HABIT-CHANGE

(First) draft of indicators

30/11/2011

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1. Introduction, objective and method

1.1. Introduction

The “First draft of indicators” is defined as Output 3.1.4 in the project application of HABIT-CHANGE. Its goal has been, to identify pressures and impacts of climate change and human activities on habitats in the protected investigation areas. Since the preparation of this output has been delayed, and meanwhile several other indicator-related outputs have been compiled, the aim of this output has been readjusted. Output 3.1.4 now comprises an analysis of current monitoring activities and it picks up the indicator-related results of all other outputs of HABIT-CHANGE, results from questionnaires and contributions of the investigation areas. These already existing results were integrated, regrouped and sorted to provide a basis for the preparation of the Climate Change adopted Management Plans (CAMPs, Action 5.3) and the setting of the SDSS – Spatial Decision Support System (Action 5.1 and 5.2). This output contains a first draft of this comprehensive indicator-set with single pieces of information still missing in some columns and rows. These missing data is planned to be added within Action 5.2.

Output 3.1.4 is presented as a report including the status quo of projects and research activities in various investigation areas related to indicators for pressures, impacts and monitoring, and a comprehensive chart with indicators for pressures and impacts in the investigation areas. The Appendix further includes three detailed contributions about indicators applicable for Biebrza National Park in Poland, and four maps regarding National Park Bucegi mentioned in the report.

1.2. Objective

Output 3.1.4 provides a comprehensive overview on climate change and human induced pressures on protected areas and their habitats as well as resulting impacts for habitats reported from the investigation areas. Main aim is to

- group pressures and impacts in a comprehensive way,
- map the “Pressure-Protected area-Impact-Habitat chains” as complete as possible as a basis for the preparation of CAMPs and the SDSS (WP 5),
- include instructions how to monitor the pressures and impacts and further remarks, thus the comprehensive chart could be used as an informative reference work.

1.3. Method

Different sources have been used to compile the information for the comprehensive chart.

Evaluated Outputs of HABIT-CHANGE:

- 3.1.2 – Stakeholder Dialogue,
- 3.1.4 – Estimating usefulness of faunistic indicators for the assessment of habitat vulnerability to climate change within a protected area – List of potential faunistic indicators related to climate change within the area of the Biebrza National Park,
3.1.4 – Indicators of habitat and landscape changes in protected areas (on example of the Biebrza National Park) in view of climate changes,

3.1.9 – Report on actual habitat types and potential conflicts – Natural Park Bucegi,

3.2.2 – List of climate-change induced and related pressures on protected areas,

3.2.4 – Report and maps with potential forest habitat changes,

4.1.3 – Indicators for forest ecosystems,

4.1.4+4.1.5 – Alpine Habitats – Nature Park Rieserferner Ahrn. Combined report on: Action 4.1.4 Potential Pressures, Action 4.1.5 Indicators for NATURA 2000 reporting,

4.3.1 – Report on indicators for change on landscape and habitat level – draft,

4.3.1 – Selected landscape and habitat level indicators of climate change in the Biebrza National Park (BNP),

4.3.2 – Report on monitoring techniques,

4.3.3 – List of selected applicable indicators,

4.5.1 – Report on: 4.5.1. List of Indicators.

Evaluated posters from the 3rd partner meeting in Portorož:

- Balaton Upland National Park,
- Biebrza National Park,
- Danube Delta Biosphere Reserve,
- Flusslandschaft Elbe – Brandenburg Biosphere Reserve,
- Körös-Maros National Park,
- Lake Neusiedl/Fertő-Hansag National Park,
- Natural Park Bucegi,
- Rieserferner Ahrn Nature Park,
- Sečovlje Saline Nature Park,
- Triglav National Park and
- Vessertal-Thuringian Forest Biosphere Reserve.

Evaluated questionnaires filled in by all the project partners and associated partners with information about regional and local pressures and impacts relevant for the investigation areas.
Three contributions of the Biebrza National Park compiled especially for this output have been evaluated also: (1) “Estimating usefulness of faunistic indicators for the assessment of habitat vulnerability to climate change within a protected area. List of potential faunistic indicators related to climate change within the area of the Biebrza National Park” by Arkadiusz Gawroński Frugile, (2) “Indicators of habitat and landscape changes in protected areas (on example of the Biebrza National Park) in view of climate changes)” by Leszek Kucharski, (3) “Review of the Polish literature on climate scenarios and projections and Participation in preparatory works on cc impact indicators on ecosystems” by Małgorzata Liszewska.

For tracking back the sources of information every row of the comprehensive chart name the sources of information used, thus the original documents can be consulted for further information.

