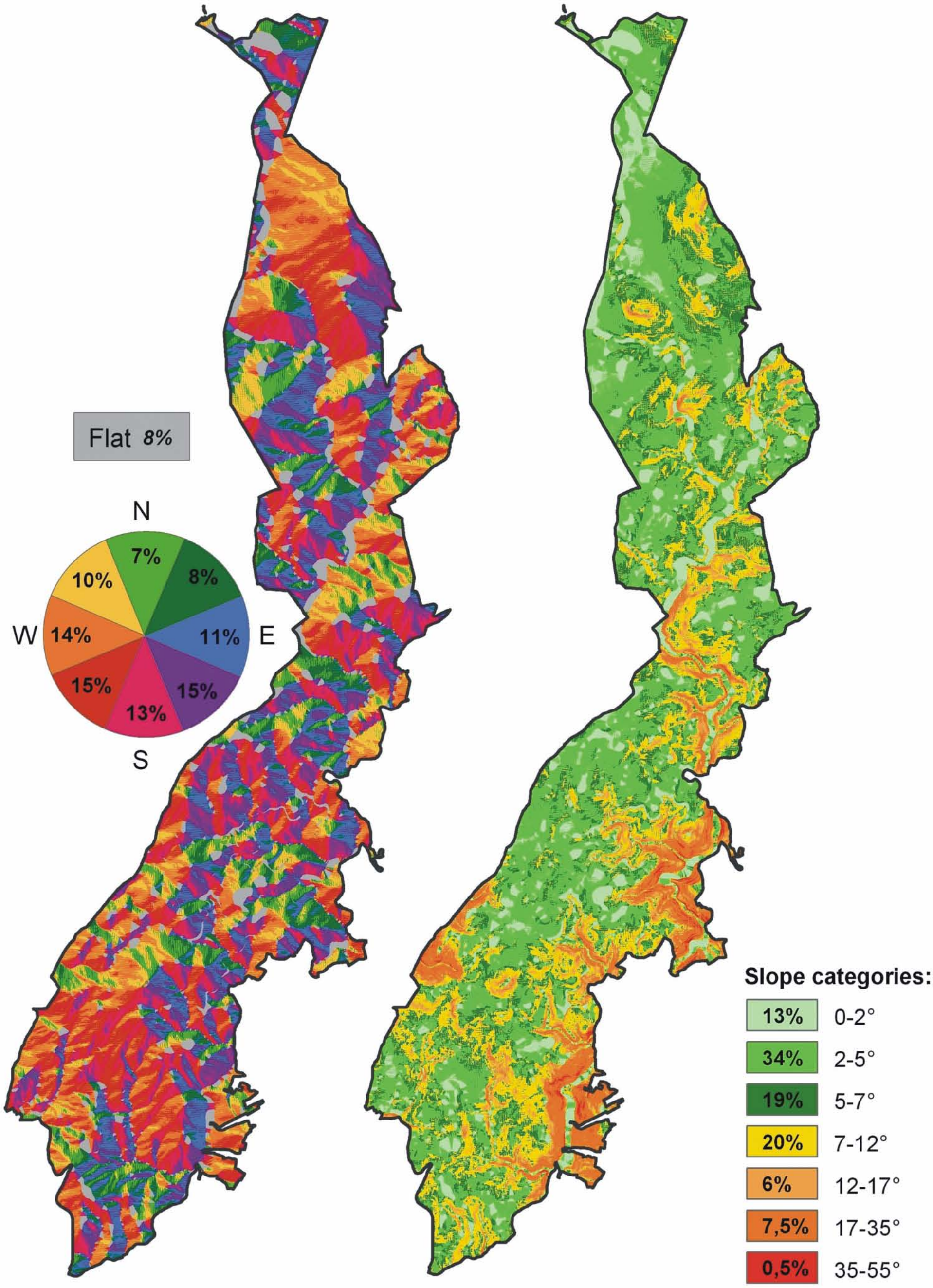

Plate G Aspect representation (left) and slope analysis (right) for the Natural Park Bystřice River Valley.

GIS analyses for topoclimatical research

GIS technology is the new tool for the landscape analyses and with Remote sensing data using get a powerful tool for modelling. GIS application can be used for different tasks and needs (digital cartography, modelling, real time analyses etc.). We used GIS for two main tasks. For the first we need some input data for modeling or detail characterization of the region. We used digital topographic and thematical data which help us to determine some specification of the studied area (precise DEM, slope characteristics, aspect, profile generation, etc.). Besides standard extension of ArcGIS or ArcView 3.x. we use Surface Tools (Jennes Enterprises), Diagram Wizard (Alta4) etc. Selected outputs are presented on Plate G. The derivates of DEM analyses come into other analyses or calculations (Solar Analyst, Surface Tools etc.).

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Ambient air pollution assessment

Martin Jurek

Air quality research and monitoring had gained attention primarily due to negative impacts of airborne pollutants on human health, yet recently ecosystem health has been taken into consideration as well. Various air sampling methods applied at mostly automated monitoring stations belong to the standard tools of air quality monitoring. Such measurements are usually located within larger urban areas and industrial zones, while rural areas remain widely neglected as prevailingly clean and safe from any harmful pollution (Kotlík et al., 2005), with only a limited number of the pollution background measurement spots. However, certain areas in the rural landscape may experience air pollution levels comparable to cities, mainly because of unfavourable terrain features of settlements and communications. This applies in particular to deeper valleys where local conditions allow for frequent inversions and inhibited mixing of emissions into the ambient air. Although the Bystřice River valley represents a nominaly rural area, its bottom contains significant air pollution sources: households using coal, wood and natural gas for local heating, a railway using diesel-fueled engines, road traffic, stone quarries and also larger industrial plants: the foundry of Foundeik s. r. o. and household appliances factory of Mora Moravia s. r. o., both located in Hlubočky-Mariánské Údolí, as well as a plastic products company Granitol a. s. in Moravský Beroun.

Temperature stratification characteristics

Temperature inversions in the Bystřice River valley have been recently studied by Vysoudil (see this volume, pages 47-50). An overall longer-term statistics of temperature inversions in the valley cannot be derived from direct measurements due to lack of meteorological stations in the natural park area. Nevertheless, differences in temperatures recorded at stations in Olomouc (49°34′ N, 17°15′ E, 225 m a. s. l.) and Červená (49°47′ N, 17°33′ E, 749 m a. s. l.) can be analysed to obtain a rather general description of the (pseudo)vertical temperature profile characteristics for the natural park area. Coufal (1973) defined three basic types of temperature stratification in the atmospheric boundary layer: (1) *very stabile* with vertical temperature gradient of up to 0.3°C/100 m; (2) *neutral* with vertical temperature gradient between 0.4° to 0.8°C/100 m; (3) *labile* with vertical temperature gradient of at least 0.9°C/100 m. Daily temperature records (at 07, 14, 21 CET) from Olomouc and Červená were analysed for the period 1981-2000 with the following results: the maximal occurrence of very stabile boundary layer stratification occurred in January (34.7% of all time possible) and December (30.5%), while in the summer months (June-August) its occurrence decreased to 15.1-16.5% and in fact reduced to short night episodes. The labile stratification reached maximum in occurrence during the spring months of April (34.8%) and May (32.5%), while in the winter months (December-February) it occurred in only 14.3-14.7% of all time possible. A further analysis of temperature stratification occurrence during individual meteorological situations (Typizace povětrnostních situací pro ČR, 1946-2005) showed that the very stabile stratification occurred most frequently with south-western anticyclonic situation (58.8% of all time possible), followed by the situation of an anticyclone above Central Europe (47.5%) and by the south anticyclonic situation (46.8%), while it occurred only at limited frequency with the norh-eastern cyclonic situation (8.9%), eastern cyclonic situation (9.1%) and north-western cyclonic situation (9.6%). On the contrary, the labile temperature stratification occurred most frequently during the eastern cyclonic situation (48.3%) and north-eastern anticyclonic situation (44.7%) but only rarely during the south anticyclonic and south-western anticyclonic situations (both 5.7%).

Emission inventory analysis

Pollution prevention is considered to be the most powerful tool of air quality management. As part of the legal-administrative process of controlling the amount of pollutants released into the atmosphere, regular emission inventories have been carried out in the Czech Republic (and former Czechoslovakia) since the 1980s. Air pollution sources are classified into four distinct categories: REZZO 1 – large pollution sources (mainly industrial plants); REZZO 2 – medium pollution sources (smaller industrial and public service sources), REZZO 3 – small pollution sources (local heating); REZZO 4 – mobile pollution sources (mainly traffic). The REZZO 1 inventory has been collected annually since 1982 and represents the most accurate dataset of the four categories (REZZO 2-4 have been updated less frequently and carried out as estimates based on proxy data, such as fuel distribution statistics and public censuses). Combined with detailed meteorological and terrain data, emission inventories can be used in modelling spatial dispersion of pollutants (the current standard model used in the Czech Republic is SYMOS ’97). A less detailed, yet sufficiently informative tool on spatial distribution of the sources of air pollution is producing grid maps of emission densities.

In order to assess the longer-term development of industrial emissions in the district of Olomouc, grid maps (resolution 2 km × 2 km) of average annual emission densities from industrial air pollution sources (REZZO 1) were produced for particulate matter (PM), sulphur dioxide (SO_2) and nitrogen oxides (NO_x) for the decades of 1981-1990 and 1991-2000. Figure 1 shows the difference in the emission amounts for particulate matter. Five major spatial clusters of pollution sources can be identified, representing areas of Olomouc, Šternberk, Uničov, Litovel, and Hlubočky. The last one, even though not being an urban area, shows significant industrial activity. Despite a pronounced decrease in the emission amounts, the area of the natural park remained influenced by industrial air pollution towards the end of the 1990s, both by the industrial production in the southern part of the natural park area and by the sources located in the city of Olomouc.

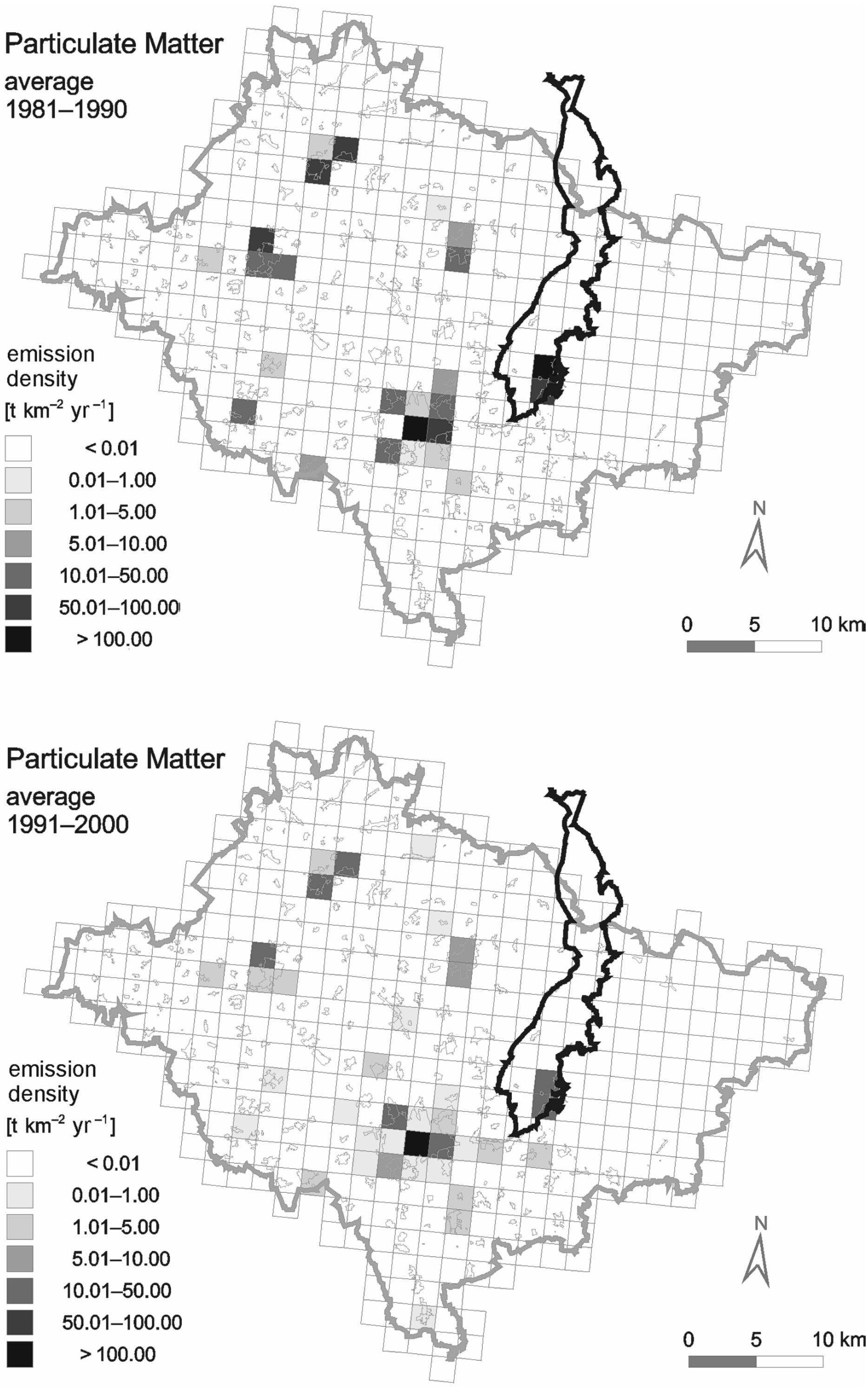

Figure 1 Average annual emission densities of particulate matter from industrial sources in the district of Olomouc.

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Sustainable hydrological research

Renata Pavelková Chmelová

Hydrological research carried out in the Natural Park Bystřice River Valley focuses on the runoff conditions and limitations (hazards) for the studied area. It helps to understand the physical geographical processes in the landscape possibly induced or influenced by human activity.

Land use and cover changes (LUCC) Database

The LUCC database has been created at the Department of Socioeconomic Geography, Faculty of Science, Charles University of Prague, as a part of several grant projects. The database contains archive data from approx. 13,000 cadastral units covering the entire area of the Czech Republic. Data from years 1845, 1948, 1990, and 2000 were elaborated.

The year 1845 covers data from 1825-1843, when military mapping in the scale of 1:2,880 (so called "stable cadastre") and registration of real estates were carried out in the region. These activities had happened before free-market and capitalistic relations of production were enforced. The year 1948 captures the early post-war period, after the displacement of Germans from border areas, yet before the collectivisation of agriculture. The year 1990 represents the end of the communist era and the beginning of transformation processes. The year 2000 shows, how the decade of changed economic factors, influenced by restitution, privatisation and transformation of agricultural cooperatives and state farms impacted land use.

All data originate from detailed land registration (cadastral mapping) of the Czech region, which had launched in 1826 as the so called "stable cadastre" (precise triangulation network, cadastral maps scaled 1:2,880). Cadastral data from the years 1845-1948 were obtained from the archives of the Central Archive of Land Surveying and Cadastre in Prague, more recent data from databases of the Department of Central Databases of the Land Surveying Office in Prague.

Eight land-use categories were created: arable land, permanent crops, meadows, pastures, forested areas, water planes, developed areas, and other areas. These categories were combined into three general categories: agricultural land, forests, and other areas.

Outputs in terms of tables and cartograms based on the network of cadastral areas of all regions of the Czech Republic are available. These outputs serve for other analyses of the state and further development of the area of the Czech Republic using the smallest territorial units – the cadastres (Bičík 1998, 2003).

LUCC data allow for landscape development analyses based on "change indices". These aggregation indices characterise ecological, economic or recreation potential of the studied area. An index called "Ratio of Human Influence" (RHI) demonstrates the rate of human pressure in the landscape as ratio of more exploited areas and less intensively exploited areas:

$$RHI = \frac{AL + UaL + OL}{Me + Pa + FL + WL}$$

AL *– Arable land,* ***UaL*** *– Urban area land,* ***OL*** *– Other land (routes, non-used land),* ***Me*** *– meadows,* ***Pa*** *– pastures,* ***FL*** *– forest land,* ***WL*** *– water land*

RHI takes the values from zero to infinitude; lesser values express lower human influence in the landscape.

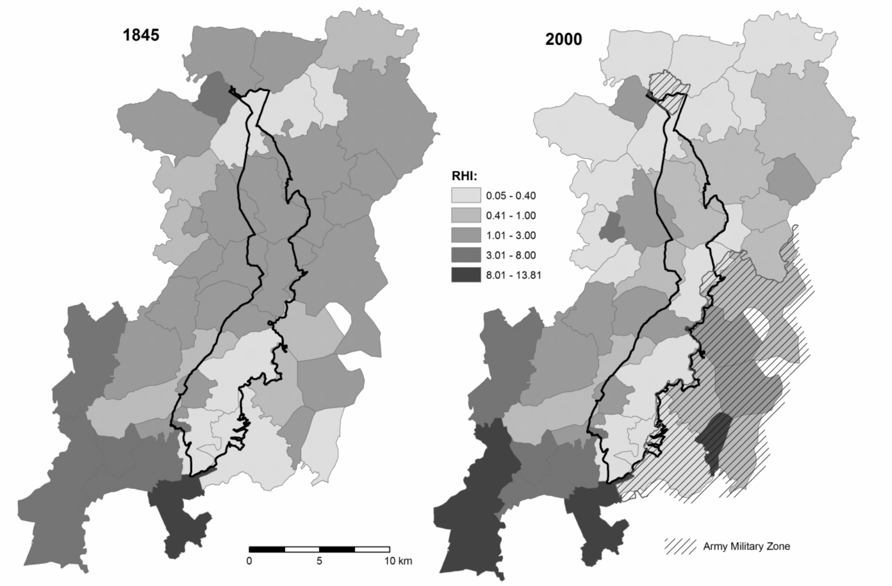

Figure 1 Demonstration of RHI for the region

Maps of RHI in periods 1845 and 2000 (Figure 1) show pronounced differences in the central and northern parts. Human pressure decreases and the main part of the natural park is in lowest category – natural landscape. This change was induced by tree significant occurences during the 150 year period. After the WWII German population was displaced from the region of Czech Sudeten and in 1946 Army Military Zone was established around Libavá. Recently, human influence in the landscape decreased with transformation of the Czech agriculture after 1989.

Usage and interpretation of the calculation issues must be taken with critical aspect. The values are claculated for the whole administrative unit, we do not evaluate landscape microstructure and quality of partial fragments inside of it. It is not so effective make the comparison of different time horizonts (Lipský et al. 1999). Possible way is to compare regional variation in one year. We are studying development of the regional formula for ecological quality of the area, not development of this quality. For detailed information see (Kabrda 2003).