**Definition of terms**

In this output the term “pressure” is used similar to the term “difficulties” in the output 3.2.1. The terms “pressure” and “impact” have been used according to the definition in the HABIT-CHANGE Glossary (http://www.habit-change.eu/index.php?id=187):

**Definition Pressure**: “In HABIT-CHANGE pressures are defined as consequences of human activities which have the potential to cause or contribute to adverse effects (impacts). Examples for pressures are release of chemicals, physical and biological agents; human induced climate change; extraction and use of resources; patterns of land use. Pressures can be separated in CC related pressures and non-CC related pressures. Pressures are answering the question: What is the physical cause of adverse changes of habitats?”

**Definition Impact**: “Following the IPCC definition (climate) impact is the ‘consequences of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts.

• Potential impacts: All impacts that may occur given a projected change in climate, without considering adaptation.

• Residual impacts: The impacts of climate change that would occur after adaptation’ (2001, p.989).

The term impact is used in the DPSIR concept and the vulnerability concept of the IPCC. In HABIT-CHANGE the term impact is used as link between the DPSIR concept and the vulnerability concept. In this project an impact is considered a change in the state of a system caused by pressures like climate change or land use. HABIT-CHANGE is focused on environmental impacts (esp. on habitats). The assessment of economic impacts on ecosystem services or their life supporting abilities (ecosystems functions) is not considered main interest of HABIT-CHANGE.

Climate impacts may be positive or negative. They can be the result of extreme events or more gradual changes in climate variables showing either directly or indirectly effect. Examples for direct impacts are changed abiotic conditions (e.g., soil moisture) for protected habitats. Examples of indirect impacts are changes of agricultural practices due to increasing drought stress. Already observed impacts of CC on protected habitats should be monitored, while modelling will provide insight in new impacts.
(Climate) impact is answering the question: How will protected habitats react to climate change and what changes are likely to happen?"

In this output the term “parameter” is used in the same way as in Output 4.4.3 and similar but also slightly different as in the Outputs 4.3.3 and 4.5.1. In this output the term “indicator” is used similar but also slightly different as in the Outputs 4.3.3 and 4.5.1. The terms “parameter” and “indicator” have been intended to be used according to the definition in the HABIT-CHANGE Glossary (http://www.habit-change.eu/index.php?id=187):

**Definition Parameter:** “In HABIT-CHANGE a parameter is defined as attribute of an object. A parameter can be measured or assessed in qualitative or quantitative terms. Parameters are considered raw data. There are several parameters that are regularly monitored (e.g., soil moisture, water discharge, species abundance). Parameters can be used for/as part of indicators to measure variables. Parameters are answering the question: What is the qualitative or quantitative condition of a facet of an object like at a given time?”

**Definition Indicator:** “In HABIT-CHANGE an indicator is defined as a selected quantitative or qualitative parameter or set of such parameters which is combined with a regulation how to do the measurement or assessment. Indicators should be combined with values and if available also with thresholds. They include a dimension unit, if a quantitative assessment is possible. Indicators can be used to measure and describe the characteristic of a phenomenon/system/habitat of study (variable) or the impact of a pressure or a response. They need to be target oriented (e.g., able to assess changes). Indicators of climate change and land use change on habitat level need to be:

- responsive to habitat development,
- easy to obtain and understand, and shall
- indicate other and larger scale processes, and should be
- quantifiable.

An indicator is answering the question: How can characteristic and change of an environmental phenomenon or a habitat be measured and described?”
2. Status Quo of projects and research activities in investigation areas related to indicators for pressures, impacts and monitoring

In this first part of the report the information obtained from questionnaires filled in by the investigation areas is compiled in an abstract per investigation area. The focus lies on user related indicators. It was the intention to evaluate already existing monitoring and management programs in the investigation areas. Indicators should be scanned out of monitoring concepts and reports, which are already in use.

Structure (Status Quo of each investigation area):

What has been done? (Research reports)
What happens currently? (Monitoring programs and indicators)
What is planned? (Management plans and indicators)

Information was obtained from the investigation areas:

- Balaton Uplands National Park
- Natural Park Bucegi
- Danube Delta Biosphere Reserve
- National Park Fertő-Hanság
- Lake Neusiedl National Park
- Rieserferner-Ahrn Nature Park and
- Vessertal-Thuringian Forest Biosphere Reserve.

2.1. Balaton Uplands National Park

2.1.1. What has been done?

The Balaton-felvidéki National Park mainly consists of six separate landscape protection areas, which were united in 1997. It assembles now an area of 56,997 hectares. Parts of it are declared as Nature 2000 areas and Ramsar sites. Hydrological and meteorological surveys and a vulnerability study for the Lake Balaton were carried out. In 2008 an indicator system with ecological, economic and social parameters was developed. This system contains special indicators for measuring climate change like water temperature, wind speed and air temperature in connection with biological parameters like algal biomass, composition of fish species etc. A case study was carried out to test a framework for regional scale habitat-based vulnerability assessment of natural and semi-natural ecosystems (Czúcz et al., 2008).
2.1.2. **What happens currently, what is planned?**

Over 430 ha of wetlands will be restored by water retention from precipitation. By the end of the project, the restored hydrology of the area should provide the ideal microclimatic conditions to help these wetlands recover in the dry pannonic climate. At the same time, scientific monitoring will lay the basis for the long-term maintenance of the rehabilitated areas. As a part of the monitoring the aim of our measurements is to detect the special microclimate features of the study area using vertical profiles of climate elements (Szegedi et al. 2006).

The “Indicator System for the Lake Balaton Region” serves as an adequate basis for a climate change related indicator system. For the region of the National Park it seems sufficient.

### 2.2. Natural Park Bucegi

#### 2.2.1. **What has been done?**

Bucegi Natural Park, part of Romsilva – The National Forest Network, protected area since 1990, and Natura 2000 site since 2007, lies on a surface of 32,497.6 ha located between 800 – 2,507 m altitude.

The Natural Park Bucegi is structured into four protection zones: 12.55 % - highly protected, 23.14 % - fully protected, 58.19 % - sustainable managed and 6.10 % - human activities sustainable development. The protected area functions on the bases of a Management Plan (that renews every 5 years) and defines the 11 general management sectors and also the 15 management units that target the strict and integral protected area.

In these last years a special attention was shown to the evaluation of all natural resources exploitation activities with negative impact on the biologic diversity. In this respect, to monitor the grazing activities two papers were written:

- Măruşca T 2006. Îndrumarul metodologic de gospodărire ecologică a pajiştilor în ariile protejate (Methodologies for the ecologic management of meadows in protected areas”), AGRAL Project 319/2006, ICDPP Braşov.

- Studii, metode şi ecotehnici de gospodărire durabilă a păşunilor din Parcul Natural Bucegi (Studies, methods and ecotechnics for the sustainable management of grazing lands in Bucegi Natural Park), contract no 318/2004, ICDPP, Braşov.

Ecological reconstruction of degraded grasslands was another significant topic for the research activity. In this respect two scientific publications were developed:


In 2003 the general map of Bucegi Natural Park was printed at a scale of 1:50,000.
During the last years, all activities made for the identification and mapping of the habitats and species as presented in the annexes of the Habitat’s Directive, made in cooperation with the Romanian Academy and with Special Research Institutes, became of major importance.

In this respect GIS data base was initiated, for habitats and species, and various maps drawn for the existing resorts, types of soil, arboretum and the forest habitats (Map 1, Map 2, Map 3, Map 4 – see the attach files).

2.2.2. What happens currently? What is planned?

A current and future concern is represented by the mapping of habitats and the monitoring of the species included in the annexes of the Habitat’s Directive.

We remark in this respect the project “Managementul speciei urs brun (Ursus arctos arctos) şi diminuarea conflictelor dintre om-urs în Parcul Natural Bucegi ca zonă model şi pentru alte arii protejate” (The management of the brown bear species (Ursus arctos arctos) and the ease of the human – bear conflicts in Bucegi Natural Park as landmark and also in other protected areas), POSDRU “Environment” (2010-2012), that has among objectives to monitor of the number of bears and to determine the support capacity of the habitats used by bears.

To continue of the ecosystem monitoring activity, to update the GIS data bases and to use the information in the management decisions and in the application of protected measurements for the plants and animals, habitats and species of community interest, represent concerns for both present and future.

To all these we can add a periodic re-evaluation of the level reached by the exploitation activities of the natural resources (forests, grasslands), responsible factor together with the climatic and environmental changes for the changes of the biological diversity.

2.3. Danube Delta Biosphere Reserve

2.3.1. What has been done?

This reserve is participating following environmental networks (since 1990): RAMSAR, UNESCO Natural and Cultural World Heritage, UNESCO “Man and Biosphere” (MAB) and it is a member of the international organizationsEUROSITE and EUROPARC FEDERATION. Cooperation agreements were signed with 12 other similar wetlands. A Danube River Basin District Management Plan (DRBM Plan) was published in 2009 by the International Commission for the Protection of the Danube River (ICPDR). A description of direct and indirect climate change impacts, plus a list of climate change projects relevant to the DRBD is included.