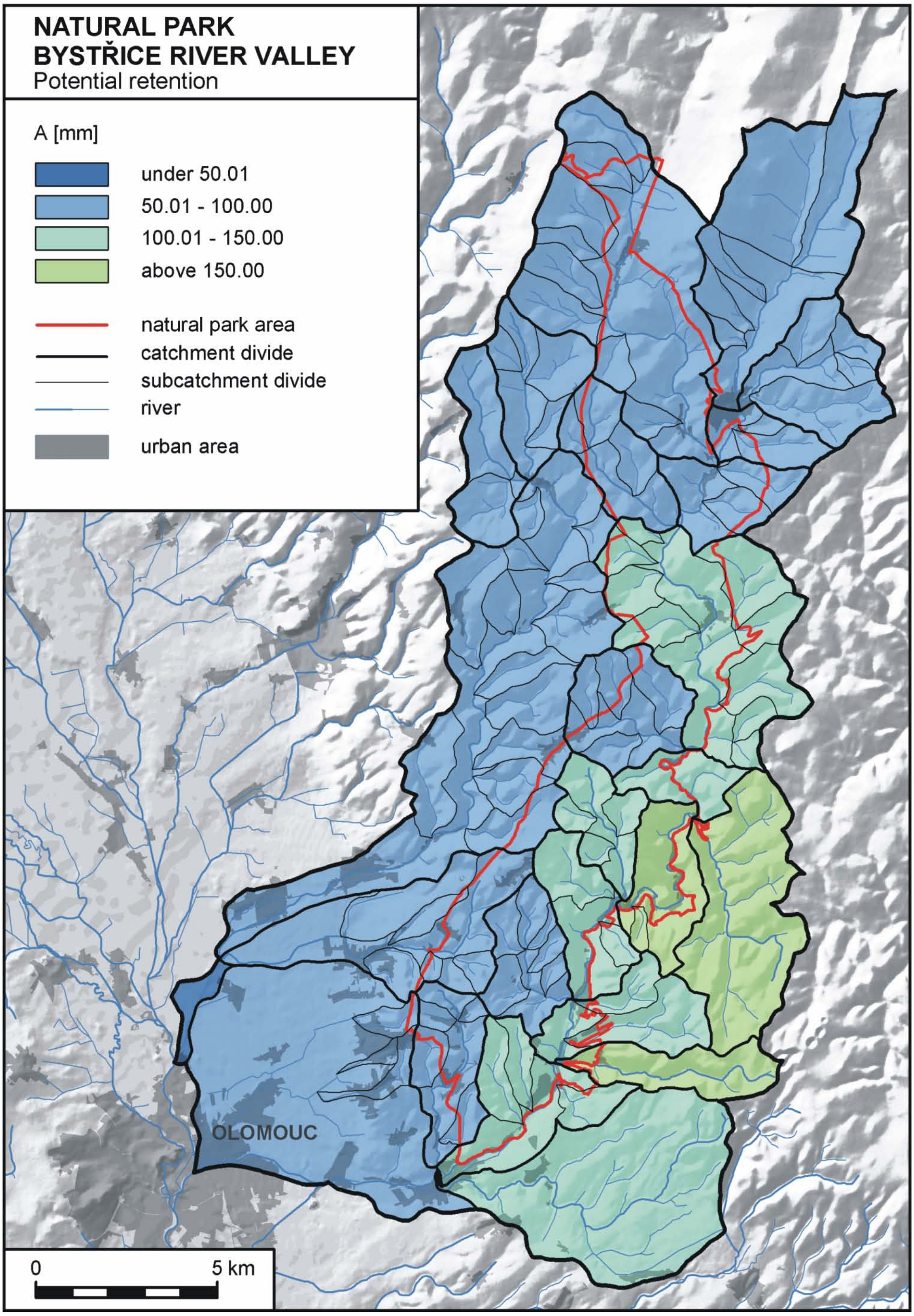

Plate H Potential retention (A) in 2004 in the Natural Park Bystřice River Valley.

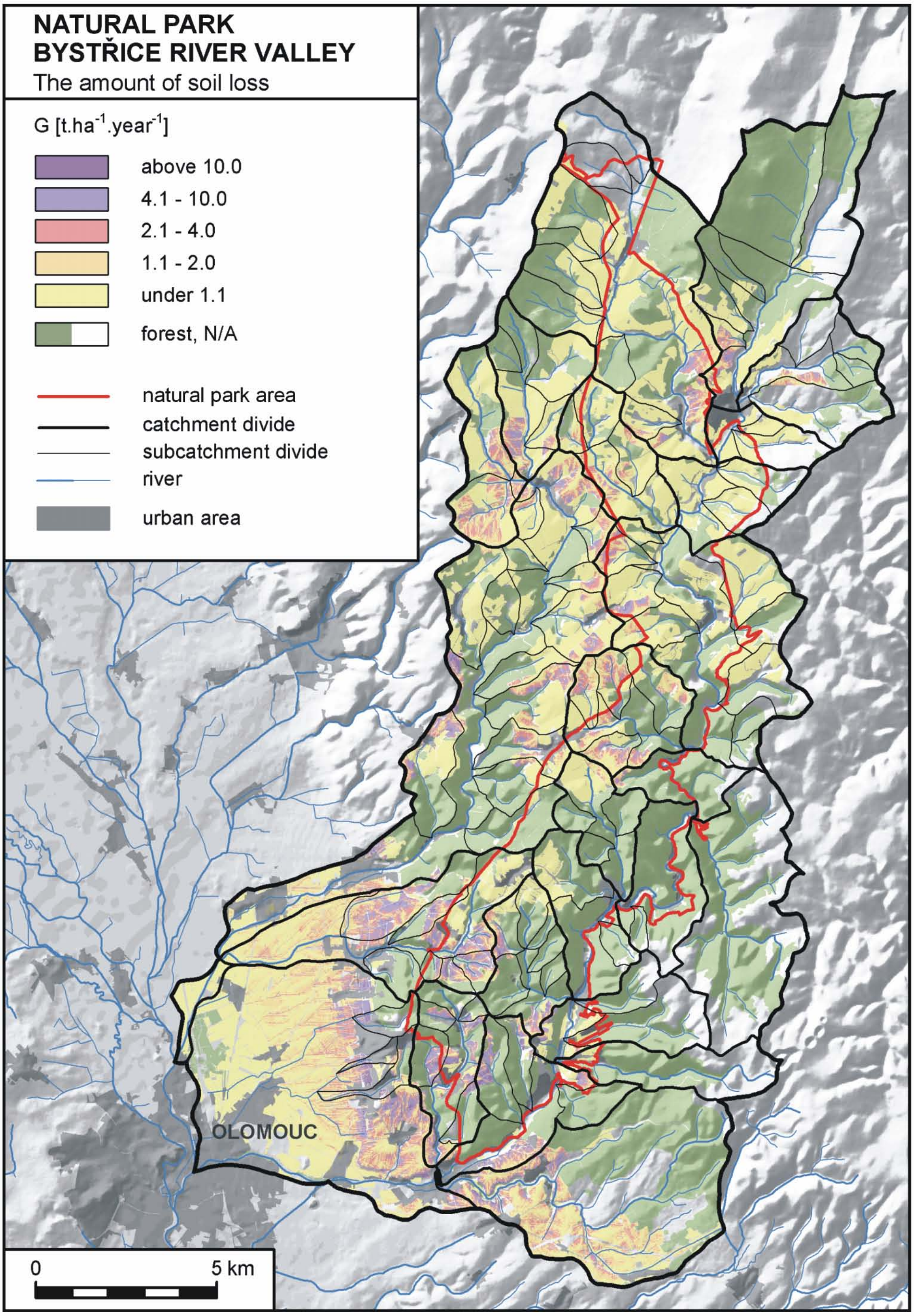

Plate I Amount of soil loss (G) in 2004 in the Natural Park Bystřice River Valley.

Runoff characteristics

Runoff of the catchment area under study was calculated using the US Soil Conservation Service method (US Soil Conservation Service (SCS), 1975). Although the method is designed for a single storm event, it can be scaled to find average annual runoff values. The requirements for this method are elementary: rainfall values and curve number. CN values range between 0 and 100, with higher CNs expressing higher potential runoff watershed. The CN is usually estimated from handbook tables, which list land use, hydrological soil group and the antecedent moisture condition. The SCS method was modified because of conditions in the Czech Republic. Official methodology (handbook tables) was published by Research Institute of Ameliorations and Soil Conservation (VÚMOP) in Prague in 1992. The equivalent of the hydrologic soil group for forest soils was determined using the method of Macků (2000). CN curves determination for forest hydrological soil group in the Bystrice river catchment was figured up according to the forest age structure and its species composition.. The CN formulation is used for further hydrologic calculation e.g. Q_D – surface runoff and A – potential maximum retention (Plate H).

Models simulating the retention capacity of catchments are used for planning landscape structural changes at the regional scale, for example, KINFIL (Kovář, 2002), DesQ model (Hrádek, Kuřík 2000), WMS and AGNPS, which have been tested particularly for the very specific conditions prevailing in the Czech Republic. Problems arising from the use of these models are primarily connected with the lack of direct hydrometric observations in a majority of small watersheds, which might otherwise be the basis for model calibration. Hydrologic effects of land use changes have been thoroughly described by Calder (1993). The major changes affecting hydrological status of a catchment are in particular: forestation and deforestation, intensification of agriculture, drainage of wetlands, road construction and urbanization.

Soil erosion

The most important equation for measuring run-off is the Universal Soil Loss Equation (USLE) (Wischmeier, Smith, 1965, 1978). This basic method calculates water erosion at the top of the slope where the erosion begins:

$$\mathbf{G = R \,.\, K \,.\, L \,.\, S \,.\, C \,.\, P \; [t.ha^{-1}.y^{-1}]}$$

G – soil loss per unit area (t/ha . y)

R – rainfall factor

K – soil erodibility factor

L – length of slope factor

S – steepness factor

C – cover and management factor

P – the support practice factor

As long as the processing of data using GIS (Geographic Information System) is mentioned, two different procedures can be used for the calculation of the erosion vulnerability of a certain area:

- calculations based on the identification of runoff lines, which means the calculation of an average soil loss on an identified runoff line according to USLE.
- grid-based calculations, which means the calculation of the soil loss according to USLE for a grid (unit) of a defined size (for example 10×10 m).

Due to the character of the source data, the latter method using the grid was selected for further use. Vector data covering the area were divided into a grid of 10 m. Slope characteristics such as its length and inclination were set in the manner of gradual counting of the grids along the fall line. Subsequently, the average soil loss of each unit of the grid was calculated using a grid-calculator and the formula of USLE equation. The calculations enabled to compare the average soil loss and define the influence of land use in individual parts of the research area. Plate I illustrates the amount of soil loss (G) of agricultural land in the Bystřice catchment.

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Case study for the NATURA 2000 area Hohentauern, Austria

Nature protection supported by geospatial technologies become more and more important, not only on a global but on a local level, too. The establishment of a portfolio of data strategies and spatial information products, which serve local and public-sector users, is one major aim.

Geo-spatial technologies are well established as valuable sources of information for natural resource managers in the global context. Local applications dare on an application standard and permanent use. They often suffer due to high costs of data acquisition, analyses and still too little knowledge about the capabilities. Our case studies should give a short glimpse on the work of the Institute for Geography and Regional Science (IGR).

The aim of presenting these case studies is focused on exchange and integration of different interdisciplinary approaches and methodologies in environmental investigations of natural parks.

The Austrian case study is located in the Niedere Tauern (upper part of Styria). This investigation area represents an ideal area of interest for documenting the application of geospatial data in the fields of scientific research and in educational purposes.

Investigation area of Hohentauern

Wolfgang Sulzer

The investigation area is located in a high mountain area in the "Niedere Tauern", Central Alps, in the northern part of Styria (Plate J). The pass territory of Hohentauern is embedded into the NATURA 2000 area of Styria (see Gspurning, this volume, pages 80-83). The region divides the western Rottenmanner Tauern (including the Bösenstein group) from the Seckauer Tauern in the east, and the Wölzer Tauern in the southeast. It is characterized by high relief energy and steep slopes (ranging from 1100 to 2400 m, Plate K) and smooth valley bottoms in the entire pass region. Lieb and Sulzer (1992) described the geographic aspects of the pass territory of Hohentauern.

Natural Landscape

The geologic structure of the region leads into the antagonism of the landscape; one side is composed of jagged, strongly rugged forms and on the other side rounder forms with smooth relief is predominant. The reason for this can be found in the basic geological structure of the area, which includes silicate and carbonate rocks, in general.

Metz (1967) mapped the region for the geological map 1:50,000. The region is geologically situated between the Central Crystalline Complex (Central Alps) and the “Grauwackenzone” with included carbonate rocks. Exploitable resources and an attractive landscape exist within this context (Metz, 1967; Figure 1).

The northern unit consists of the “Grauwackenzone” with many different rocks (quartzite, phyllite and carbonate rocks, Figure 1); the eastern unit dominates greenstone and phyllite, the western part graphite-phyllite, carbonate rock from Carbon (Triebenstein, 1810 m and “Sunker Walls”) and serpentine (Lärchkogel, 1666 m).

The rocks of the “Upper Eastern Alpine Grauwackenzone” contain valuable magnesite deposits in the area of Sunk. The Sunk itself shows rugged shapings (rock walls) and karst phenomena (caves and underground drainage; Plate L-a; Nuk, 1975).

As well as in the Bösenstein group as in the Seckauer Tauern various granite gneiss and biotite schists dominate, which show massive (seldom rock walls) and smooth shaping. Micaschist can be found in the southern Bösenstein group, west of the Pöls-Valley, and in the region of the Bruderkogel (2448 m). This schist’s are part of the Wölzer Crystalline unit, which include hard rocks like marble (Brettsteiner Marble).

The north/south orientated Pöls Valley acts as an important tectonic border line, where vertical and horizontal movements occur and divide the geological unit of the Seckauer Tauern. The fault separates the Seckauer Tauern from the Bösenstein group (part of the Rottenmanner Tauern) in a 10 km horizontal movement.

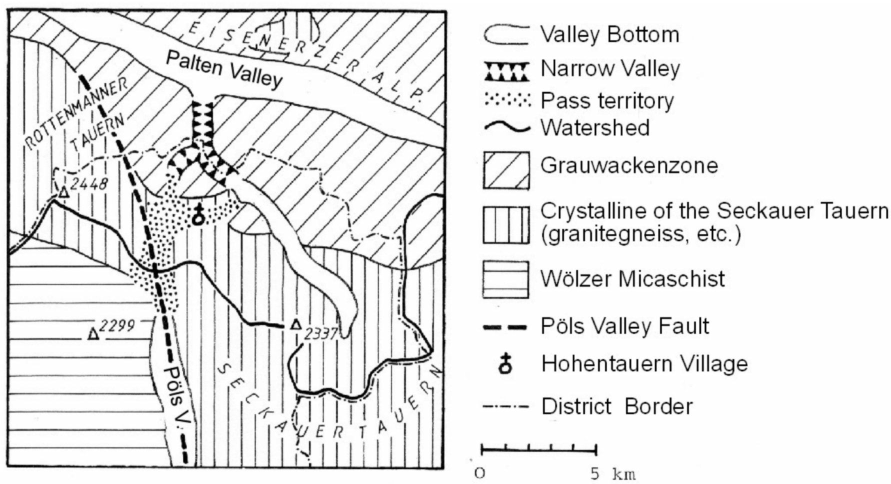


Figure 1 Pass Territory of Hohentauern in a regional outline (source: Lieb and Sulzer, 1992).

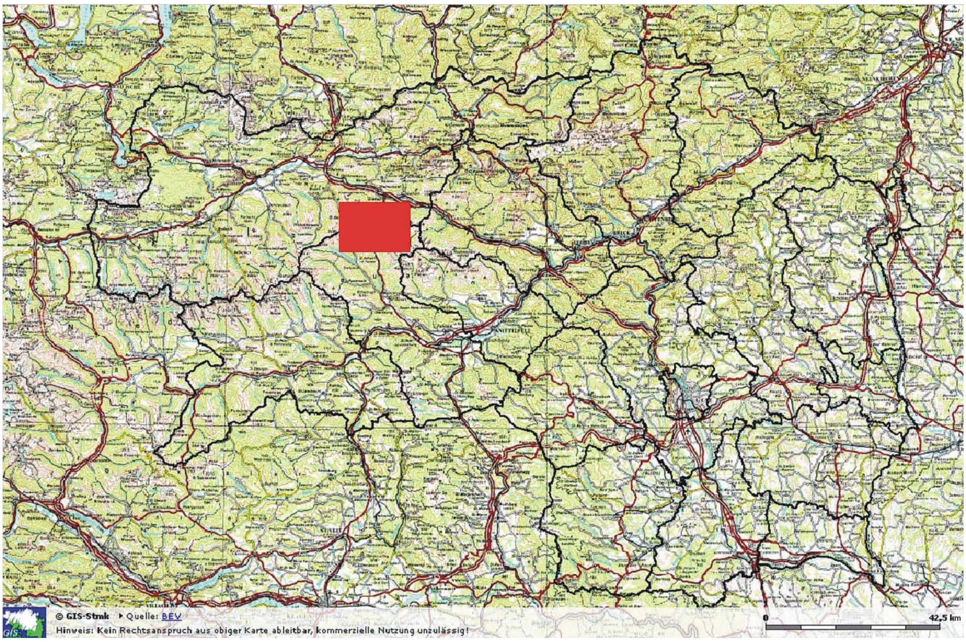


Plate J Location of the investigation area Hohentauern (source: GIS Steiermark, 2006).

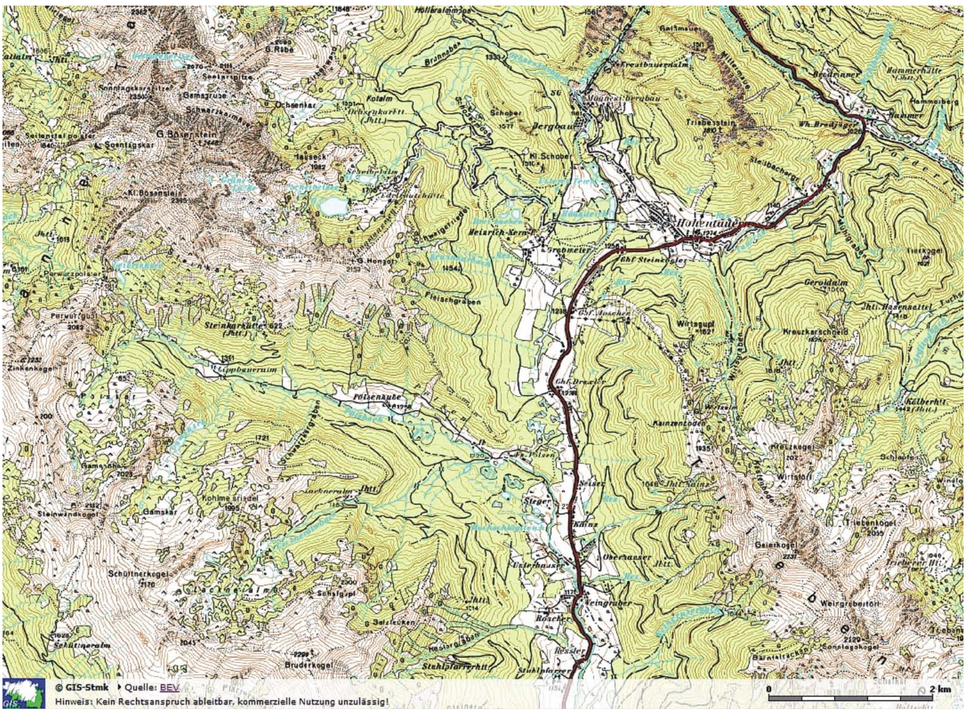
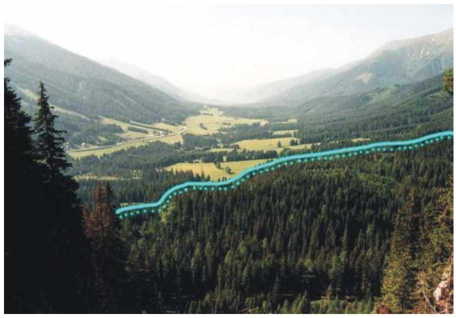


Plate K Topographic Map of Pass territory of Hohentauern (source: GIS Steiermark, 2006).

(a) Carbonate rocks (Sunk Walls) rise out of a smooth pass territory

(b) Avalanche grooves and dispersed trees dominates the region near by the upper Scheiblsee (1750 m)

(c) Pass territory of Hohentauern with largest extent of late glacial moraines “Drei Lacken” (view from “Hengst, 2159 m, over pass-village Hohentauern, 1274 m, to the west)



(d) Forested area of the late glacial moraines (view from Schober, 1577 m, to the south into the Pöls Valley)

Plate L Some photographs of the investigation area. Photo: W. Sulzer.

Plate M Tourist infrastructure in the pass territory: old roadhouse “Tauernwirt” (left), ski runs (right).