International projects and conventions:

PHARE Project CBC RO 2004 /016.942.01.01 “Integrated system for monitoring the environment factors, the biodiversity and natural resources from the Danube Delta Cross border Biosphere Reserve Romania/Ukraine” (2006-2008)
Project „Danube Delta – Landscape of the year 2007 - 2009”

PHARE Project CBC RO 2005/017-539.01.01 „Cross border cooperation demonstrating the multiple use and benefits of wetlands restoration (in Zagen and Stensovsko Zhibrianskie Plavni Polders) in Danube Delta Cross border Biosphere Reserve Romania/Ukraine” (2007–2009)

Scientific Publications (examples; exclusive books, maps and PhD thesis):


2.3.2. What happens currently?

Integrated Monitoring Program of the biosphere reserves:

The selection of the domains and parameters of the integrated monitoring system is based on causal concepts, aiming the identification of impact factors that could determine the lack of balance of the Danube Delta systems. The selected domains included in the integrated monitoring system are: climate and air quality, hydrology, hydrobiology, water quality, soil quality, biodiversity, natural resources, economic activities and human population. For every one of these domains, key-parameters were identified and monitored in order to allow gathering information with maximum efficiency.

International projects:

DANUBEPARKS – Danube River Network of Protected Areas – Development and Implementation of Transnational Strategies for the Conservation of the Natural Heritage at the Danube River. Danube
Delta Biosphere Reserve Authority applied within South East Europe (SEE) Transnational Cooperation Programme 2007-2013.

“Integrated Information System – Support for DDBRA Management to Improve the Conservation Status of Ecosystems”

Ramsar Initiative for Black Sea Coast Wetlands/ Black Sea Coast Wetland Initiative (BlackSeaWet) 2009-2012.

Ongoing Projects:

National:

MORFDD - New and innovative model used as scientific tool in decision making on protection and ecological reconstruction of wetlands and preservation of protected areas based on mathematical modelling of morphohydrography and water quality (Project leader - Dr. Eugenia Cioaca) www.ddni.ro/morfdd

NARDUS - Inventory of natural grassland with high biodiversity value in order to scientifically support the management measures for their protection (Project leader - Dr. Jenica Hanganu) - www.ddni.ro/nardus

International (as partner in projects financed by the European Commission):

EU Framework Programme VII

EnviroGRIDS - Building Capacity for a Black Sea Catchment Observation and Assessment System supporting Sustainable Development (2009-2013) Theme 6 - Environment (including climate change)

TESS - Transactional Environmental Support System (2008-2011) Theme 6 - Environment (including climate change) http://www.tess-project.eu

EU Framework Programme VI


2.3.3. What is planned?

Implementation of the Danube River Basin District Management Plan, as a forecast the “action Plan” for 2009-2012 is published.

2.4. Fertő-Hansag/Lake Neusiedl National Park

2.4.1. What has been done?

The Fertő/Neusiedler See National Park is appointed UNESCO Biosphere Reserve, European Biogenetic Reserve, IUCN National Park and a World Natural Heritage site.
The local water directorate (North-Transdanubian Environmental Protection and Water Directorate) has made regular water quality, water quantity (hydrology) and meteorological measurements in the Hungarian part of Lake Neusiedl, while the local national park (Fertő-Hanság National Park) has carried out different fish ecological, ornithological, faunistic and botanical monitoring. The change of the reed belt was classified/qualified in several times too. The last map about the reed-belt was updated in the year 2007. The result of vegetation-mapping in NATURA 2000 areas was published by Fertő-Hanság National Park in 2009.

In the past over 600 ha of salt marshes/wetlands were restored by the local national park to improve the diversity and habitats.

In 2001 a framework plan for maintainable development and preservation of the ecological potential of Hungarian Lake Neusiedl and its environment was made. Ten years later, in 2010 a “Rábca and Fertő Sub-Basin District Management Plan” was published. Furthermore the Fertő-Hanság National Park has got a 6-years (2009-2014) development plan.

Some international projects, studies:

2004-2007 – LAKEPROMO project. The main object of the project was to promote international and multilevel cooperation in the field of water management.

2008 – Hungarian-Austrian-Finnish research cooperation to analyse the wind-induced hydrodynamics and sediment transport of Lake Neusiedl ("Dr. Józsa J. et al. (2008): Wind-induced hydrodynamics and sediment transport of Lake Neusiedl – Hungarian-Austrian-Finnish research cooperation from lake-wide to bay-wide scale").