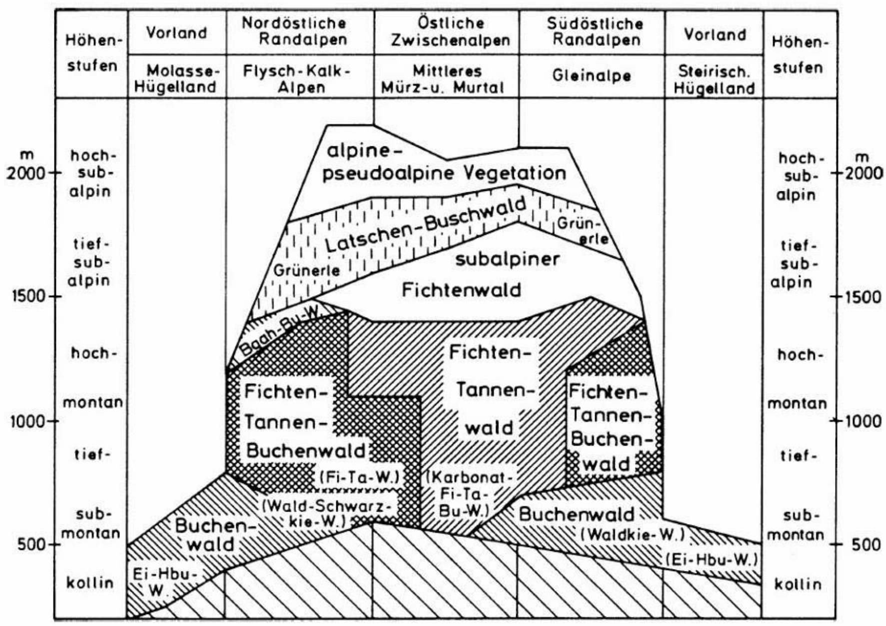


Figure 2 Vegetation Profile through the Eastern Alps (Mayer, 1984).

The diversity in geologic, geomorphologic and climatic (see contribution of Lazar and König, this volume) conditions reflects in typical vegetation structures, where each of the geo-factors causes special vegetation cover. The coincidence of carbonate, silicate and magnesite rocks offers various flowers, vegetation communities and habitats, due to the different soil conditions. The morphological situation with its recurrent moraines forms the basis of the abundance of bogs. The relative/absolute height, relief and variety in climate conditions/elements reveal typical vertical vegetation structures (Figure 2). The surrounding of Hohentauern shows a succession of pastureland on the one hand, and montane spruce (*Picea abies*) forest on the other hand. Deciduous trees can be found along small rivulets (Alnus incana) and on some steep carbonate slopes (*Fagus sylvatica*). Avalanche grooves often advance down near to the valley bottom and were covered with *Alnus viridis* (Plate L-b). They grow on shadowed wet slopes, too.

The forest line reaches in the mean value 1780 m a. s. l. (max. 1910 m a. s. l.); their variation is very high, due to the mentioned avalanches grooves and influence of human activities (pasture land). A special pine (*Pinus cembra*) and larch (*Larix decidua*) form the timber, resp. the tree line. Within the sub alpine vegetation, Pinus mugo dominates the shrub. The alpine vegetation is formed by various flowers and lower shrub, and is variable in respect to the soil conditions.

The decisive factor for the recent landscape shaping was the Pleistocene glaciation of the pass region. The glaciation was not part of the inner alpine glacier net; it was situated in the eastern fringe of the alpine glaciation and had only some (and short) contact areas with the large side branch of the Enns Valley glacier, the

Palten glacier, and some contacts over lower passes with other main valleys of the Wölzer Tauern (Figure 3).

Their maximum extent in that area is not even exactly mapped. The pass valley bottom was covered by an ice core, which was proofed by Draxler and van Husen (1978) by identifying a Gyttja horizon (organic material) in a depth of about 100 m with a dating of approx. 30,000 years before present, which means before the maximum of Würm. This horizon can be interpreted as the relict of a bog, which former open water body was dammed by so called advancing gravels from an advancing glacier.

The late glacial retreat can be recognized by the different levels of cirque in the Bösenstein group (Lieb and Sulzer, 1992). The late glacial moraines had their largest extent within the investigation area. Plate L-c shows an overview from the mountain summit Hengst (2159 m a. s. l.) to the west. The former glacier extended from the lower left side of the picture towards the area marked with a line. The late glacial moraines area is covered with forest, some lakes can be observed within the area, which were formed by “dead ice bodies”. The area is also called “Drei Lacken” (Three Lakes). Plate L-d (view from Schober, 1577 m a. s. l., peak towards south) shows the late glacial moraines area in the front of the picture. The former glacier extended from the west (right side), down from the upper Cirque of Bösenstein (2448 m a. s. l.) towards the pass region.

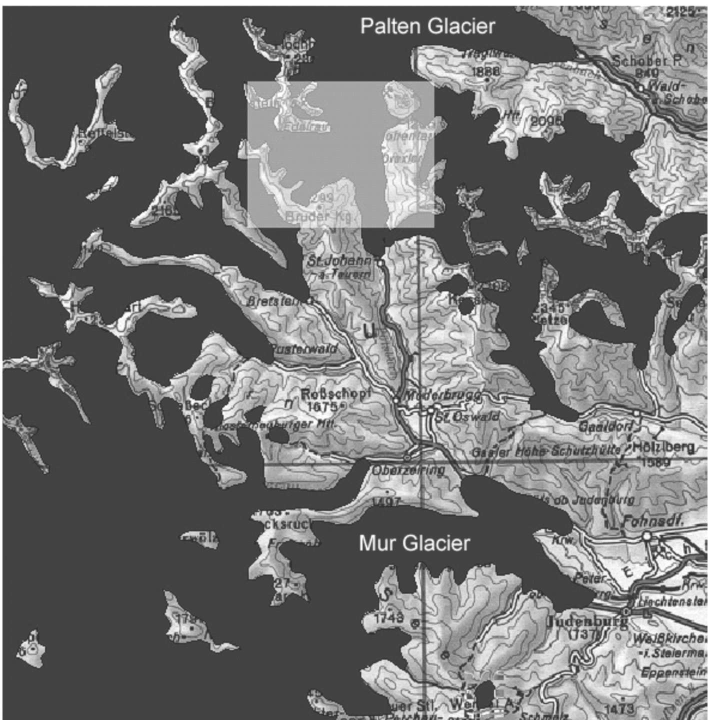


Figure 3 Würm glaciation in the surrounding of the investigation area (own drawing).

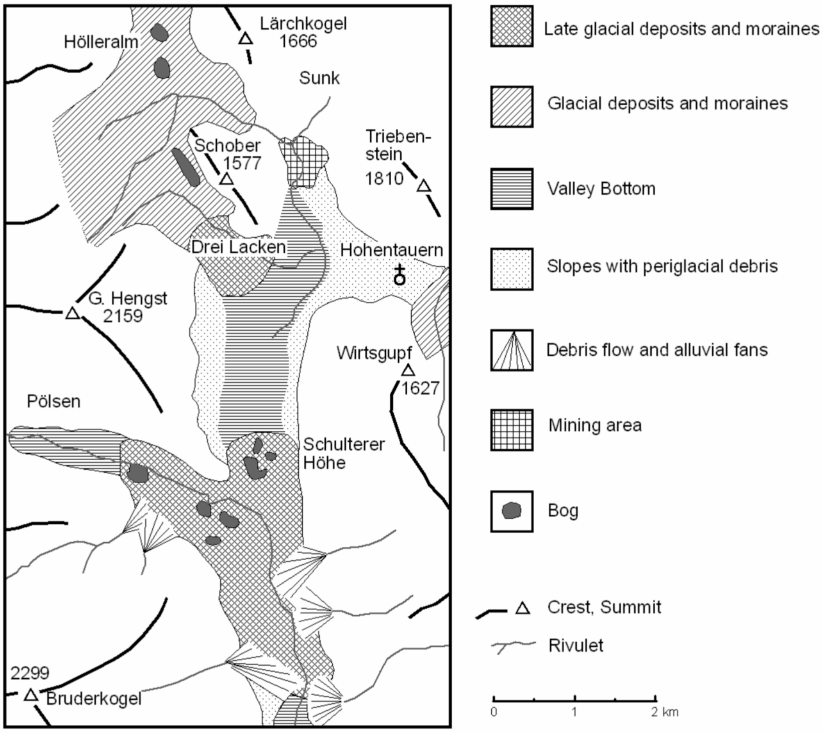


Figure 4 Geomorphologic and glaciological sketch map of the pass territory (source: Lieb and Sulzer, 1992, modified).

Cultural landscape

The possibility of passing the Central Alps was important for settling activities in that area. Hohentauern connects the Enns Valley with the Mur Valley. Even the Romans (Noric Street) used this pass (1230 m a. s. l.) for crossing the Alps between the Po Valley and Danube Valley. With the foundation of the Abbey of Admont (1074 AD) in the Enns Valley and integration of the area into their property, intensive clearings and settlement founding started. In the course of expensive road construction and an arising mining activity (magnesite and graphite) Hohentauern got sustainable influenced, in the beginning of the 20th century. Figure 5 shows this development of the inhabitants of the community Hohentauern (9,203 ha). The shaping of the graph is connected with the mining activities in the region. Whereas 400 people live in the second half of the 19th century, a continuous increase can be noticed (with a short declining before World War II) until the maximum (948) in the year 1961. With the modernisation (and accompanying reduction of man power) and finally the termination of the mining activity in 1991, the population declines to approx. 500, nowadays.

Today, the most important economic factor is tourism (Plate M). Several hotels were built along the main road. Due to the high see level (special alpine climate and snow security) and the landscape variety (contrast with smooth pass territory and high mountain environment) summer and winter tourism finds good natural conditions.

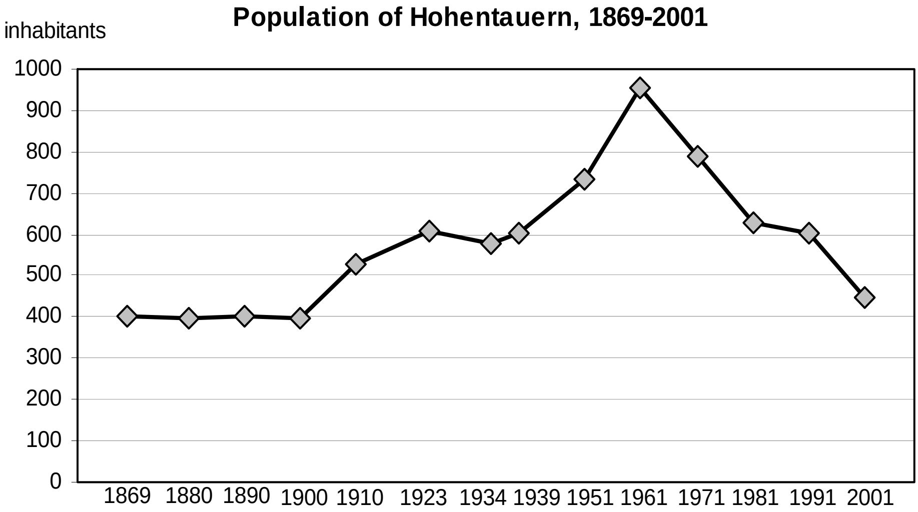


Figure 5 Development of the population in Hohentauern (source: Statistics Austria).

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The demand of geospatial data integration

Josef Gspurning, Wolfgang Sulzer

Conservation and protection of natural and cultural heritage typically sets up a network of legal conditions and, in most cases, concurring interests. Figure 1 sketches the most important factors creating the Styrian "conservation scenery".

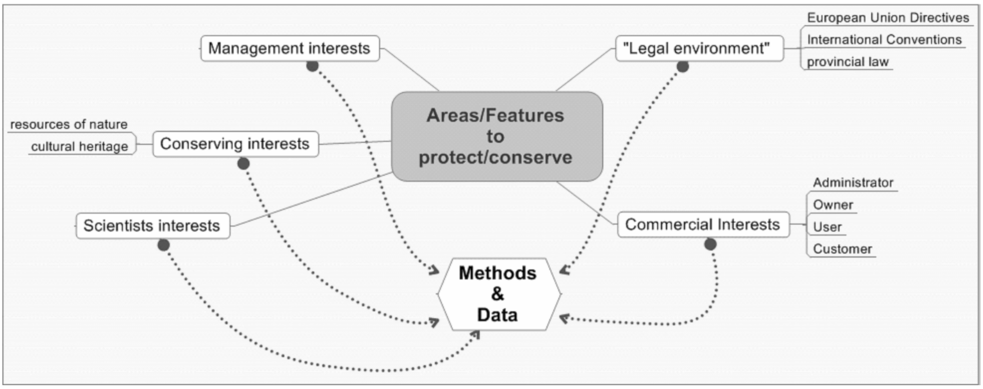

Figure 1 The scenery of nature conservation

Interpreting Figure 1 it may be important to keep in mind that, first of all, the entire multilevel legal framework *per se* produces demands on the conservation system. This means, that the transformation of international conventions and EU Directives into provincial law as well as the execution of their tenor requires a special set of geodata and an appropriate methodology. In the case of nature conservation there are basically three compelling steps on the way to put the conservation process into action.

1) Taking an inventory: Usually for the legislative instance there is a strong need to create databases for acquisition, cataloguing and indexing spatially referenced features. Doing so brings up new fields to consider: Referring to local, regional, national and international needs, issues of scale, accuracy, precision and semantics have to be discussed even if in the case of a newly created database; things might get rather complicated, if already existing databases should be integrated or homogenized and different data formats, data types or different methods are used during the acquisition phase. To avoid upcoming standardization problems most of the basic datasets (e.g. administrative boundaries, roads or railway networks…) were provided by local, regional or European authorities.

2) As a matter of course doing conservation/protection work automatically includes the need for controlling the results and evaluation of the measures taken. From the GIS-specialists point of view monitoring brings in one more dimension – time. But the implementation of time series data used to describe and analyze static snapshots at different stages or dynamic chances means that all arguments mentioned under 1) are still valid. Furthermore, handling of time series data require specific tools for management and information retrieval. And at last acquisition, management, analysis and presentation of time series data usually raise the costs to a significant level so that the public available supply of appropriate data decreases rapidly.

3) Unlike most of the approaches mentioned under 1) and 2) researcher's work can be described best as intensification/densification of knowledge. This often implicates the need for data that is a) still not available (thematically), b) still not available at a favored scale level (spatially and thematically), or c) data generated by the means of newly developed tools or sensors.

Taking into account all these problems there seem to be only two strategies for successful implementation and operation of geo-technological information systems: The employment of industrial standard or open (source) standard systems. Especially on scenarios where cost effectiveness is an important criterion, the last-mentioned option might fit the needs best.

Remote sensing represents a useful addition to other techniques in order to obtain various pieces of information about a protected area in time (see 2). Conventional aerial photographs, aerial maps, digital satellite data, and high resolution images can be used to provide information. Time series of images, for instance, can reveal changes to the landscape (e.g. regulation of rivers, construction of houses, changes to sensitive land use systems, etc.). Analogue and digital land use classifications for the purpose of erosion surveys and potential land use evaluations can be carried out.

In the framework of the aims and tasks of the protected areas it has been examined to which extent at least part of these tasks can be achieved with the help of remote sensing. It turned out that the remote sensing techniques mapping, inventorying, forecasting and documentation can be included. Remote sensing is primarily used for a survey of relevant environmental parameters (Table 1).

The remote sensing techniques "mapping" and "inventorying" can be integrated into the survey. It should include former developments and at the same time consider predictable changes in the subject areas mentioned above. This survey should be constantly updated; in addition to mapping and inventorying, the remote sensing techniques monitoring and forecasting also support the achievement this aim.

Table 1 Remote sensing techniques and their integration into the survey of nature protection areas

	Remote Sensing Techniques				
	Mapping	Inventorying	Monitoring	Forecasting	Documentation
Survey in the sense of regional policy	survey	landscape inventory	establishment and update of development	predict changes	for documentation and presentation (media)

Documentation is particularly important for spatial planning. Documentation in the form of a graphic presentation of remote sensing products, combined with questions of spatial planning, e.g. as a basis for meetings of authorities and politicians, is an important means of supporting decision-making. Processes which are relevant to planning (e.g. the chronological development of despoliation of the landscape) can be illustrated in an impressive way, and the problems they engender can be more easily comprehensible by people who are not necessarily concerned with these problems as experts but can help to resolve them, e.g. at a political level.

Land use mapping is an important means of surveying. Basically, it documents the structure of land use (location and size) in the respective region and, combined with a Geographic Information System, serves as an important basis for further, more detailed analyses. The land use map is the basis for a number of other conflict and land fitness maps, e.g. maps of soil erosion, recreation and adventure areas, ecological compensation areas, and the overlap of agricultural fitness and actual land use.

GIS – Applications

Josef Gspurning

As mentioned in the chapter about the role of data integration, an effective realization of nature conservation is strictly bound to an operational management and analysis system and useful spatial data. Because of the possible problems (Stokes and Morrison, 2003) and the transnational importance of the subject, the extensive knowledge about GIS (especially the more precise vector based version) as a valuable toolbox is indispensable (Beach et al., 2002; Cooperrider et al., 2001). Therefore in the year of 2005 the Institute for Geography and Regional Science (IGR) of the University of Graz has established an integrated educational project for graduate students focusing on the design and the implementation of a GIS, the acquisition, integration and enrichment of spatially referenced data and the solving of biosphere related problem scenarios. As geographical scope the NATURA 2000 area of Hohentauern in Styria was defined, because of the fact that the preconditions make the investigation area very suitable for “Bio-GIS” training and research purposes. Although “Hohentauern” is conceived as a long time project, in the first phase the emphasis of the work lays on acquisition, standardization and integration of spatial data for (nature) conservation relevant research (see Table 1).

Table 1 Current research topics of the “Hohentauern Project”

Key Issues	*Topics*
Avalanches	modelling of potential avalanche hazard areas
NATURA 2000 area Bösenstein	RS-based mapping of the NATURA 2000 area
Recent changes of high mountain landscape	Visual interpretation of historic aerial photographs, data integration and generation of orthophotos
Geological issues	Visualization of the geological landscape genesis
Soil erosion	Mapping of real erosive structures and modelling of erosive potential
Vegetation changes	Analysis of vegetation structure and its changes
Digital terrain modeling	Production of an ASTER-based DTM and comparison with the official Austrian DTM
Glacier retreat	Simulation and visualization of the retreat of the Bösenstein-Glacier; construction of a virtual world of the late glacial
Valuing of landscape	Development of a standardized tourism assessment scheme for mountainous landscapes
Geomorphological mapping	GIS based (semi-) automatic morphological classification

Geoecological structuring of the investigation area	(Semi-) automatic construction of a geo-ecological map
Hydro-electric power plant SUNK	Simulation of the consequences of a hydro-electric power plant
308 KV high voltage power line	Feasibility-/visibility study for a high voltage power line
Habitat modelling	Habitat analyses for golden eagle, brown bear and lynx
Roman roadway	Finding the route of an ancient roman road
Ski centre Hohentauern	Feasibility study for a ski centre “Hohentauern”

Selected Applications from the “Hohentauern Project”

Table 1 brings up selected key issues of the actual research which is mainly done in labs and fieldwork by graduate students and under the guidance of the IGR’s GIS- and RS-staff. Because of its complexity which might go beyond the scope of this paper the following subchapter can only present extracts of a selected study to give a representative review of the works done so far and the methods used. In the brackets the names of the responsible members of the project team are annotated.

The approach to assess mountainous landscapes in terms of tourism (E. Stangl and E. Judmaier, 2005) can be seen as a contribution to sustainable commercialisation of natural landscapes. Figure 1 shows the location of the investigation area between the village Hohentauern (southeast corner) and the Bösenstein Range (western part) taken from the Austrian topographic map (scale 1:50,000). Within this area a wide variety of different landuse types and relief units can be found.

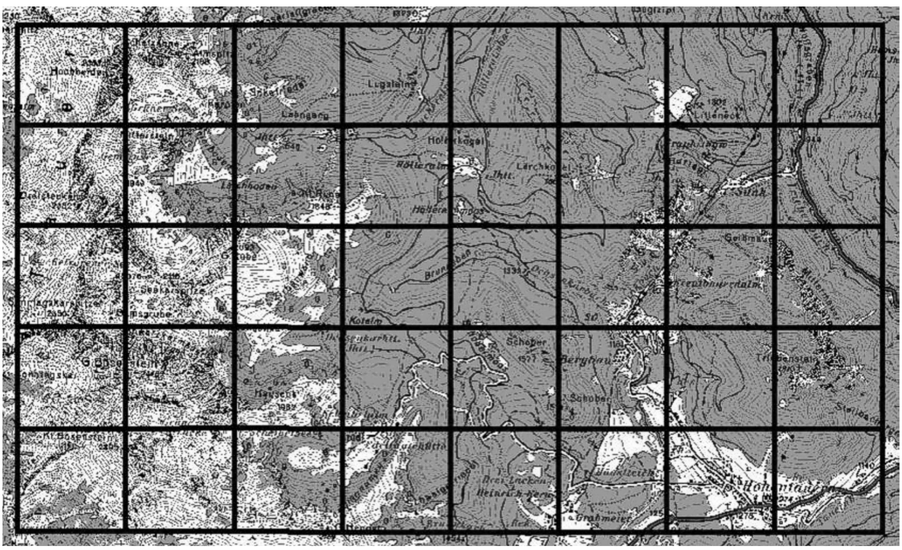

Figure 1 Hohentauern Investigation Site (ÖK50)

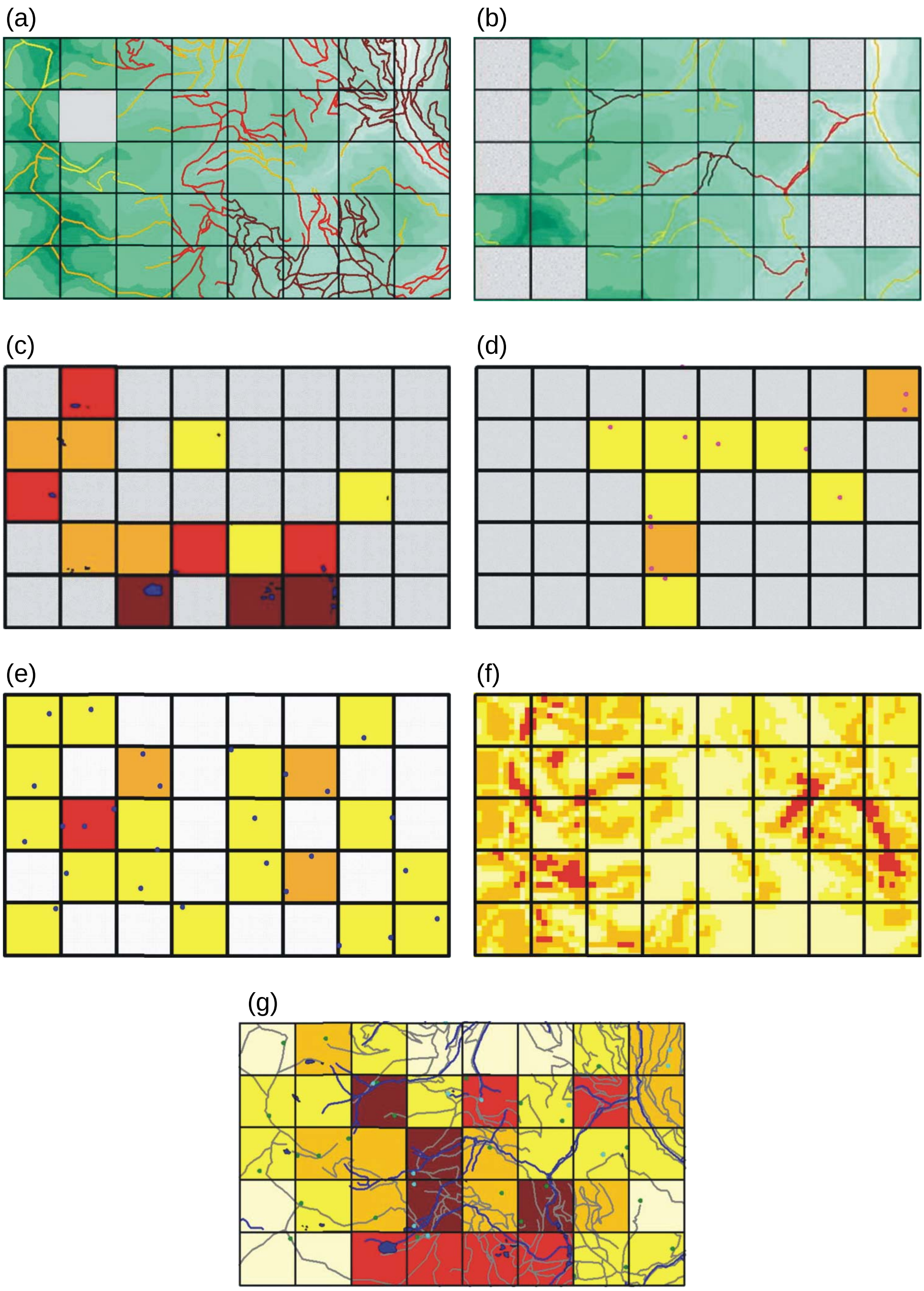

Plate N Classification of tourist attractiveness – thematic layers: (a) accessibility through the road network; (b) accessibility of rivers, ponds; (c) accessibility of lakes; (d) alpine huts; (e) attractive viewpoints; (f) roughness of terrain; (g) attractiveness in terms of tourism.

The main task of the investigation was the attempt to develop an appropriate method for classification of the “overall touristic attractiveness” of a mountainous landscape (Freudenberger and Harvey, 2003; Hunter, 1996). To reach this goal first of all several representative variables (Plate N) have been defined to describe/quantify the attractiveness; in a further step of the process the whole area has been divided into 40 classification squares.

For every thematic layer (variable), based on the quality of the environment a weighting was given to each square. In the final step of the evaluation the scores (at Hohentauern between 4.5 and 19.5) were combined by the means of map algebra. The resulting layer (Plate N-g) brings up five classes of attractiveness: Class 1 (white: 4.5-7.5) is not qualified for touristic utilization, areas of class 2 (light yellow: 7.6-10.5) are hardly useful. Also class 3 (dark yellow: 10.6-13.5) seems to be less appropriate for tourism. Class 4 (red: 13.6-16.5) and class 5 (dark brown: 16.6-19.5), located in the centre of the area appear as most appropriate parts of the landscape. Although these results mostly correspond with findings from other sources, there are still some inconsistencies, so it is obvious, that the used method needs some refinement.

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Remote Sensing – Applications

Wolfgang Sulzer

The area of Hohentauern is part of a long term investigation test site at the Institute for Geography and Regional Sciences (Graz University). Several excursions, practises and research work were applied in this area. The Remote Sensing projects were affiliated to GIS topics as mentioned in the chapter about GIS Application and the chapter about the demand of geospatial data. There can not be drawn and hard line between GIS and Remote Sensing application. Both techniques are merged together in hybrid approaches.

Visualization of Geomorphologic Features (Late Glacial Moraines) in Forested Areas by Means of Laser Scanning

This study discusses capabilities for the analysis of high-precision digital elevation models (DEM) for late glacial moraine ridges in forested areas. Three different elevation models (derived form the official Austrian map 1:50,000, one from a field based map 1:5,000 and one from airborne laser scanning, Figure 1) are used. Geomorphologic features such as moraine ridges, ice walled lake planes, undulating ground moraines, river drainages can be visualized by means of a laser scanning based DEM. The results of identifying geomorphologic features in DEM will facilitate scientific field work by pointing out special areas of interest. The data used in this study have been processed for the EU project “High-Scan” at the Institute of Digital Image Processing of Joanneum Research, Graz. The image data have been delivered for the test site by TopoSys.

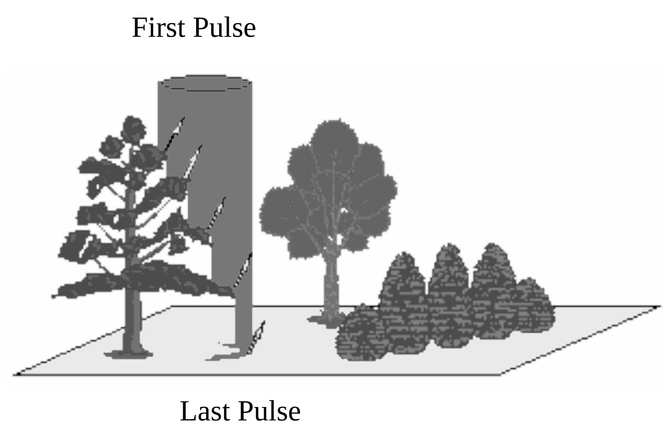
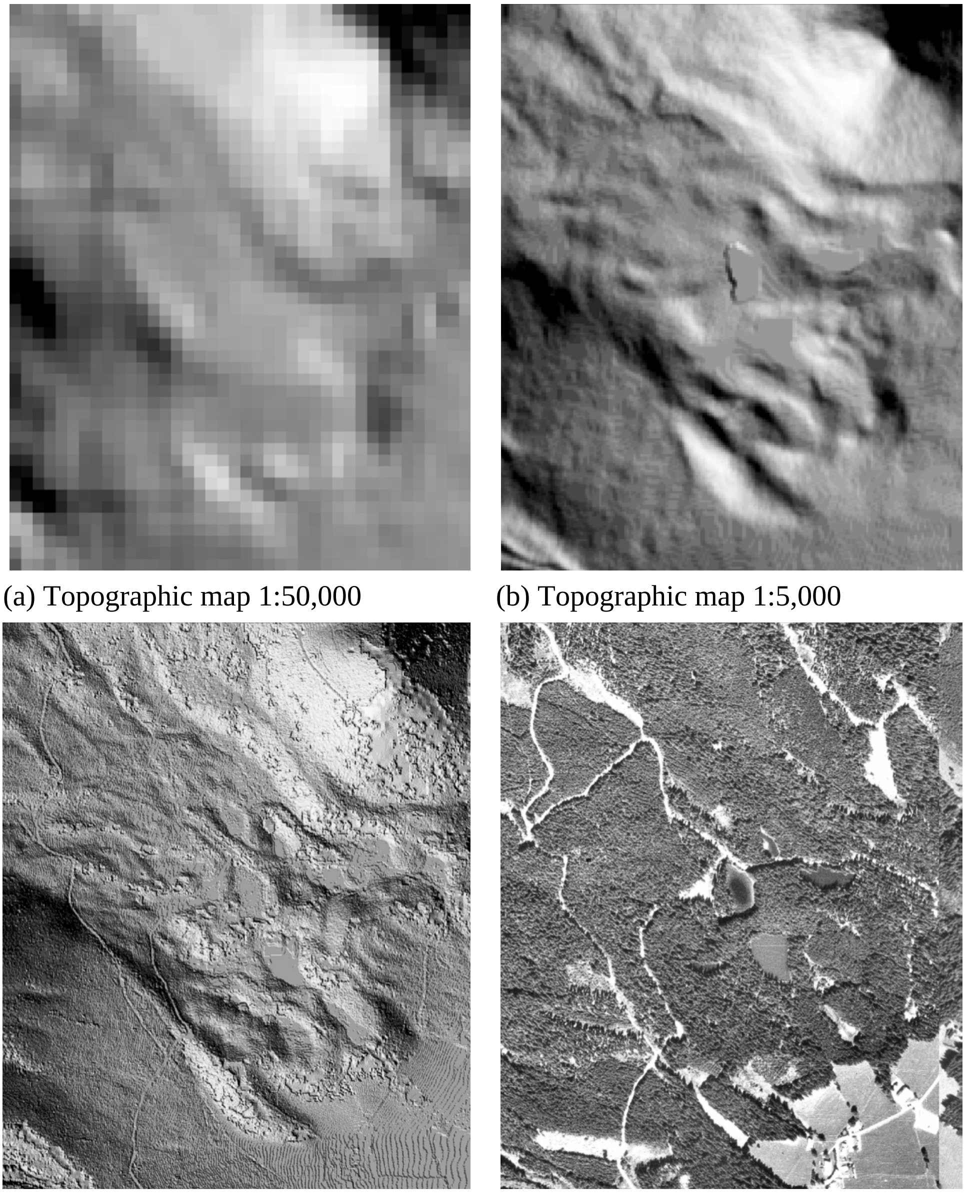


Figure 1 First and last-pulse mode (Source: TopoSys GmbH)



(a) Topographic map 1:50,000
(b) Topographic map 1:5,000
(c) Laser scanner
(d) Orthophoto

Figure 2 Comparison of different hill shades and the orthophoto

The accuracy of the laser DEM with a resolution of 1×1 m varies between 14 and 40 cm. The airborne based DEM can keep step with the terrestrial based map, plots small features in relief even much better than the smoothed 1:5,000 topographic map and, of course, the 1:50,000 topographic map (Figure 2). With the basic geomorphologic information derived from the laser scanner, a scientist can verify specific items in the field. Remote sensing methods in general will not substitute field work (sediment and soil analyses, etc.), but can support and make geomorphologic field work much more effective.

LANDSAT-NIGHTPASS – The Application for Climatic Regional Planning in a High Mountain Region

The LANDSAT sensor records night pass images only on request, which is problematic due to the long leading time (more then on week), where an estimation of the weather conditions is very difficult. An acquisition window (each 16 days) which is situated within longer and stable clear atmospheric conditions can be nearly impossible. The presented image was recorded on the 9th October 1986. The northern adjacent scene (Upper Austrian Region) and the Enns and Palten Valley and the adjacent Hohentauern pass territory (arrow in Figure 3) shows good weather conditions. The scene covers an area of 185 km × 185 km with a ground resolution of 120 m × 120 m and spreads across the Northern Alpine Foreland to Slovenia in the South. The thermal channel operates in a spectral range of 10,4-12,5 µm.

The night pass-image of LANDSAT TM (channel 6) allows an exhaustive analyses of thermal structures in the mountainous alpine region and supports the generation of a climatic bas map (climatope map), in which the thermal distribution (combined with parameters like frost and inversion structures) is drawn.

Within the process of generating climatic maps the thermal imagery will support:

- quick analyses of the distribution of "quasi" surface temperatures
- total cover of the investigation area
- thermal acquisition of the investigation area from the valley bottom up to the highest peaks at one moment
- documents the relationship between land cover and thermal characteristics
- mapping basis for the delineation of climatopes
- better differentiation within climatopes
- instrument for checking field measurements
- combined analyses with DTM´s
- mapping scale 1:50.000

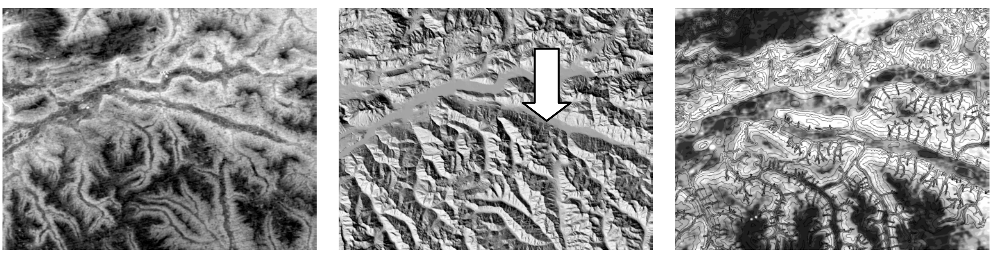


Figure 3 Comparison of the thermal image (left – dark grey values: low temperature, bright: warmer), DEM (centre) and the climatops (right)

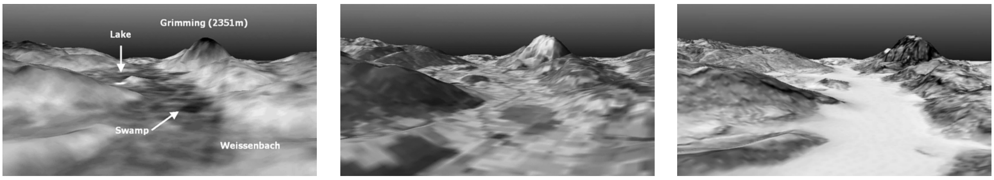


Figure 4 Perspective view of thermal image, LANDSAT-TM and slope image

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Climate and land use planning in the region of Hohentauern/Styria

Reinhold Lazar

Introduction and problem statement

In Styria climate suitability maps have been compiled since 1989. Detailed climate maps at an adequate scale (1:50,000) get annotated with planning information and then they are made available to the planning offices of the Government of the Province of Styria as planning fundamentals.

The climatic distinctiveness of this test area, the region of Hohentauern, will be explained and the aspects for land use planning are discussed from a climatologic view.

Location of the investigation area

The region around Hohentauern is located in the area of a pass leading from the northern downward slope to the southern one of the Niedere Tauern. It is flanked by the Ennstal respectively the Paltental in the north, and mainly by the Upper Mur Valley and its side valleys in the south. The altitude range ranges from the bottom of the Ennstal with about 600 m above sea level over the top of the pass of Hohentauern with about 1200 m to the crest and peak locations of the Rottenmanner Tauern, the summit altitudes of which reach up to 2450 m. The tree-line lies at an elevation of 1900 m or locally at 2000 m, the limit of permanent settlement at about 1200 m. In matters of traffic, the investigation area is of secondary importance due to the lower passage of the Schoberpass, which lies further east.

The area is mainly affected by side valleys of the Tauerntal (Pöls River) and the Upper Mur Valley from the south respectively by side valleys of the Ennstal from the north, whereat these U-shaped valleys are edged by ridges, which are marked heavily by cirques only partially. Anyway, the high mountain relief is so distinctive that the alpine risk potential must not be disregarded. Descents of avalanches and mudflows occur consistently.

Climatic overview

The investigation area belongs to the inner alpine main crest of the foothills of the Eastern Alps, which get lower and lower here (Niedere Tauern). Precipitation falls sufficiently with approaching flows from the north-west sector as well as from the Mediterranean (southeast to southwest), and an annual precipitation sum of 1,800 mm is exceeded above the tree-line. In valley locations it still reaches 1,000 to 1,400 mm, whereat showers and summer precipitation -as an effect of plentiful thunderstorms - are predominant. In contrast to the Northern Alps, a slightly continentally toned influence can be observed, which is stronger at the southern downward slope of the Tauern (especially in the upper Mur Valley). In these valleys with noticeably less precipitation (700 to 900 mm), the contrast between winters with little snow and thunderstorm-rich summers increases stronger, also the thermal differences. January temperatures range from –6 to –3°C (the lower ones are in the basin locations and in cold sections of side valleys), July temperatures are at an average of 13 to 17°C, whereat the height above sea level is essential. In summit locations at about 2000 m the parameters change to a more maritimely influenced climate (January around –6.5°C, July 8.5°C). The number of frost days in valley locations changes between 150 and 120 d/a, whereat the higher values are reached in cold valley sections.

Ventilation depends much on the orographic general conditions, so in Hohentauern (1200 m, pass location) an annual value of wind speed of 3–4 m/s is achieved, while in Trieben (700 m, in the Paltental) it is only 1.4 m/s. In altitudes above the tree-line the wind speed significantly increases to 5 m/s and more, especially in crest and peak locations. Thereby it is to consider, that winter is definitely predominant in the annual cycle of wind speed for these crest locations, while valley locations are best ventilated in spring (about 2 to 2.5 m/s). Fog conditions also depend much on the topography of the respective valley, whereat the valley region with the most fog and the least wind at the same time is the area of Liezen/Selzthal (100 to 120 fog days/year). The valley sections with the least fog are located at the southern side of the Tauern at about 800 to 1100 m altitude (20–30 days/year). Concerning the inversion conditions, the region around Selzthal, which has already been mentioned, is very unfavoured (inversion predominates in about 70% of the nights), while in Hohentauern an inversion is only recorded in about 30% of the nights due to its favoured pass location.