2010-2011 – Hydrological study to support the new operational regulation of the sluice gate Fertőszél. According this new regulation the water-level of the lake (datum level) was raised with 10 cm.

2.4.2. **What happens currently?**

The above mentioned monitoring programs are still in progress.

2009-2012 – TRANSECONET – Transnational Ecological Networks in Central Europe. “TransEcoNet elaborates strategies and gives recommendations how to develop and manage transnational ecological networks in Central Europe. In particular the focus is on less or unprotected landscapes, so-called gaps, between protected areas.” (Hahn, 2010)

In the frame of the GeneSee project the whole lake Neusiedl and Hansag-channel will be surveyed geodetically. The result of this project will be a new high-resolution digital relief model.

2.4.3. **What is planned?**

Implementation of the published sub-basin management plan.
2.5. Lake Neusiedl/Fertő-Hansag National Park

2.5.1. What has been done so far?

The Austrian national park administration has worked out a “Short Version” of the Management plan for National Park Neusiedler See – Seewinkel (Kohler & Korne 2006) which provides a prospective overview of the final document. This document was planned to be published in 2007 already, but the necessary decision of the managing board on content details and implementation aspects is still missing.

In May 2011 an extensive mapping of vegetation types according to the Habitat Directive was completed for the whole district of Burgenland including the Austrian areas of Lake Neusiedl/Fertő-Hansag National Park.

Research reports were produced in 2004, 2006 and 2008, establishing mainly two priorities: ornithology, and a longtime-monitoring (1990-2007) of the pasturing program (with vegetation-ecological and faunistic methods), but also a fish-ecological monitoring was performed on a regular basis. In the last report (2008) one part was devoted to “Monitoring and Management of wild animals”.

Lists of mammals, amphibians, reptiles and birds had been published, but are rather out-dated, as the literature referred dates back in part as far as 1989. The “Bird Check List” dates back to 1996. Anyway, especially the ornithological monitoring produces the highest number of publications every year.

In Nemeth (2011), „Monitoring der in Kolonien brütenden Schreitvögel des Neusiedler Sees. (Monitoring of breeding colonies of Ciconiiformes from Lake Neusiedl, published by Naturschutzbund Burgenland), the author concludes that the increase in the population of the Great Egret (Egretta alba) and the appearance of the Purple Heron (Ardea purpurea) and the Pygmy Cormorant (Phalacrocorax pygmaeus) could be a result of the global climate warming.

Several publications concerning the ornithological monitoring were published in the current journal of Birdlife Austria, „Egretta“– some addressing climate change. For example in Egretta 51 (2010):


The authors of the latter study conclude that the breeding season of the Eagle Owl in the whole area (Mostviertel, Lower Austria) started on average 10 days earlier than at the start of the study period in 1986. At the Alpine foothills, it even started two weeks earlier on average.

2.5.2. What happens currently?

At large, many different management actions take place seasonally and at need. Although no official management plan has been published yet, an annually adapted working programme is approved by the board directors, but this regulation is for internal use only.
The highly specific meadows and pastures management is monitored and continuously adjusted year by year. The current research project is called the “Vegetation Ecological Pasturing Monitoring”. But others are mentioned also: among them the “Monitoring and Management of Wild Animals” has not been continued, but the “Fish Ecological Monitoring at Lake Neusiedl”, and the “Ornithological Monitoring”, as well as the ground- and surface water quality monitoring are still in progress.

As the preservation of the saline habitats is of very high importance, it is obvious that regular measures are based on specific indicators. Groundwater level and water retention are measured in relevant areas, in cooperation with the local holders of water rights.

Another program, TRANSECONET – Transnational Ecological Networks in Central Europe, which is a CENTRAL EUROPE project also – is already described above (chapter 2.4.2.). It will be finished April 2012.

At the same time many other research programs and projects are in progress. On the regional level, the Austrian Programme for Rural Development, which runs from 2007 until 2013, finances the Society for Support of Regional and Agricultural Projects (“LEADER”). “PaNaNet”, the Pannonian Nature Network, financed by the European Territorial Cooperation- Programme (ETZ AT-HU, ERDF) is active until 2013.

The EULAKES project (European Lakes Under Environmental Stressors) is part of the CENTRAL EUROPE Programme too, and aims at the support of governmental departments responsible for Lake Neusiedl, to mitigate the impact of climate change. This project is carried out by the AIT, the Austrian Institute of Technology, together with the Naturschutzbund (Nature Protection Association) Burgenland, and terminates in 2013.

All projects facilitated by the national park administration are carried out together with the Department for Hydraulic Engineering of the Province of Burgenland, in cooperation with the landowners. The goal is to re-establish near-natural conditions in the dry Seewinkel area and to slow down the water run-off, mainly caused by drainage channels for agriculture, as much as possible.