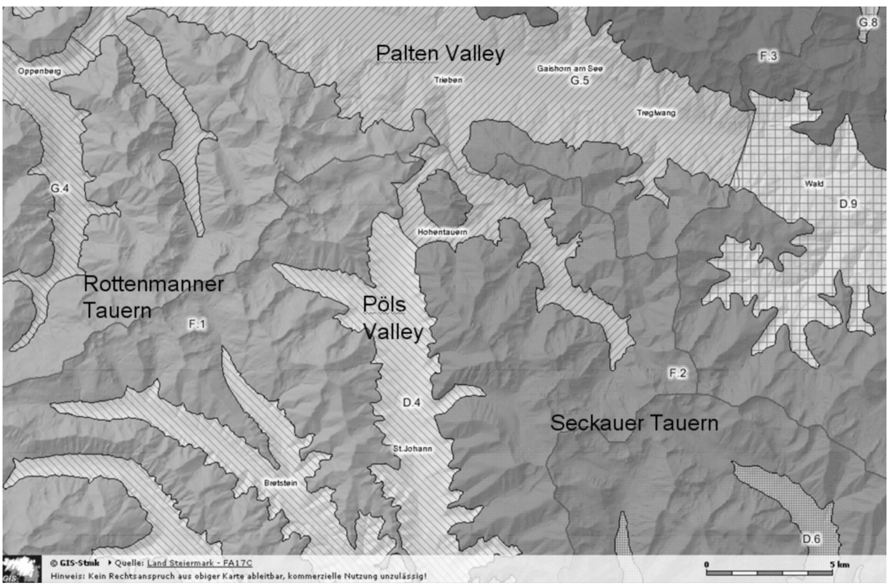

Figure 1 Climatic overview (source: GIS Steiermark)

Methodology of the climate suitability maps in Styria

Climate suitability maps have been compiled since 1989 in Styria, there was a first effort in 1983 with Radkersburg in Southeast Styria before (Naturraum-potentialkartenatlas, R. Lazar et al. 1983). In the following years, refinements and extensions have been carried out; in particular there have been added maps with planning information (evaluation plan) to the climate maps.

In Styria the project of climate suitability maps was finished in 2006, whereat the results can be downloaded from the internet (homepage of the Government of the Province of Styria). They include a colored map of the ground level climate conditions for the night and morning hours – as an important basis for the climate classification in different valley sections with high and low probability for inversions, illustration of ventilation and consideration of characteristics like forest, houses and dams for the stagnation of cold air. In addition to the base plan there are available a flow map and a fog map. In the flow map, the night-time wind conditions are displayed as a basis for the diffusion conditions for bigger emission sources in altitudes from 50 m over ground, whereat details about the power of the wind system, altitude over ground and speeds are quoted. Undercut slopes respectively sections which are overflowed are quoted as well; they are much more affected by immissions than other hillside situations. In the fog plan, an evaluation of the individual valley sections has been done - in steps each with 20 days/year. Finally there is the evaluation plan with a differentiation between habitation (suitability for settlement) and industry/trade. In this suitability plan there are three categories (suitable, suitable with conditions and little respectively unsuitable).

Previous experiences have shown that some land use planners already use these basics for their compilation of zoning plans, but they are still too few. After all, valley sections with building bans or restrictions are displayed in the evaluation plan, which are binding for the communities.

The climate suitability maps are the basis for a sustainable urban and land use planning from a climatic view, emphasising the preservation and improvement of air quality.

Important climatic characteristics in the investigation area and suggestions from an immission climatic and sustainable view (basis: climate suitability maps 1:50,000)

The core zone around Hohentauern should stay reserved to touristic purposes, larger firms and industry would be problematic from an immission climatic view. The side valleys of Enns and Mur are concerned of this to a large extent, partially also the Paltental itself. Therefore, an industrial site in Trieben with its magnesite work is relatively unfavourable, as adjacent slopes get polluted by immissions. The frequency of inversions is too high especially in winter term and in many cases there is too little ventilation to allow for an undisturbed removal of the harmful substances. The consequence is that they are blown more or less directly to the forested slope – especially during wind direction changes and wind transverse to the valley. However, in the meantime the problems with damage to forests have heavily decreased in Styria, because reduction measures for SO_2 have been carried out or because some firms have closed at all. The Enns Valley also has such an increased frequency of inversions together with little ventilation in winter term, so that larger industrial firms should not be allowed.

From a microclimatic view, the construction of the autobahn with the building of dams in Enns and Palten Valley have led to a local disturbance of the ventilation (stagnation of cold air); therefore, it was advised in the evaluation plans to keep adequate areas free for the night-time ventilation (fresh air feeder), for instance northeast of Liezen. This is very important regarding the increasing amount of traffic and the traffic related immissions of NO_x.

Regarding emissions from domestic fuel, there also have been submitted proposals for sections of some valleys, where only low-emission heaters should be allowed. In return, certain areas which are well suitable for habitation have been pointed out – so the slope foot locations in the Enns Valley are favoured thermally as well as concerning exposure. In the Pöls Valley south of Hohentauern there are also sections, which partially have a relatively little inversion probability due to their situation at the edge of the valley, and in addition they have an increased ventilation. The Pöls Valley is one of the best ventilated valley sections of Styria (relatively high number of days with north föhn), so there is also very little fog. In contrast, the region of Rottenmann (lower Palten Valley) and the whole region of Enns Valley from Admont in the east to Aigen in the west are disadvantaged as a consequence of frequent stagnation of air and increased inversion probability.

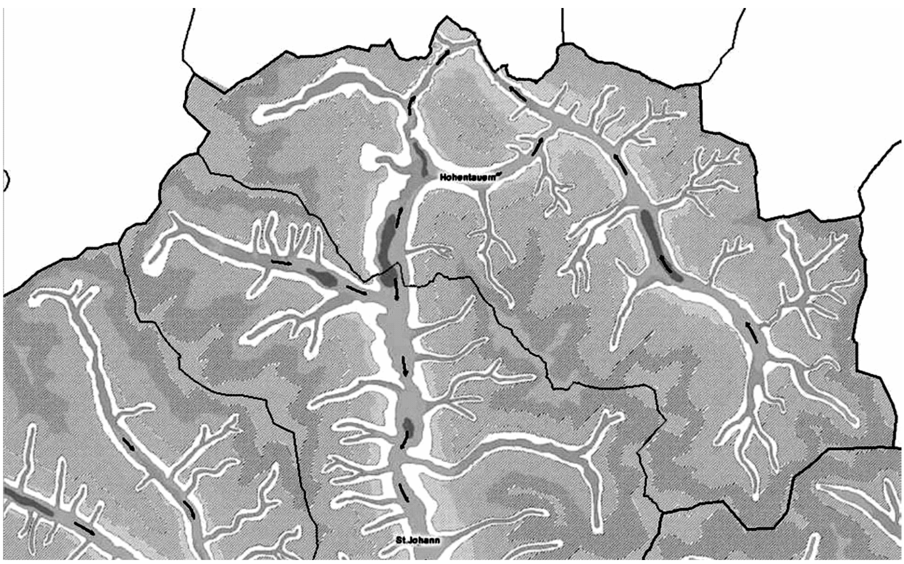

Figure 2 Detail of the digital climate suitability map (source: GIS Steiermark, legend see: http://gis2.stmk.gv.at, 2006/12)

Summary and outlook

The climate suitability maps are an important instrument for a sustainable land use planning in Styria, whereat a further improvement of air quality is of immediate importance. This could be realized in some parts of the investigation area so far, which can be verified through the reduction of immission damages by flue gases (region of Trieben, Liezen). However, in a small-scale dimension, there is still room for improvement, if the planning information in the evaluation plan should be realized – even if it is regarded as standing contrary to economic interests.

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GIS-based modelling of mean annual precipitation (1971-2000)

Christoph König

This study deals with regionalisation of mean annual precipitation in Upper Styria, where the Hohentauern investigation area is situated. There are other studies which included regionalisation of precipitation in Styria. Some of them used GIS, others date back to pre-geoinformatic times. This one tries to include the modelling of orographic precipitation for the first time in Styria.

Investigation Area

Styria can be divided into five regions with similar weathering (Wakonigg, 1978):

- Northern Alps (Nordstaugebiet)
- Enns Valley and Niedere Tauern
- Mürz Valley
- Upper Mur Valley
- Rim Mountains – Foreland

Four of these regions are part of the investigation area; only the region Rim Mountains–Foreland is situated outside. The regions show variable precipitation characteristics, such as a vertical gradient which is an important factor in this study.

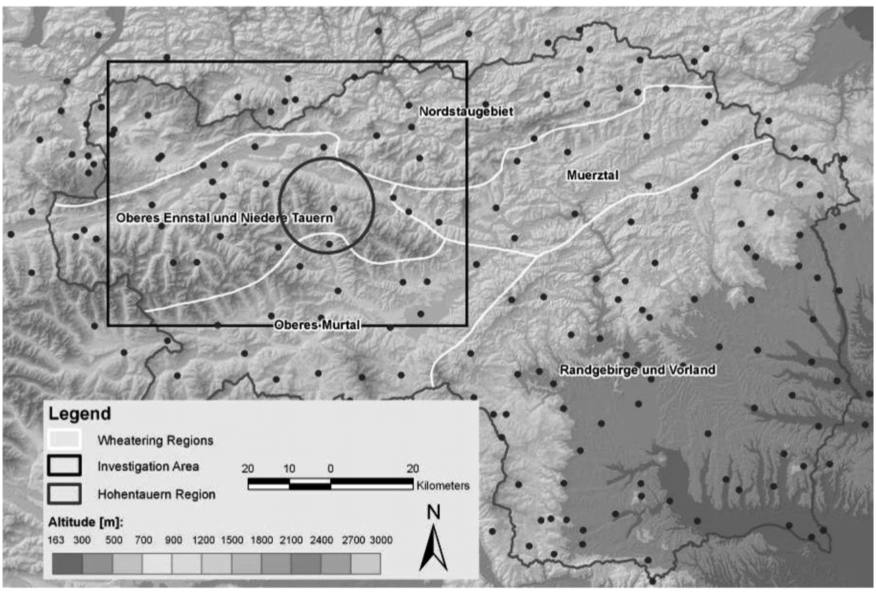

Figure 1 Styria, its weathering regions, the investigation area and Hohentauern

Data

Precipitation data is only available punctual. 110 gauges are situated in Upper Styria and the surrounding areas. The measured values are wind – corrected and therefore higher than those, which were used in most other studies. These gauges are used to calculate gradients and for interpolation. A DTM (Digital Terrain Model) with a resolution of 97 meters is used to model the impact of altitude on precipitation.

Modelling

The modelling is based on two hypotheses, which make it possible to calculate the spatial distribution of precipitation. These hypotheses are the dependency of precipitation from altitude and the dependency on distance to the outer rims of the northern Alps, where the biggest amounts of precipitation are measured, due to orographic uplift and accumulation caused by the barrier effect of the Alps.

The first factor is well-known and in similar studies mostly taken into consideration within regression analysis. The modelling of the second, however, is a rather new attempt and, therefore, more of an examination, how this factor can contribute to achieve improved results.

Modelling the influence of altitude

Generally, precipitation increases with a rising sea level, up to a height of about 3500 m, because increasing advection is bigger than the decreasing atmospheric humidity. Research areas are not over a sea level of 3000 m. Consequently, there is a progression in precipitation with a rising sea level in every altitudinal belt. In fact, there are a lot of different local gradients, caused by windward and lee effects and streaming divergences and convergences. Due to the lack of data local gradients cannot be calculated but generalised gradients are included. Upper Styria is divided into four regions, which show different vertical gradients (Table 1). The dependency of precipitation and altitude is modelled by the use of a regression analysis with linear trend (Plate O).

If values are reduced to sea level and are interpolated with kriging (in ArcGIS Spatial Analyst) the result is a surface of precipitation without the influence of altitude (Figure 2). This surface leads to the second part of modelling, because it shows a spatial pattern of horizontal distribution.

Table 1 Regional gradients of precipitation

Region	*Gradient (mm/100m)*
Northern Alps	77,5
Lower Alps and Upper Enns Valley	89,0
Upper Mur Valley	91,7
Mürz Valley	90,4

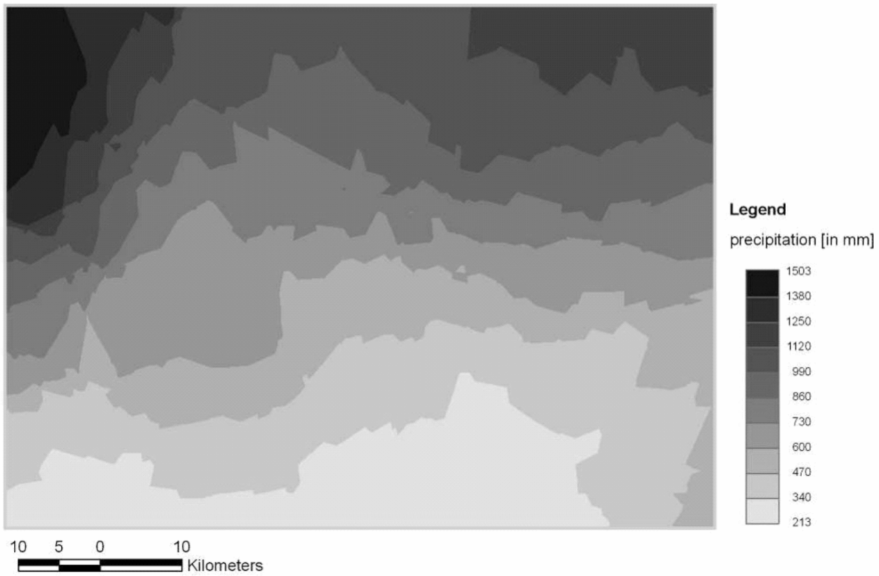

Figure 2 Precipitation surface reduced to sea level

Modelling the distance to accumulation areas

The areas with the most precipitation in Styria are located in the North Alps. Generalised precipitation decreases with growing distance from these areas. This dependency is the second part in the modelling process, because like the altitude it describes a spatial distribution of precipitation. It is modelled by the use of a regression analysis with polynomial trend (Figure 3).

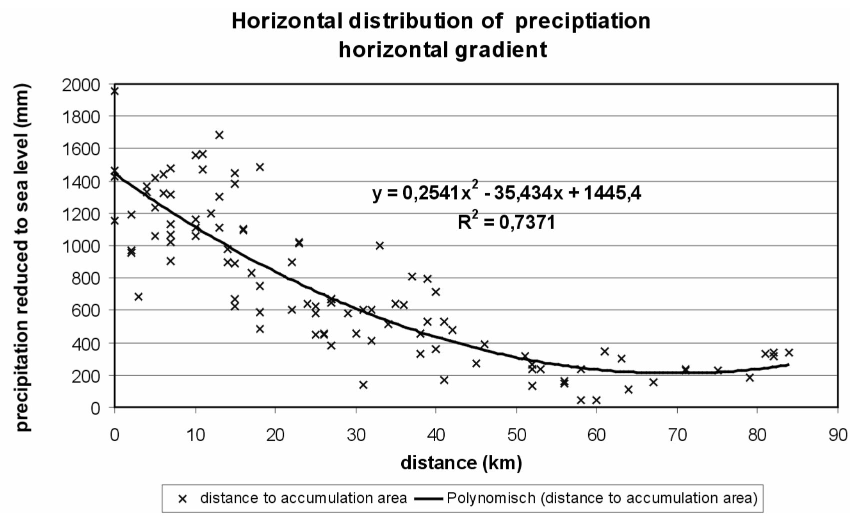

Figure 3 Polynomial gradient of the dependency of precipitation on distance from the maximum area

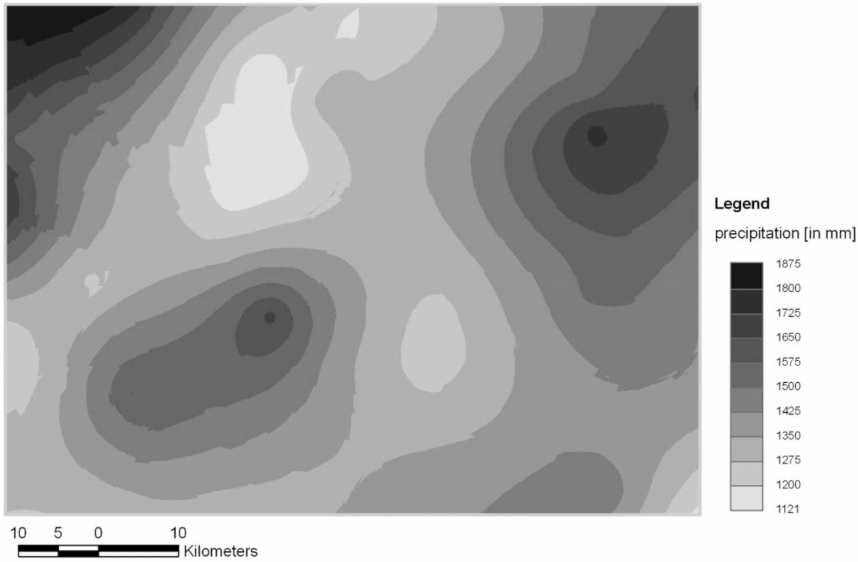

Figure 4 Precipitation surface reduced to sea level and eliminated accumulation in the North Alps

By the use of this polynomial regression equation ($0{,}2541x^2 – 35{,}434x$; x = distance in kilometres) precipitation (reduced to sea level) values are projected to zero meter distance. These values are again interpolated using Kriging in ArcGIS Spatial Analyst. The result shows a precipitation surface without the influence of altitude and without accumulation in the North Alps (Figure 4). The maximums in this surface are originated from the second accumulation in the Lower Alps and streaming convergence.

Calculating the results

The spatial distribution of precipitation with real distance is calculated by subtraction of the distance gradient. The polynomial regression equation $0{,}2541x^2 – 35{,}434x$ (x = distance in kilometres) is put into a raster file, so that it can be subtracted of the precipitation surface (Plate P). To get real height values the vertical gradient is added by the use of map algebra in ArcGIS Spatial Analyst. The final formula is:

[Mean annual precipitation] =
= [precipitation surface – distance gradient + height gradient]

Finally the result is smoothed using Focal Statistics in ArcGIS Spatial Analyst. The function FocalMean calculates the mean value of neighbouring cell values. In this case, cells in a quadrate with a side length of 10 cells (970 meters) are used.

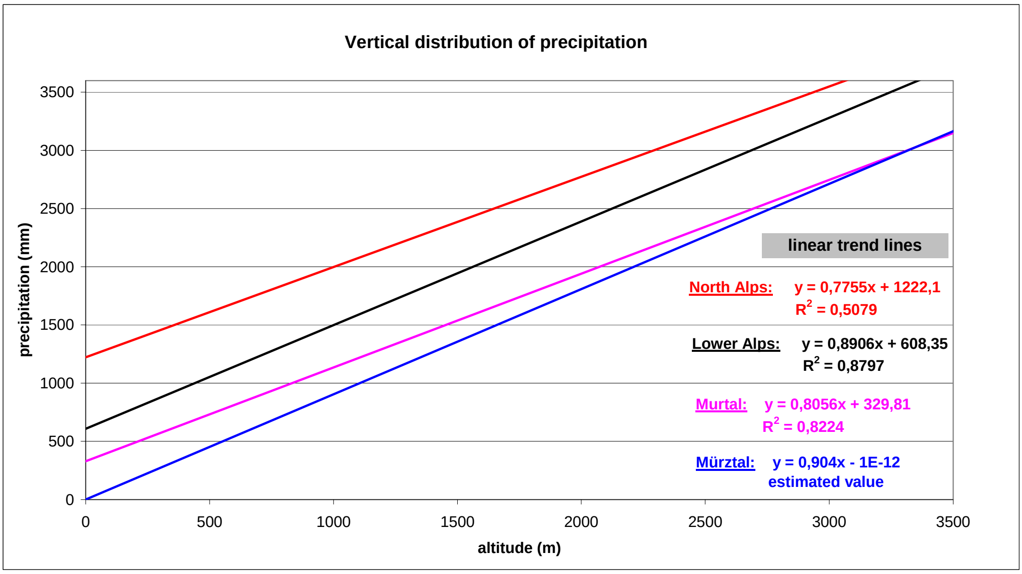

Plate O Linear gradients showing the effect of altitude on precipitation

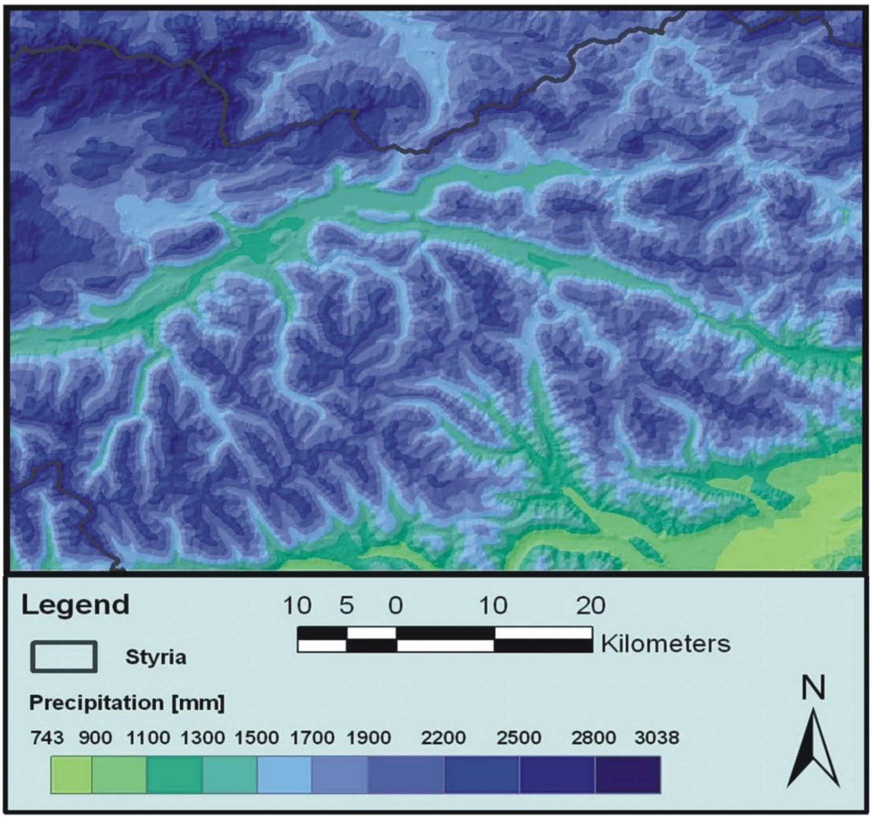

Plate P Mean annual precipitation (1991-2000)

Findings

The result matches well with the input data, but show little differences to older studies. Generally, the high altitude results are excelsior than in these studies, what can be explained by the use of wind – corrected data and different gradients.

These high mountain values which accomplish 3,000 mm per year do not seem extraordinarily high and are absolutely in the range of realistic values. Due to the deficit of high mountain gauges and difficulties in measurement it is unknown how much precipitation actually falls in Upper Styrian Mountains consequently further improvements would need better and more data.

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Case study for the Triglav National Park, Slovenia

The geographic characteristics and significance of Triglav National Park as a principal protected area in Slovenia

Barbara Lampič, Irena Mrak

Triglav National Park (TNP) is the only national park in Slovenia encountering 83,807 ha or 4.1% of states territory. Situated in the northwestern part of the country it also covers a large part of Julian Alps. Park was named after Triglav (2864 m), the Slovenian highest mountain in the heart of the protected area. According to IUCN demands TNP is divided into 2 protected zones - the core area (55,332 ha) and the peripheral – buffer zone (28,475 ha).

Middle Triassic rock formations are most typical for TNP, with limestone and dolomite covering the highest percentage of park surface. Recent relief is mostly the result of last glaciation (Würm) and the intense corrosion that places TNP among the most classic areas with the high-altitude karst relief features. Most of them were primary reasons for the protection of the area. Subterranean waters, karst springs, watercourses and glacier lakes are invaluable assets. The mountain ridges between the Sava and the Soča rivers mark the watershed between the Mediterranean and the Black Sea. Forests cover two thirds of the park territory; the predominating tree species on the south side of the park is beech (*Fagus Sylvatica*), whereas spruces (*Picea Abies*) and larches (*Larix Decidua*) are characteristic for the northern side of the park.

Average temperatures in the warmest month range from 20°C in the valley and 5.6 °C in the mountains, and in the coldest month the temperatures range between 0.7°C and –8,8°C. The annual average of precipitation exceeds 1500 mm. There are 120 to 146 precipitation days per year. The highest meteorological station in Slovenia is Kredarica (2,514 m), situated in the vicinity of the summit of Triglav. The observations are held from 1954 and are beside the usual synoptic use also a very important indicator of climate changes. The mean annual temperature for the period 1961–1990 at the station was –1.7°C but it is significantly rising in last decade. The consequences are most obviously seen in the vanishing nearby Triglav glacier, situated about 300 m away from Kredarica. The mean annual precipitation for the period 1961–1990 was 1,993 mm and the amount stays within the average also in the past decade. According to the observation period 1954–2004 the wettest month is October (230 mm) and the driest one is February

(98 mm). The highest temperature measured at Kredarica was 21.6°C (July 27, 1983) and the lowest –28.3°C (January 7, 1983). The highest snow cover of 7 m was measured in April 2001.

Triglav glacier as a climatic indicator and laboratory

Triglav glacier, the most southeastern glacier in the Alps, lies in the Julian Alps on the northeastern slopes of Triglav (2864 m) between 2400 and 2550 m above see level. Because of its quite low altitude, it is particularly sensitive to climatic changes and therefore it is an interesting object of scientific research. At the end of the 19th century the glacier surface was 45 ha. It was reduced to 15 ha in 1946 to only 4 ha in 1994. In 1993 and 1994 the glacier fragmented into few ice sheets that were still present in 2006.

Triglav glacier has a long monitoring history held by Geographical Institute Anton Melik ZRC SAZU from Ljubljana. Annual glacier measurements are performed from 1946 (Gabrovec, 2007). Since 1999 The Geodetic Institute of Slovenia added the photogrammetrical measurements of the glacier. Changes in glacier volume and extent are an illustrative indicator of climate changes. During the last decade, the trend of rapid glacier retreat has been characteristic for all Alpine glaciers. In Slovenia, there are two glaciers, Triglav glacier and Skuta glacier (Kamnik Alps), both exceptionally sensitive to climate changes due to their extreme southeastern position and low elevation. According to the indicators mentioned before, Slovenian glaciers are small but their relative shrinkage in respect of their present extent and volume is greater than the shrinkage of other Alpine glaciers (Kazalci okolja, 2005).

In last 15 years only, more than 300,000 m^3 of ice melted. In last 50 years the glacier thinned at certain places by more than 35 m and its volume decreased by two millions of m^3. The data of glacier measurements performed by the Geographical Institute and the meteorological data from Kredarica provide material for a qualitative analysis of the impact of meteorological factors on the melting of the glacier. Decisive for the decline of the glacier's size are both the rise of temperatures and the amount of winter precipitation. (Gabrovec, 2007).

Table 1 Oscillation of Triglav glacier (1900-2005)

Year	Area (ha)	Altitude (m a.s.l.)	
		upper rim	bottom rim
1900	32,0	2600	2280
1952	12,5	2565	2390
1995	3,0	2545	2415
1999	1,1	2510	2440
2003	0,7	2495	2445
2005	1,14	–	–

Source: Gabrovec, 2007

Table 2 Triglav glacier's volume (1937-2005)

Year	Volume (10^3 m^3)	Area (ha)
1937	8,000	27
1952	2,000	13
1975	700	11
1992	400	4
1999	60	1,1
2005	20	0,7

Source: Gabrovec, 2007

Plate Q North face of Triglav (2864 m). Photo: I. Mrak.

Plate R Planina Dedno polje: the agriculture function of high mountain pastures is usually replaced by tourism function. Photo: I. Mrak.

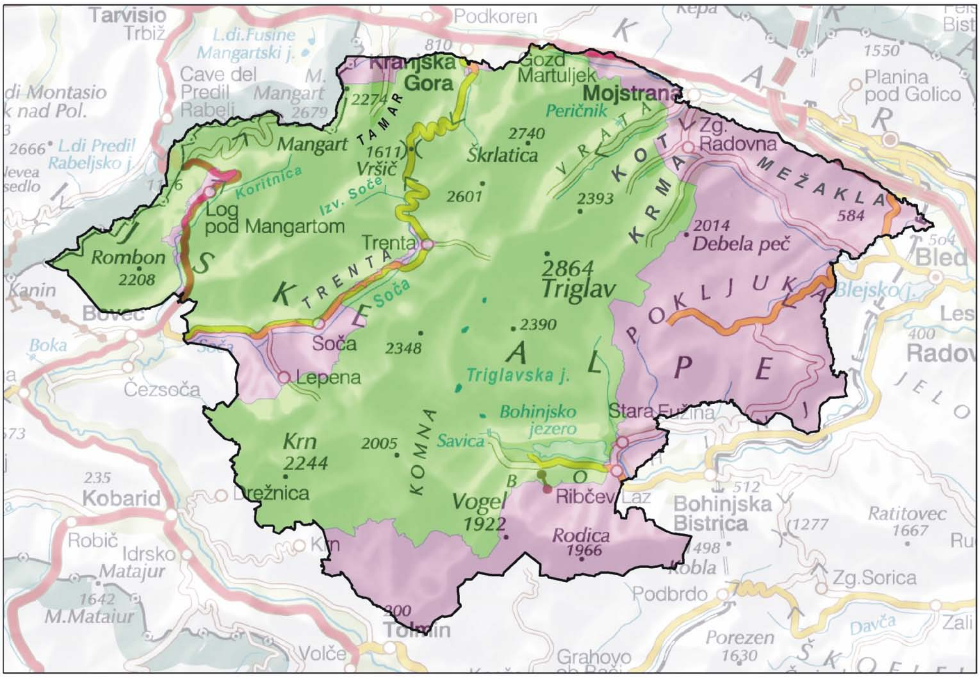

Plate S Present extent of Triglav National Park and protection areas.

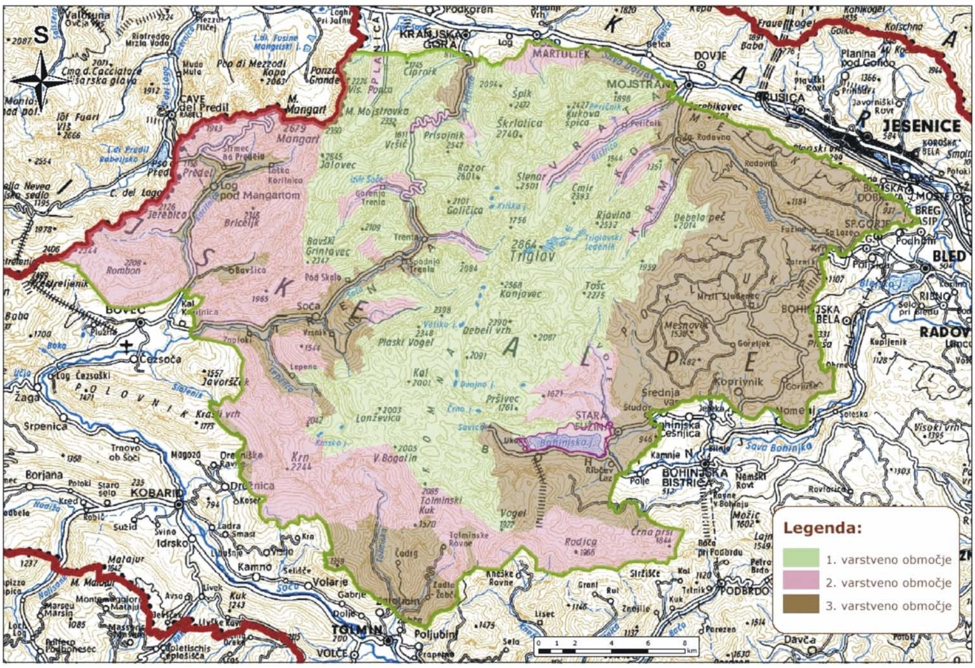

Plate T Proposed protection in Triglav National Park.

Figure 1 The remains of Triglav Glacier. Photo: M. Gabrovec.

Oscillations of Triglav glacier are result of complicated combined effects of various climatic factors in the warm and cold halves of a year, in its melting and accumulation seasons. In the early 20th century it still extended to the upper edge of Triglav north face (measured about 32 ha), a century later it only measured 0.7 ha and was only about 3 meters thick on average. If the process of the last decade continues, Triglav glacier will vanish completely in the course of ten years (Gabrovec, 2007).

Protected natural monuments and cultural heritage

Within TNP (protection II by IUCN) there are different types of protection areas, nature reserves, natural monuments etc. The total number of minor protected areas in the park is 58 – the core and the buffer park zone, 5 nature reserves, 2 areas of man influenced natural monuments and 47 natural monuments. There are 387 nature values of state importance, 7 special areas of protection (NATURA 2000) – one of them being the special SPA protection area and six of them are areas of pSCI. Within the park there are also 3 ecologically important areas.

Although protection and conservation of nature is the primary objective of a national park, Alpine national parks are endowed with a responsibility to preserve the autochthonous, pristine cultural heritage as the basis for sustainable development. For Slovenia, the Alpine cultural heritage is of utmost importance because it connects Slovenes with other Alpine nations. The cultural heritage of TNP is very interesting and diverse, because the park also lies at the crossing of various cultures. Evaluation and preservation of the cultural heritage is an extremely demanding but rewarding task.

The official register of immovable cultural heritage (Ministry of Culture, 2007) contains 300 units of different types of cultural heritage within TNP. Numbers of registered units are changing since units are in the process of registration. According to the type of heritage, secular architectural heritage prevails (approx. a third of all registered units), followed by memorial heritage (almost 25%), settlement heritage (approx. 17%), religious architectural heritage (just over 14%) and archaeological heritage (almost 7%).

Population and settlements in Triglav National Park

- There are 25 settlements in the park with 2,352 inhabitants (2006). Ukanc and Bavšica are located in the core zone of the park, and the remaining 23 settlements are in the buffer zone. The economic activities in the park consist mainly of agriculture, wood processing, mountain pasturing, recreation and tourism.
- Especially mountain tourism already has a long tradition. First mountain huts within the park area were built at the end of the 19th century and rapidly spread after 1893 when the Slovene Alpine Society was founded. Today, the entire area of Julian Alps is traversed by the uniformly marked trails. Within TNP area the Alpine Association of Slovenia runs 32 mountain houses and huts.
- The villages and hamlets of TNP are strung out between 250 m (the lowest-lying buildings of Zadlaz-Čadrg) and 1000 m a. s. l. (Koprivnik in Bohinj area) and even 1350 m a. s. l. (the highest-lying structures of village Goreljek).

History and present issues of Triglav National Park protection

TNP is one of the oldest European parks; the first protection dates back to 1924 when the Alpine Conservation Park was founded. Established to protect the unique mountain landscape, specific flora and fauna as well as the cultural heritage, TNP remains the only national park in Slovenia.

On July 10, 2003 the UNESCO office in Paris adopted a Decision to include Julian Alps and TNP into the international network of biosphere reserves MAB. Julian Alps have thus become part of a network of model regions of sustainable development.

Crucial steeps in TNP protection:

- 1906-1908; first proposal on protection of the area around Triglav mountain by Albin Belar - unfortunately his idea was not realized.
- 1924; The Alpine Conservation Park in Triglav Lakes Valley was founded (area 1,600 ha).
- 1961; Decree proclaiming the Triglav Lakes Valley as the Triglav history National Park (area 2,000 ha).
- 1981; Act on Triglav National Park enlarged the protected area and defined the park's present borders (area 83,807 ha).
- The Julian Alps and Triglav National Park were included into the UNESCO MAB (Man and Biosphere) network.
- 2004-2007; New Act on Triglav National Park in preparation.

The principal function of the managing authority of TNP (Triglav National Park Public Institution) is the protection of the park. Beside this other crucial tasks are:

- Nature protection and conservation of cultural landscape.
- Ensuring sustainable park development; to harmonize the nature protection issues and development of tourism, agriculture, hunting and forestry.
- Park promotion; info centers, info points, info materials, park trails, organizing guided tours, various workshops, different education programs.
- Research task including working on research project, data acquiring, field work etc.
- Management; ensuring implementation of the park's objectives, setting an example of management conduct for other protected areas. An important element of the park's activities is participation in the preparation of the new Act on Triglav National Park and preparation of professional groundwork for the Triglav National Park Management Plan.

Present and future perspectives of Triglav National Park

The reality in the park is daily conflicts between protection and conservation function of the park and demands of local population, which are especially obvious in Bohinj lake area (where the majority of people in the park live). There are also immense pressures on the lake Bohinj shore where different investors are waiting to build new tourism facilities, especially hotels. The problematic is present Act on Triglav National Park that does not meet the contemporary development issues and also the absence of Triglav National Park Management Plan. The draft version of the new Act on Triglav National Park proposes different protection regime in three proposed zones/areas of protection that will still meet the IUCN criteria but the question of future extent and exact park regime still remains uncertain.

TNP in present situation faces the underestimation on different levels. The major concern is the local inhabitants not seeing the protected area as a development opportunity. There is also the state level on the other hand – the importance of the park is also in its research role that is at the moment totally neglected. Since TNP is the only national park in Slovenia therefore it is also a sort of a national symbol and its future role should be the concern of the entire nation.

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The climatic data acquisition issues in mountain areas

Matej Ogrin

Protected areas with highest level of protection, such as national parks, are often settled scarcely and particularly in mountainous terrain, vast areas are even unsettled. Therefore areas without or with very few settlements in many cases do not fulfill the conditions, which would include them in different national monitoring networks, which are formed to serve the public with providing useful environmental information (meteorological, hydrological and other information) in real time. Unless some additional monitoring is established, such as military, scientific or any other kind of monitoring network or system, these regions can become uncovered spots with lack of spatial information.

Dealing with meteorological parameters such as precipitation or air temperatures, in mountains we can expect very big gradients on a small scale. Due to mountain relief, some meteorological processes are very intensive in fact they can be much more intensive than in lowlands. Some of them also influence other areas in their surroundings, such as precipitation runoff, snow and soil avalanches, etc. To get a real insight in intensity, dimensions and spatial distribution of these processes, measurements *in situ* are necessary. Lack of infrastructure (electricity, roads etc.), lack of personnel and severe conditions are the most common reasons which made many methods useless.

On the other hand, there are some nature processes or phenomena, which take place only in high mountains, and were in lowlands never observed before, so no previous experiences can be applied. These are the reasons, that in mountainous terrain of protected areas we use some other methods, which are useful in these specific conditions. After all, we must not forget special protection regimes in these areas, so all activities and new objects must obey spatial legislation of protected area. We are going to introduce two methods, which turned out to be very efficient to get an objective insight in meteorological processes in mountain areas. The two methods were used in the area of Triglav National Park.

Snow water equivalent (SWE) measuring method

SWE shows the amount of water in snow cover. This information is useful for estimating precipitation intensity, potential water amount for river discharge, load of snow weight on objects, etc. It represents millimetres (mm) of water, which we would get, if all of snow cover would melt and no melted water would run off or evaporate. Consequently, because 1 mm of water per sq m means also 1 kg per sq m, we also get the load of snow per surface (pressure on the surface).

Measuring of SWE must be done in an appropriate spot. Surface must be flat, far enough from obstacles such as vegetation, buildings, rocks, etc. On the measuring spot there must not be sources of heat, neither signs of wind erosion or accumulation. And finally, it is necessary that measuring spot is out of reach for snow avalanches (Vrhovec, 2000; Sluga, 2000).

In lowlands measurements are relatively easy and accurate. If done correctly, they can be even more precise than measuring precipitation with pluviometer, because snow gathers on the edges of pluviometer and it is very hard to distinguish which part of snow on the edge would fall in to pluviometer and which would not.

However, in mountainous terrain circumstances differ from those in lowlands. Winds are stronger and in many spots they often cause erosion and accumulation of snow. There is also not much flat surface, so in many places the measuring of snow can not be done. Data of snow depth, even if measured correctly, give different information about snow conditions in mountains, because of very small part of flat terrain. On slopes snow accumulates differently.

For measuring SWE two methods are used: tube method and cylinder method. Both methods sample snow cover through its whole profile, however they have some differences. A tube method samples snow cover through its whole profile (H) at one time or, if height of snow cower exceeds the length of a tube, so many times (X), that we get is all snow from surface to the bottom. It depends also on length of tube (d):

$X = H / d$

Tube method enables relatively quick sampling, so it can be done on many spots in short time. It also gives better accuracy of precipitation data. The disadvantage of this method is that at sampling along the whole tube length, we do not get insight in separate layers of snow cover.