The goal of connecting habitats through fallow areas, supported by the ÖPUL-programme – a programme of provincial government subsidies (Landscape Maintenance Fund), which ends after 2013 – is threatened to be missed. This could cause increased isolation and fragmentation of the landscape and its habitats in the future.

2.5.3. What is planned?

A stepwise regulation of the management, its compilation in an official management plan and the successive publication of this plan, will only be possible, when the current development of the whole area according to the specifications of the European Water Framework Directive will be realised.

A project on the “Development of high-precision and high-resolution digital relief model in the area of the Austrian-Hungarian Neusiedler See-Seewinkel/Fertő-Hanság National Park” is still in the design stage. It is also planned to compile all monitoring reports and related documents produced in cooperation with the National Park, and to make them available in digital format in the NP Centre.
2.6. Rieserferner-Ahrn Nature Park

2.6.1. What has been done?

A Natura 2000 Management plan has been developed and published; additionally studies on dragonflies, the vegetation of the bog and on permafrost soils were carried out.

Scientific Publications (examples; exclusive books, maps and PhD thesis):


Libella 2009, Odonatologische Erhebung im Naturpark Rieserferner-Ahrn.


2.6.2. What happens currently?

Land owners get premium for abdications of grazing in sensitive Natura 2000 areas. And several bogs are dammed to enhance the internal water supply.

2.6.3. What is planned?

Monitoring of the bog vegetation, the permafrost soils and the glaciers.

In this Nature Park the monitoring of permafrost soils and glaciers are used for measuring climate change. Also the vegetation of the bogs can conclude to climate change.

2.7. Vessertal-Thuringian Forest Biosphere Reserve

2.7.1. What has been done?

The Vessertal is an UNESCO biosphere reserve surrounded by the Thuringian Forest nature park, 90% of the area is covered by forest. Many groups of plants and animals have been inventoried and the hydrology and biology of the Vesser River has been studied in detail. Since 2003 there is an annual expert conference on biodiversity, conservation, cultivation etc. Since 2002 environmental quality goals are defined and serve as background for further activities. There are more than 140 measure points for monitoring abiotic parameters and three permanent forest monitoring areas.
2.7.2. What happens currently?

Three permanent forest monitoring sites were installed to track possible changes in plant species composition in the core zone of the reserve. Additionally, there are several measuring points for parameters like water gauge, air pollution, acidification etc. are distributed around the reserve area.

Scientific Publications (examples; exclusive books, maps and PhD thesis):


2.7.3. What is planned?

Extension of the biosphere reserve area (now 17,000 ha) as such reserves should have at last 30,000 ha in Germany; Monitoring of the three forest sites and the several measuring points for abiotic parameters.

The forest sites for vegetation monitoring and the measuring points for abiotic parameters provide for sufficient climate change indicators.
3. Comprehensive chart with indicators for pressures and impacts in the investigation areas

The following chart comprises indicator-related results from questionnaires and contributions of the investigation areas and provides a basis for the preparation of the Climate Change adopted Management Plans (CAMPs, Action 5.3) and the setting of the SDSS – Spatial Decision Support System (Action 5.1 and 5.2).