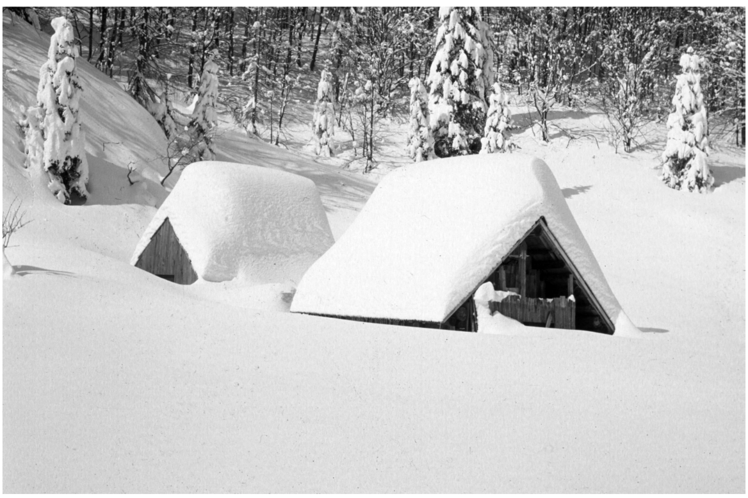

Figure 1 Deep snow cover in winter 2005/2006. Photo: J. Ortar, M. Ogrin.

Figure 2 Measuring of temperature in snow cover after a sample was taken with a tube. Photo: M. Ogrin.

The second method is a cylinder method. With a small cylinder (or any other shape of the sample), each layer of snow cover separately is sampled. This takes much more time because first we have to dig a hole through the whole snow profile to set the standing point, than we have to identify each layer and finally we take a sample of each layer. Cylinder is therefore small, about 10 cm long and with diameter about 5-7 cm.

Although this method takes more time than a tube method, it is less accurate, because at each sampling errors appear, and since each layer is sampled (there can be more than 10 layers in a profile), the total error is a sum of partial errors. But this method enables us to see the “precipitation” history of all winter and with using this method through a whole winter on same spots, we can get a very good insight in transformation of snow cover and also other processes within snow cover (such as transport of vapor towards surface, etc).

In years 2004-2006 both methods were used in Triglav National Park and both turned out to be useful at estimating winter precipitation in mountain areas, where there are no pluviometers. Comparison of results with the precipitation amount in Julian Alps, measured with pluviometers showed, that in winter 2003-2004, pluviometers caught about 56% of total snow precipitation. Of course this number varies from winter to winter, but nevertheless, gives us a confirmation of using SWE methods not only to estimate the real precipitation, but also to estimate the errors of pluviometers.

We have to note, that measuring of SWE gives accurate and therefore applicable results only in winters with relatively deep snow cover with frequent snowfalls and when windy conditions are relatively calm. Otherwise snow accumulation caused by winds creates many snowdrifts in lee sides and big areas without snow cover or only with thin icy layer. In such cases and also in dry, warm and sunny winters, when sun melts the snow everywhere except in shadow sides, measuring of snow cover with SWE method gives us insufficient information to get a real data of precipitation. This is also the case when snow cover is thin and when the rainy conditions prevail, so some precipitation and melting water can run off. But winters with such conditions are rare, and especially in southern part of Triglav National Park, where, due to condensation of humid south-western winds, heavy snow precipitation appear often, in most winters measuring of SWE is an appropriate method to get good precipitation information from many spots in mountain areas.

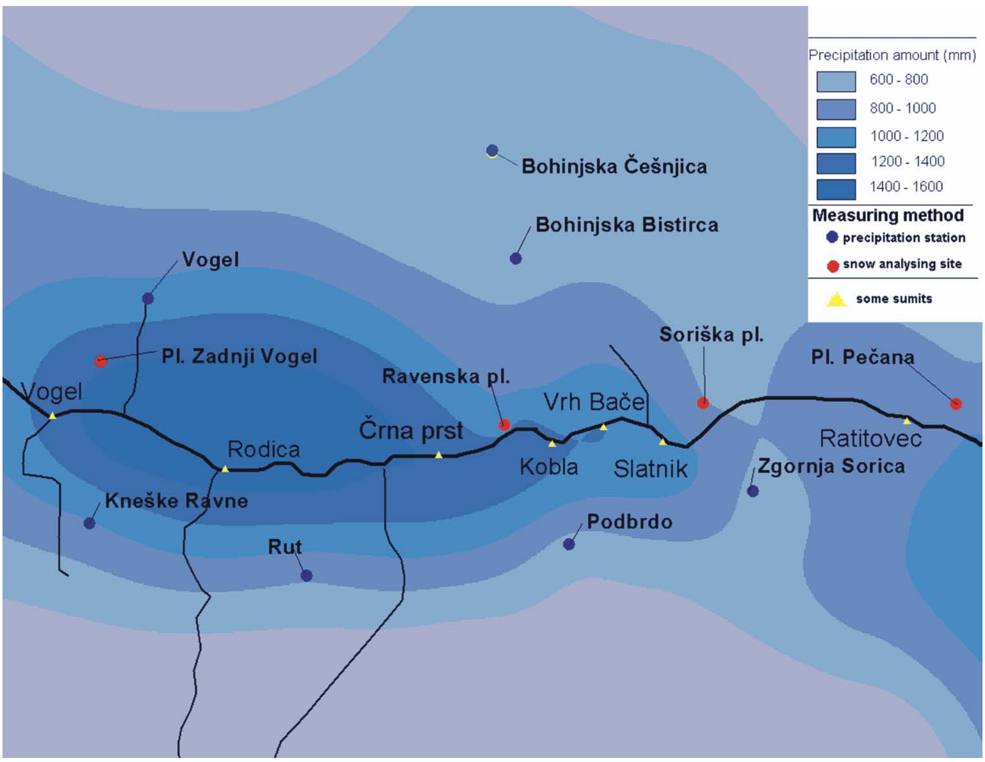

Plate U Precipitation amount and snow analyzing sites in Bohinj lake area.

Measuring of temperature conditions in dolines and other concave relief shapes in mountain areas

Temperature conditions on higher elevations of Triglav National Park are observed with only two stations within Slovenian national monitoring network that work constantly. One of them is Kredarica, with elevation 2515 m, and the other is Vogel, 1510 m. Kredarica is also the highest station in Slovenia and therefore it provides information important information from the atmosphere at these elevations. Vogel station is located on the edge of small plateau in Bohinj ridge in southern Julian Alps. The main problem at this station is that it lies at the edge of the plateau, where terrestrial effects are small and as such it does not provide information on temperature conditions in the interior of the mountain area. The second deficiency is that this station does not measure temperatures every hour. This location was selected mainly because of ski resort Vogel – the measurements are possible because people stay there throughout the year. There is one more automatic station at Rudno polje at elevation 1347 m. It is located at a very good spot in the interior plateau of Julian Alps, named Pokljuka. Conditions there are similar as in many other mountain plateaus, but this station is very unreliable due to the often loss of data.

The temperature conditions from interior parts of mountain areas can differ from these at the edges significantly. Especially in calm, clear weather, due to terrestrial effects, nocturnal temperatures in the dolines can be up to 30 degrees lower, and maximum temperatures can be higher than on the edges of plateaus or at the interior ridges. Extremes in these concave shapes can be much higher than outside, especially at the bottom. Temperature conditions in the lowest parts of dolines and other concave relief shapes are very useful information from many reasons. They provide ecological information on conditions the vegetation and also animals are exposed to. Also for all hikers and others, who visit these areas, these information are useful when planning their hike.

To get a real picture of temperature conditions in Alpine dolines, we started with air temperature measurements in some of them on plateaus Komna and Pokljuka and on some other places in the interior of Julian Alps. All are located in Triglav National Park. The reason to start measurements is also known facts from other Alpine countries, where in similar conditions extreme temperature minimums were measured. In doline Gruenloch (1270 m a. s. l.) in Austria, on January 21, 1930 the lowest temperature measured in the Alps was recorded, –52,6 ˚C. According to these values it was very likely, that also in other dolines, temperatures can fall very low. In fact, they can fall much lower than experts predicted without any previous measurements. After three years of researching, results confirmed our prediction and it turned out, that in dolines of Triglav National Park temperatures can fall under –40˚C. Because locations, where measurements are taken are not easily accessible, instruments and all the other necessary equipment are modified in comparison with those in the lowlands.

We constructed special radiation shields to make conditions for thermometers in them similar to those in meteorological box. Comparisons showed, that for nocturnal time, temperatures measured in these shields vary less than 1 degree compared with those in a meteorological box. For daytime, shields were not good enough and measured temperatures were too high, so we had to improve them for the coming measurements. However, further improvement of radiation shields are expected, to minimize daily differences between meteorological box and modified radiation shields.

To get daily and nocturnal temperatures of the air, we placed a meteorological box in one of the dolines on Komna plateau. Because we can expect a high snow cover in winter (up to 3 m), we constructed a special two level stand, so that in case of high snow cover, we will maintain the height around 2 m above the floor.

For all objects, we got permission to place the objects in space by the management of Triglav National Park. According to the law of Triglav National Park, all objects for measurements are placed and built with materials and in such extent and dimensions, that negative impacts on environment are negligible.

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Geographic information sources for Triglav National Park

Marko Krevs

In general, extensive databases are probably not seen as necessary condition for efficient management and visitors' enjoyment in natural/regional/national parks or in protected areas. Several examples may prove this opinion ignorant or wrong. In Scottish Natural Heritage (Pringle, 2003) the "nice policies", like targeting integrated approach to conserving and managing the protected areas, encouraging recognition of the link between natural heritage and personal well-being, efficient use of natural and renewable resources within their carrying capacity, are supported by more than 800 databases, 700 employed in 40 offices, and four teams taking care of geoinformation. Of course, their goals reach far beyond mere conservation and economic management of the protected areas. At the end of the day, the employed have to prove that they, and these databases are needed – also by innovative results of the use of geographic information systems.

If we are searching the possibilities for international research cooperation related to protected areas, we face a variety of differences in terminology, legal regulations, experiences, mixtures of natural and "cultural" landscapes, actual land uses and plans for the future. Modern digital geographic databases may contribute to making the communication between the researchers from different countries easier or even possible. But due to different national spatial research histories and importance given to different geographic data sources, also these hopes may not always prove true.

No activities of the Triglav National Park administration have so far been focused on development of databases serving specific research and management needs of the park. Therefore the specificities of Slovenian state geographic data sources[1], related to the international cooperation discussed within this project, are relevant to the research of this area, and may be summarized in the following way.

State topographic and cartographic system is composed of digital raster and vector maps of scale 1:5,000 up to 1:1,000,000, digital ortophoto images of scale 1:5,000, and digital elevation model of spatial resolution 12.5 m. Except the latter, the mentioned sources are easily comparable to the sources of similar scales from other countries. Their major methodological "imperfections" are the time scale heterogeneity (maps/ortophoto images for sparsely inhabited areas are less frequently updated, and parks or protected areas are usually situated in that areas),

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[1] Data from GURS (SMARS, Survey and Mapping Authority of the Republic of Slovenia, http://www.gu.gov.si/en/), the main provider of spatial data for Slovenia, have just recently become available for free to non-commercial users. This fact might stimulate also the development of specialized databases such as for TNP.

and the fact that majority of these data have yet to be transformed into information usable in sustainable environmental research.

Several land use and land cover data are available for the area of TNP. Beside the Corine LC[2], a “Statistical GIS”, derived from Landsat TM/ETM imagery and several state registers and cadastres, Land use data derived from ortophoto images (Zajem rabe tal z ortofota, 2002), and some other data derived from Landsat imagery, e.g. vegetation index NDVI calculations. The land cadastre is only partly applicable because the “land use” attributes are only partially up to date, and no archives in digital form are available.

There are two data sources about buildings that are of very high quality and are important, because a lot of other data, e.g. about economic and other activities, and population may be attributed to their spatial position. The first dataset contains centroids of house numbers, exists for the whole country since 1980s, but only data since 1995 are of appropriate quality. This data are obviously available only for the buildings that can be attributed a house number, so quite a number of buildings without it (e.g. industry buildings, agricultural buildings around the “home”) are excluded. The new cadastre of buildings (updated since 2002) includes all buildings, presents their ground plan outlines, their height, and in close future[3] also several attributes about the division of the use of the surfaces within each building. Several parts of Triglav National Park are populated, and these areas have to be studied and managed with special care. Besides, the populated areas surrounding the parks, potentially and actually influence the sustainability of the functioning and development of the parks.

Beside the mentioned above, also other data sources exist, e.g. on forests, soils, geology, or some specific measurements (precipitation measurements by M. Ogrin within Triglav National Park are mentioned in this volume, see pages 103-108), and may contribute to research cooperation – as source of data, or as methodological idea or a ground for further development.

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[2] This data source is usually not applicable for such research, mainly due to quite low spatial resolution and quite un-compatible data for different countries despite using supposedly the same methodology for interpretation of remotely sensed images, and their “translation” into land cover maps for all the countries within the program. A project Harmonisa (Mandl, 2006; URL: http://harmonisa.uni-klu.ac.at/harmonisa/application.jsp; 15 April 2006) very clearly shows the differences between the results of implementation of supposedly the same methodology. And we can be quite sure that similar problem occurs elsewhere in the studied region, and in many fields of research and planning activities.

[3] In spring 2007 a real property census should be completed as a basis for the introduction and implementation of a new law of real property taxation. These data will attributed to the cadastre of buildings data simultaneously with data from several other datasets, e.g. on infrastructure, population, etc.

Complex measuring of the circumstances of living in the area of Triglav National Park

Significant percentage of protected areas (11%) and areas of NATURA 2000 (36%) in Slovenia pose an important question on future regional development. Despite emphasizing the importance of nature and cultural heritage protection the population still percepts protected areas as development limitation and only in few cases as an opportunity for future economic development.

The past ambitious plans on extension of protected areas (landscape and regional park) were not implemented due to poor political will and were replaced by the introduction of NATURA 2000.

Protected areas development merely depends on the management where the crucial development role is to be trusted to the local population. In regional development plans protected areas are defined as nature units with very high quality and as such they are important, but only in case if:

- the protection is accepted and supported by local population,
- the social capital and human resources are present and developed,
- the demographic potential is suitable and well aware of the development potentials of such areas.

Only if the local population estimates the natural environment protection as the crucial factor of the high level of quality of living, the nature protection aims will be entirely implemented (Plut, 2006).

The area of Triglav National Park has been rarely in the research focus, but very often represented a part of a wider area of research. In that way Triglav National Park participated also within the geographical research of level-of-living for whole Slovenia (Krevs, 1998, 1999) or it's rural areas (Krevs, 2000a). The geographic concept of level-of-living relates to complex measuring of the circumstances under which the local population lives. In the mentioned research, 108 indicators were used to measure the following aspects (or contents) of level-of-living:

- property and income of population,
- housing,
- population,
- employment,
- education,
- supply,
- other services,
- possibilities of leisure activities,
- personal transport accessibility,
- natural threats to residential areas,
- physical-geographical characteristics of residential areas, and
- pollution of residential areas.

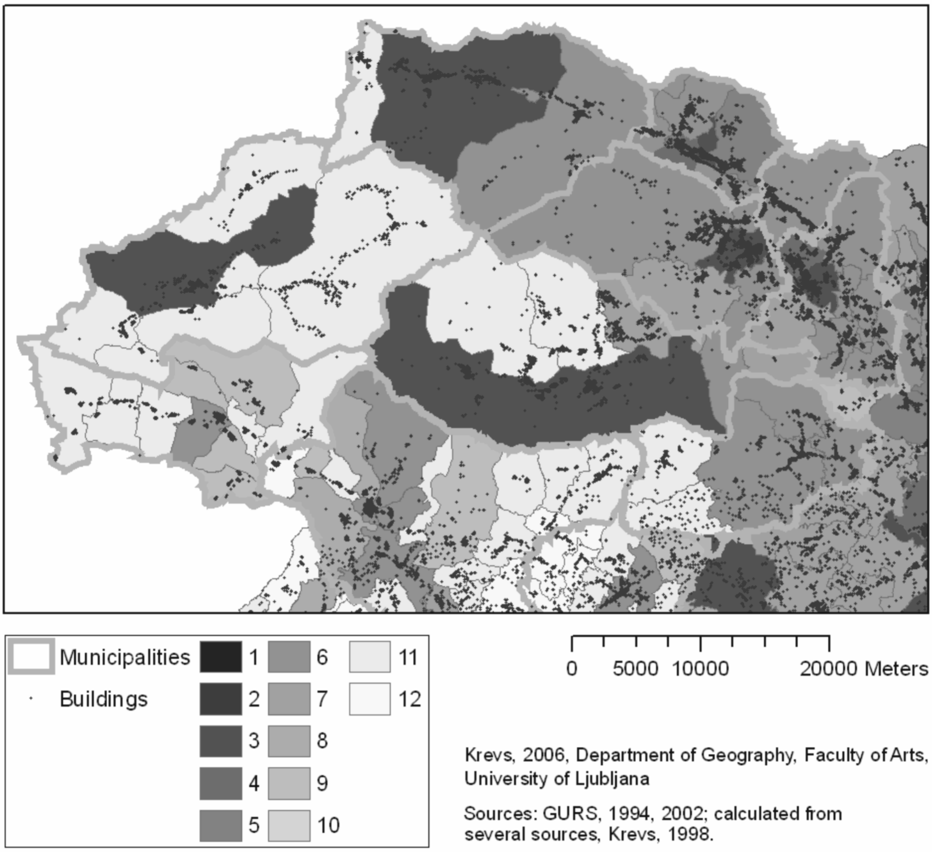

Figure 1 Types of level-of-living, based on a complex classification scheme. Areas in dark colors are characterized by predominantly urban circumstances of living, while lighter colored areas are predominantly rural in character.

The concept is clearly anthropocentric, since all the indicators directly or indirectly measure the level, intensity, or accessibility of certain circumstance of living to local population. Although many protected areas in Europe are uninhabited, several parts of Triglav National Park are inhabited. The conditions of living within the protected area as well as in it's vicinity therefore play an important role in the planning and monitoring of the park.

Share of employed population in the lowest income tax class show one extreme aspect of the distribution of incomes within the population of the wider area of Triglav National Park. In the central and western municipalities in the park very high shares of population with the lowest incomes may be taken as indication where the development policies should focus also on approaching social and demographic problems. There are no areas of high average income tax base per capita within the park, and only few in its vicinity.

Table 1 Brief descriptions of the “types of local level-of-living”

Type No.	Descriptions of types
Type 1	very favorable circumstances for leisure activities, supply, services, favorable for employment, education, traffic, non-favorable from the aspect of natural treats to residential areas, pollution of residential areas
Type 2	favorable circumstances from aspects of population characteristics, employment, education, traffic, housing, services, property and incomes of the population, non-favorable from the aspect of pollution of residential areas, natural treats to residential areas
Type 3	very favorable circumstances for leisure activities, favorable for services, supply, education, employment
Type 4	favorable circumstances from aspects of education, housing, employment, services, supply, traffic, leisure activities, non-favorable from the aspect of population characteristics, pollution of residential areas
Type 5	favorable circumstances from aspects of traffic, education, employment, property and incomes of the population, non-favorable from the aspect of pollution of residential areas, natural treats to residential areas
Type 6	favorable circumstances from aspects of housing
Type 7	values of all indices are around Slovenian average
Type 8	non-favorable from the aspect of natural treats to residential areas
Type 9	non-favorable circumstances from aspects of services, education, supply, leisure activities, traffic
Type 10	non-favorable circumstances from aspects of housing, property and incomes of the population, traffic, employment, education
Type 11	favorable circumstances from aspects of population characteristics, pollution of residential areas, non-favorable circumstances from aspects of supply, traffic, education, very non-favorable circumstances from aspect of natural characteristics
Type 12	favorable circumstances from aspects of pollution of residential areas, non-favorable circumstances from aspects of supply, services, education, traffic, leisure activities, employment

Source: Krevs, 1998.

Within this study three aspects of level-of-living are related to natural environment. All of them are measured in a complex and anthropocentric way, only for the populated areas. Natural threats to residential areas are especially high in the Upper Soča valley. Physical-geographical characteristics of residential areas in the whole park are among the least favorable in Slovenia. Of course, the natural beauty and environmental qualities were not taken into this account. On the other hand, the areas of the park are among the least polluted in the country.

The overall index of level-of-living shows very favorable circumstances for living in some parts of municipalities of Bled, Bohinj and Tolmin – marginal areas of Triglav National Park. In quite a few areas, especially in the western areas of the park, the circumstances of living are among the worst within the country. Only three local communities within the park have been classified as “urban” (type 3), Kranjska Gora, Bohinj and Bovec. Only few areas (in upper Sava valley and in municipality Tolmin) enjoy some suburban advantages of level of living. Majority of western and some central areas within the park are characterized by extremely peripheral rural circumstances for living.

As shown in another case study in this volume, the sustainable development protected areas is not only the matter of conservation of the natural environment, but often even more a problem of demographic and economic sustainability. Therefore, such complex approaches, developed into more concrete policies, may be among the important fields of international research cooperation in the future.

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Demographic vitality of population as an important development potential of protected areas

Barbara Lampič

Significant percentage of protected areas (11%) and areas of NATURA 2000 (36%) in Slovenia pose an important question on future regional development. Despite emphasizing the importance of nature and cultural heritage protection the population still percepts protected areas as development limitation and only in few cases as an opportunity for future economic development.

The past ambitious plans on extension of protected areas (landscape and regional park) were not implemented due to poor political will and were replaced by the introduction of NATURA 2000.

Protected areas development merely depends on the management where the crucial development role is to be trusted to the local population. In regional development plans protected areas are defined as nature units with very high quality and as such they are important, but only in case if:

- the protection is accepted and supported by local population,
- the social capital and human resources are present and developed,
- the demographic potential is suitable and well aware of the development potentials of such areas.

Only if the local population estimates the natural environment protection as the crucial factor of the high level of quality of living, the nature protection aims will be entirely implemented (Plut, 2006).

Rural and peripheral areas of Slovenia are already merely encountered in different categories of protected areas and/or NATURA 2000 areas. Their future development should base on the fact of the highly preserved natural environment as a competitive development advantage and main potential for encouragement of endogenous regional development.

As the majority of changes usually depend on human potential, the »vital« population structure is significant for sustainable use and future development of protected areas and areas of NATURA 2000. It has been proved that the use of just demographic data (no. of population, ageing index etc.) does not enable a thorough analysis and further projections of demographic development as well (and also the preparation of suitable measures). The projections and measures are far more effective by using the concept of demographic vitality (i. e. household vitality). The development actor is not an individual, but household - family as integrity. Vital household (family) units represent the important economic potential; they take care of residential function – by preserving the settled area and maintaining the cultural landscape.

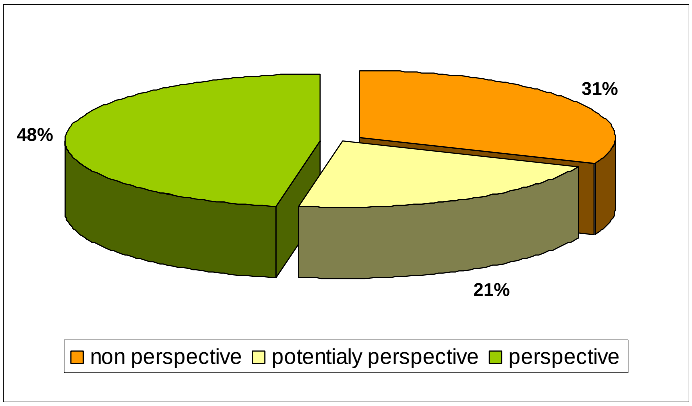

Plate V Households perspective in Upper Posočje valley.
Source: own survey, 2003.

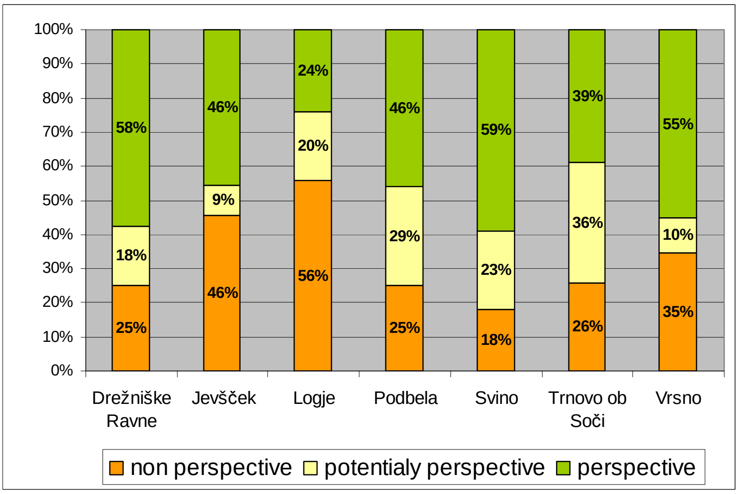

Plate W Households perspective in selected settlements.
Source: Own Survey, 2003.

The vitality of a settlement or wider region is to be attained by monitoring households' vitality of particular settlement (and settlements) of selected area – in our case a part of protected area of Triglav National Park and it's surrounding.

Our survey refers to Zgornje Posočje region, which is partly included in Triglav National Park but the region as a whole is strongly connected with it. The survey (field work – questionnaires) in seven selected settlements, 182 households, and 564 inhabitants indicated that we should not be limited to only tight aspect of vitality based only on households age structure and on "reproduction" and "working" potential. Development of particular regions hardly depends on vitality deriving from several socio-economic factors (age, education, employment of household members etc.).

In an extensive study of different smaller Slovenian regions (different types of rural areas), the household demographic vitality in selected settlements was defined on the base of age of each household member and the number of household members. This methodology determined seven household vitality types: extending from the most vital (all household members younger than 35 years, the opportunities for family creation are the best) to aged ones (all household members encounter more than 70 years so they are non- perspective from vital and working point of view). (Klemenčič, Lampič, Potočnik Slavič, 2005)

Household vitality types:

1 – all household members over 70 years old,

2 – all household members over 50 years old,

3 – all household members over 35 years old (older parents, children over 35, singles over 35 – potentially vital households),

4 – parents, singles or children between 25 and 35 years (potentially vital households),

5 – three-generation households , children under 25 years,

6 – two-generation households, children under 25 years,

7 – young households (all members under 35 years).

We want to emphasise that only the household reproduction vitality aspect is too narrow. For example, households with members elder than 50 years (non-perspective from reproduction aspect – similar to the households with members over 70 years) still attain numerous functions and an important role as they are (mostly) able to work although they are officially »retired«. These particular generations (between 50 and 70 years old) still cultivate the land in many rural areas of Slovenia or are of great help to younger (if living close by).

The household vitality types in selected settlement of region should be represented from the perspective aspect. We distinguished three main types, which are also useful for valuation of demographic potential in protected areas:

- perspective households (most vital households, young families - all members under 35, often two or three generations living together),
- potentially perspective (vital: mature generation, the probability of family creating is low),
- less perspective (non-vital: all household members older than 50).

Case study indicates important local discrepancies among settlements: some of them are absolutely non-perspective from vitality aspect; on the other side some have good vitality potential. It is very interesting that some settlements hold positive demographic index based on the in-migration of retired people (returning back to the place of origin or to secondary homes), but from the vitality aspect they still remain non-perspective. We are aware of proposed methodology insufficiencies; therefore by evaluation of regional development perspectives, the combination with endogenous potentials and regional economic cycles should be taken into consideration.

In seven investigated settlements of Upper Posočje Vally, where people live in the vicinity of Slovenian single national park, field work results gave us an impression about situation on demographic vitality in this area. Nearly half of all households are still vital from the demographic (no. and age of households members,) and working activity aspect. On the other hand more than 30 % of investigated households are non-perspective, household members are aged, they have no descendants, usually they are not able to cultivate the land etc.

On the other hand we can observe striking differences among investigated settlements. More than 50 % perspective households were registered in three settlements (Svino, Drežniške Ravne, Vrsno) close to Triglav National Park border. Other four settlements have much lower share of perspective households, in two settlements close to Slovene-Italian border (Logje and Jevšček) the share of non-perspective households is explicitly significant.

The evaluation of households from demographical vitality perspective helps us predict the future demographic and also regional development of settlements and regions. The population in peripheral rural regions (frequently protected areas) is far more sensitive for regional structural problems therefore sustainable development planning should be integrated in policies and legislation in protected areas.

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Sustainable tourism development in mountain areas

Irena Mrak

Mountain areas throughout the globe are facing rapid changes because of new activities that are being introduced. Due to specific geographic conditions the high mountain areas in history remained uninhabited. People were only occasionally present usually as hunters, shepherds or miners. It was in the 19th century that people started to visit mountain areas with the intention to trek, climb or simply enjoy the nature.

In past few decades extension of the amount of spare time, the overall easier access to mountain areas, promotion of the healthy way of living, the large amount of literature (guidebooks, maps…) and also the urge to spend more time in natural environment are just few basic reasons for the tremendous enlargement of tourism and recreational activities and therefore the increased number of visitors in mountain areas.

Especially in the 1970s there were common debates about the problematic future development of mountain/alpine areas on one hand and the protection of their natural and cultural characteristics on the other. The opinions used to be very diverse. The fact that the intact natural environment and attractive and dramatic landscape are crucial and basic capital of mountain tourism development was already well recognized. It was also well known that nature values such as gorges, lakes, various other geomorphic phenomena, typical alpine flora and fauna, alpine vegetation conation, the color of streams and lakes etc. are irreplaceable and therefore in need to be protected from the negative impacts of newer and newer tourism and recreation activities (Jeršič, 2001). These new tourism and recreation activities need the intact natural environment on one side but on the other hand in order to use it specific buildings and devices need to be built. The preservation of natural environment is also threatened by the crossways of needs and interests of various tourism and recreation activities (Jeršič, 1999).

The impacts of tourism and recreation in mountain areas are environmental, social, cultural and economic. Their intensity is rapidly increasing due to development of tourism and recreation activities (Newsome et al., 2002). The increasing numbers of visitors, taking part in different sport activities are already having negative consequences and impacts on the environment (Swarbrooke, 2003), since the environmental vulnerability indicators show the lowest regeneration and neutralization capabilities especially in mountain areas (Špes et al., 2002).

The majority of recent researches reveal the negative environmental tourism impacts, among them the following ones are emphasized:

- the quantity and quality of natural resources is getting minor,
- negative impact on water; especially the drinkable water,
- limited food and energy resources,
- surface degradation.

The negative environmental impacts are also shown as air pollution (gasses, noise), trash pollution and trail erosion (endangering the soil and the bedrock). Wastewaters, oils and various chemicals pollute water. There is also a special type of pollution, called the visual pollution as a consequence of recreation and tourism infrastructure constructions that are in conflict with the natural environment (UNEP, 2006). Mountain tourism and recreation is: disturbing wildlife, influencing vegetation destruction, causing trail erosion, having negative impact on air (noise pollution) and water.

As one of the positive impacts the establishment of protected areas can be emphasized. In mountain areas they usually play double role - they are established to protect the unique mountain landscape but they also act as coordinators of various needs of tourism especially between the highly equipped areas with different infrastructure and relatively intact natural and/or cultural landscape (Jeršič, 2001). The positive impact of protected areas for local population is the enhanced infrastructure as well as wider economic opportunities (Newsome et al., 2002).

The tourism and recreation have merely negative impacts on the sustainable development. Among them the environmental impacts are the most obvious. They can be estimated as well as measured. The social, cultural and economic are harder to define and measure, and are spatially more widespread. One of the possible ways to define the sustainable tourism and recreation activities in mountain areas is to develop a sustainable tourism development model.

Figure 1 Krnsko lake is one of the most popular tourism spots in Julian Alps.

Figure 2 Checking the water quality in the area of Valley of Triglav lakes. Photo: I. Mrak.

The main purpose of the model is to define all those tourism and recreation activities that are causing negative environmental impacts and also mainly negative social and cultural impacts and are therefore not suitable for mountain areas. Additionally they are also economically not sustainable. On the other hand the model helps to define all those activities that are acceptable, recommended and sustainable in mountain areas.

The following basic questions are to be answered in order to reach the sustainable tourism development model:

- How to define all impacts of recreation and tourism in mountain areas if we take into the account the rapid development of new tourism and recreational activities?
- How to measure the environmental impacts of recreation and tourism in mountain areas?
- What is the carrying capacity of mountain landscape from the recreation and tourism point of view?
- How to make a model to estimate the tourism and recreation impacts in the mountainous landscapes?
- When can we speak about the sustainable mountain recreation and tourism?
- How to make a model of sustainable mountain recreation and tourism, considering the specific geographic conditions and also specifics of the tourism and recreation activities in such areas?

The proposed steps to reach the final sustainable tourism development model are:

- identification of tourism and recreation environmental impacts,
- field water pollution analysis, trail erosion estimation, defining areas of endangered species,
- identification of mountain hut equipment in terms of energy sources and waste water drainage,

- interviewing tourism and recreation stakeholders focusing on the awareness about the negative environmental tourism impacts,
- statistical analysis on visitors,
- types of tourism activities and their expected environmental impacts.

The result of the combination of the mentioned indicators is the model of environmental impact assessment of tourism and recreation in mountain areas. The final sustainable tourism development model includes geographic conditions as well as the impacts and development demands of tourism and recreation.

The sustainable tourism development planning in mountain areas as well as in all types of protected areas should base on the analysis of the environmental carrying capacity that poses the limitations to development of different tourism and recreation activities.

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Conclusion

International cooperation of scientists and dissemination of knowledge and researching experiences is one of the most important objectives in present internationally orientated project. The role of protected areas in the context of sustainable local and regional development acquires great importance. Development of protected areas merely depends on the management but the crucial development role should be recognized and supported from the local population. Therefore the protection is of great importance for future development, if it is accepted and supported by local population, if they are well aware of local/regional development potentials and if the social capital and human resources are present and developed.

The future development of rural areas should base on the fact of the highly preserved natural and cultural environment as a competitive development advantage and main potential for encouragement of endogenous regional development.

The primary objective of the international project was to stimulate the cooperation of universities and diverse groups of scientists. Project "Sustainable environment research: promoting international cooperation and mutual assistance in natural parks', in which geographical research institutions from three Central European countries: the Czech Republic, Austria and Slovenia took part, represent a model of future cooperation of scientists. Namely, each of the cooperating research groups studied in greater detail and presented the concepts of their protected areas operation (at the national/regional level) and presented different methodological approaches to the evaluation of natural and socio-geographic features and processes in these areas on the example of a sample protected area. This can, in a long run, present expert bases for the planning of their future sustainable development. In addition, presentations of sample protected areas and effects of the previous management and the use of space enable researchers to check methodological bases for the present and future researches. Confrontation of different methodological approaches can indicate a more harmonized future monitoring of processes in protected areas not only in the cooperating three countries but also in other countries in EU.

The publication is one of the first outcomes of the joint project, which sum up the general purposes of natural park protection in the participating countries, describing the geographic settings of the investigation and field work areas, and, documents the specific activities in the nature conservation areas.

In the fist part of the publication the different concepts and of nature protection and areas in the Check Republic, Austria and Slovenia were listed and documented. Different conservation aspects embedded in different cultural and natural landscapes requires specific levels of protection within local, governmental (e.g. state and country level of natural parks), European (NATURA 2000) and international (National Parks) law.

The second part of the publication is focused on case studies of the three nature conservation areas and the specific research approach of the involved project partner. All case studies are introduced by a geographic description of the region.

The Natural Park Bystřice River Valley is settled nearby Olomouc in the Check Republic and represents a landscape along a river system, which is eroded into the higher Bohemian Massif. The Park consists of forest cover, agricultural land, and quite a number of settlements (including traditional industries and mining activities). NATURA 2000 area of Hohentauern (Austria) is embedded into the Niedere Tauern (upper part of Styria) and represents a conservation area in the eastern part of the Alps. The high mountain environment is intensively used for recreation (alpine tourism and skiing). The Triglav National Park in Slovenia is an example for a National Park status and represents a mainly calcareous environment, where alpine tourism plays an important role in the conservation.

The following research programs and approaches were applied and described in selected case studies:

Natural Park Bystřice River Valley (Czech Repuplic)

"Geographical description of Natural Park Bystřice River Valley" gives a geographical overview about the natural park.

"Sustainable topoclimatical research" deals with the geographic location in respect to the climate, a documentation of the climatological measurement net, the observation methods and measurement with stations and the data acquisition along different cross sections.

"The application of GIS in sustainable topoclimate research" focuses on two main problems/topics: (1) The general data acquisition situation of topographic information, GIS data and Remote Sensing and photogrammetry data in the Check Republic and the acquisition of field data and different thematic information. (2) The second topic deals with the documentation of GIS analyses for topoclimatical research. Different geographical data were processed within GIS techniques. To obtain data, map products and information about the climate parameters in the natural park area.

The case study: "Sustainable hydrologic research" documents the analyses of hydrological features and parameters to understand the runoff conditions in the park drainage system. This case study was applied with GIS techniques including a setup of unique database for land use and land cover changes.

NATURA 2000 area of Hohentauern (Austria)

"Investigation area of Hohentauern" introduces the Austrian case study area.

"The demand of geospatial data integration" within GIS and Remote Sensing environment is discussed in the first part of the case study. GIS and Remote Sensing application, which were carried out within different research projects and teaching activities in the investigation area of Hohentauern.

"GIS Applications" focuses on the current research topics (varying form natural to human induced landscape features and processes) are listed, and selected topics and results presented. (e.g. the analyses of the GIS approach to asses mountainous landscapes in term of tourism).

The “Remote Sensing Applications” focus on the (1) visualization of geomorphologic features in forested areas by means of laser scanning. This case study is embedded in a large project and documents mapping of late glacial moraines and other related features with a laser scanning based digital terrain model within a dense forest canopy. The second application deals with LANDSAT – Nightpass images – the application for climatic regional planning in a high mountain region.

“Climate and landuse planning in the region of Hohentauern/Styria” documents the creation process of a climatologically landuse plan (climate suitability map), the basic concept of whole Styria and the specific map/plan in the case study area.

“GIS-based modelling of mean annual precipitation (1997-2000)” deals with the regionalization of mean annual precipitation in Upper Styria by means of GIS techniques.

Triglav National Park (Slovenia)

“The geographic characteristics and significance of Triglav National Park as a principal protected area in Slovenia” is the first part of the Slovenian case study.

“The climatic data acquisition issues in mountain areas” deals with meteorological parameters in the investigation area. Two methods dealing with (1) the snow water equivalent measuring method and (2) measuring of temperature conditions in dolines and other concave relief shapes in mountain areas are presented in this study.

The next part of the case study deals with the “Geographic information sources for Triglav National Park” in general and with specific complex measuring of the circumstances of living in the area of Triglav National Park.

The “Demographic vitality of population as an important development potential of protected areas” assists the prediction of future demographic and regional development of settlements and regions, too.

“Sustainable tourism development in mountain areas” is focused on the creation of a sustainable tourism development model, which includes geographic conditions as well as the impacts and development demands of tourism and recreation.

The project handling put together experts from geographical workplaces at Palacky University of Olomouc (Czech Republic), Karl-Franzens University of Graz (Austria) and University of Ljubljana (Slovenia). During mutual assistance it appeared that all partners dispose with approachable, large-scale and for environmental researches suitable geospatial digital databases. Their compatible formats allow application a lot of methodological environmental approaches, and in particular well comparison of issues. Main goal of project solution can be seen in the fact that despite of dissimilar approaches to sustainable environmental research exist many ways for joint research work.

To start benefit exchanges as scientific staffs as students seem to be very actually for the future. For example, in 2007, the group of geography students from Karl-Franzens University of Graz carried out field exercises and work in the Natural Park Bystřice River Valley area. The topics of field work deal with data acquisition and management of geospatial data (GPS, GIS and Remote Sensing).

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