<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Measuring instruction</th>
<th>Unit</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types relevant for HABIT-CHANGE</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure E, R</td>
<td>Climate, Air</td>
<td>Radiation</td>
<td>Duration of shining of the sun, Global solar radiation (10-years, annual, monthly, daily average)</td>
<td>Time, [h, Kcal/cm²]</td>
<td>-</td>
<td>CC</td>
<td>BRF TIF, DDBR</td>
<td>BR VTF, DDBR</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, 4-3-3 : Indicators outline_5_2ndVers.doc, HABIT-CHANGE_4_3_2_monitoring_techniques_2011-01-31.pdf</td>
<td>EIRAC (RANP): “Future projections for the Province show a clear warming trend in all seasons with a more pronounced warming after 2030. Temperatures increase until 2050 between +1°C and +2°C (up to +2.8°C in summer), “rather robust parameter” BNP: is a main indicator of climate change tendency and impact, a main characteristics determining growing season for vegetation, time of bird nesting and breeding, and the like.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Air</td>
<td>Temperature</td>
<td>Mean surface air temperature (Changes within a specific period, for e.g. 10-years, year, season, month, 10-days, day), Average of July and January (SNNP)</td>
<td>[°C]</td>
<td>depends on habitat type</td>
<td>CC</td>
<td>BNP, BR VTF, BUNP, DDBR, FHN, KNMP, LNNP, TNP</td>
<td>HABIT-CHANGE_4_1_4+4_1_5_alpine_habitats.pdf, Table_Indikatoren_DPSIR.xls, Consolidated_indicators_PIK_2011-05-31.doc, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, 4-3-3 : Indicators outline_5_2ndVers.doc, HABIT-CHANGE_4_3_2_monitoring_techniques_2011-01-31.pdf</td>
<td>BNP: •Mild winters, •Reduction of snow per season, •Earlier start of growing season (marked in SNM), •Later end of growing season (marked in SNM). “rather robust parameter”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Air</td>
<td>Temperature</td>
<td>Air temperature with thermometer, Climate station, Depending on size and steps, ca. 1 station/30 km², 2 m above ground, Continuous or hourly</td>
<td>[°C, number, days]</td>
<td>depends on habitat type, growing season: [°C &gt; 5 and forest, °C &gt; 10], Heatwave: mean T &gt;= 27 °C for x &gt; 3 or mean T &gt; 25 °C for x</td>
<td>X (PIK)</td>
<td>CC</td>
<td>BNP, BR VTF, BUNP, DDBR, FHN, KNMP, LNNP, TNP</td>
<td>Consoliated_indicators_PIK_2011-05-31.doc, HABIT-CHANGE_4_1_4+4_1_5_alpine_habitats.pdf, Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, 4-3-3 : Indicators outline_5_2ndVers.doc, HABIT-CHANGE_4_3_2_monitoring_techniques_2011-01-31.pdf</td>
<td>EIRAC (RANP): Growing season: Period of year when the daily mean temperature is above 5°, “All indicators indicate a clear trend toward a prolonging of growing season between 18 and 43 days. This is expressed by an earlier start as well as a later end of growing season.” “quite robust indicator” BucNP: •Mild winters, •Reduction of snow period and amount</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<table>
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<tr>
<th>DPSIR category</th>
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<th>Unit</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitats types (relevant for HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure E</td>
<td>Climate, Air</td>
<td>Climate balance</td>
<td>high variation of temperature over the same day (BusNP)</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td>CC</td>
<td>Consolidated_indicators_PIK_2011.xls, HABIT-CHANGE_4_5_1_weaker_indicators_final.pdf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Air</td>
<td>Wind</td>
<td>Wind speed (average, maximum, changes within a specific period, duration)</td>
<td></td>
<td>[ms, kmh]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td>BR VTF; DDBR; FHNP; LNNP</td>
<td>Consolidated_indicators_PIK_2011-05-31.doc, HABIT-CHANGE_4_5_1_weaker_indicators_final.pdf, HABIT-CHANGE_4_3_2_monitoring_techniques_2011-01-31.pdf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Air</td>
<td>Wind</td>
<td>Wind direction (average, range, changes within a specific period)</td>
<td></td>
<td>[degree, main geographic direction]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td>BR VTF; DDBR; FHNP; LNNP</td>
<td>Consolidated_indicators_PIK_2011-05-31.doc, HABIT-CHANGE_4_5_1_weaker_indicators_final.pdf, HABIT-CHANGE_4_3_2_monitoring_techniques_2011-01-31.pdf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Air</td>
<td>Wind</td>
<td>Storm, Tornado (extreme events, yearly or after storm events)</td>
<td>GIS-Polygon of damaged area, Field survey and remote sensing</td>
<td>[ha, km², number, kmh, value of Beaufort scale or Fujita scale]</td>
<td>-</td>
<td>CC</td>
<td>9410</td>
<td>BR VTF, BuNP, BUNP, KSNP</td>
<td>HABIT-CHANGE_shared_Habitat_matrix_2011-03-24.xls, HABIT-CHANGE_4_5_1_weaker_indicators_final.pdf, HABIT-CHANGE_4_3_3_indicators_bread.pdf</td>
<td>Special expertise regarding this habitat and a large proportion of this habitat in within the BR VTF.</td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Hydrologic cycle</td>
<td>Temperature, Frozen water</td>
<td>Depth and duration of snow cover (Snow cover maps derived with MODIS-Data Algorithm relating to different thresholds of indices and ratios; assessment of snow coverage dynamics and duration between years and within a year.)</td>
<td>Analysis of snow cover maps</td>
<td>[height of, days of]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td>BNP, BuNP, BUNP, FHNP, KSNP</td>
<td>Consolidated_indicators_PIK_2011-05-31.doc, HABIT-CHANGE_4_5_1_weaker_indicators_final.pdf, HABIT-CHANGE_4_3_1_indicators_bread.pdf</td>
<td>BNP: Provides information on moisture resources in soil and rivers at the beginning of growing season (length of). Provides information on the intensity of climate warming (frequency).</td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Hydrologic cycle</td>
<td>Temperature, Frozen water</td>
<td>Firn line (Changes within a specific period for alpine regions)</td>
<td>Assessment of firn lines from e.g. annual satellite data obtained over large areas, and calculation of the related glacier mass balance by comparison with results from distributed mass-balance models.</td>
<td>-</td>
<td>CC</td>
<td></td>
<td>BuNP, RANP</td>
<td>TNP</td>
<td>HABIT-CHANGE_4_3_1_indicators_landscape_and_habitat_level_2011-03-14.pdf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Climate, Hydrologic cycle</td>
<td>Temperature, Frozen water</td>
<td>Greater risk for avalanches according to the higher temperatures in winter</td>
<td>Thermometer, Field observations</td>
<td>[°C]</td>
<td>-</td>
<td>CC</td>
<td>8120, 8130, 8160</td>
<td>TNP</td>
<td>Tablee_indicators_DPSIR.xls, HABIT-CHANGE_3_2_2_CC_induced-and-related_pressures_2011-05-05.pdf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Precipitation</td>
<td>Mean precipitation (Changes within a specific period, for e.g. year [key indicator = PK])</td>
<td>Climate station, Depending on size and slopes, e.g. 1 station/30 km² (in mountainous areas)</td>
<td>[mm, index]</td>
<td>X (PK)</td>
<td>CC</td>
<td></td>
<td>BNP, BR FEB, BR VTF, BUNP, BuNP, DDBR, FHNP, KSNP, LNNP</td>
<td>HABIT-CHANGE_4_1_4_1_5_alpine_habitats.pdf, Consolidated_indicators_PIK_2011-05-31.doc, Tablee_indicators_DPSIR.xls, HABIT-CHANGE_poster_Vesoul/BR BR</td>
<td>RANP: Precipitation shows a quite heterogeneous picture with no very clear trend. Amongst the A1B scenarios, precipitation tends to decrease in summer (5 out of 6 A1B scenarios, up to 51%). In winter a slight increase is visible. Spring and summer show no clear trend with parity.</td>
<td></td>
</tr>
</tbody>
</table>

[20]
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
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<th>Habitat types relevant for (HABIT-CHANGE)</th>
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<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Precipitation</td>
<td>Maximum of precipitation (Within a specific period, e.g., daily, monthly)</td>
<td>[mm]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Precipitation</td>
<td>Distribution of precipitation (annual, in successive years), Seasonality of precipitation</td>
<td>[index]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Precipitation</td>
<td>Heavy rains, strong rainfalls</td>
<td>[mm² in mm or h, number per a]</td>
<td>&gt; 5 l/m² in 5 min, &gt; 10 l/m² in 10 min, &gt; 17 l/m² in 1 h</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Precipitation</td>
<td>Drought and dry periods (Frequency of, Length of, Dry month, Month with dry/drought phenomena)</td>
<td>[consecutive days &gt; 3 with precipitation &lt; 1 mm]</td>
<td>- X (PK)</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Evaporation</td>
<td>Potential evaporation (Changes within a specific period)</td>
<td>[mm/d]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Evapotranspiration</td>
<td>Potential evapotranspiration (Changes within a specific period) (Amount of evaporation that would occur if a sufficient water source were available)</td>
<td>[mm/d]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Air humidity</td>
<td>Relative air humidity (Changes within a specific period)</td>
<td>[%]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure E</td>
<td>Hydrologic cycle</td>
<td>Air humidity</td>
<td>Nebulosity (Changes within a specific period)</td>
<td>[lens]</td>
<td>-</td>
<td>CC</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
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</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Hydrologic cycle</td>
<td>Water balance</td>
<td>[Difference of precipitation sum and sum of potential evapotranspiration] or [Water balance deficit (expressed as difference between precipitation and runoff)]</td>
<td>(Annual average)</td>
<td>[mm/ha, Mathemathic formula based on precipitation, temperature, wind, relative humidity, -- depending on how potential evaporation is calculated]</td>
<td>°C</td>
<td>-</td>
<td>CC</td>
<td>Consolidated_indicators_PK_2011-05-31.doc, Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4.1.4.4.1.5_sjekre_habitats.pdf, HABIT-CHANGE_4.5.1_selected_indicators_final.pdf, 4.6.2, Indikatoren._novelle_5._2nd_Vers.doc</td>
<td>BNP, BR VTF, BUNP, DDBR, FHNP, KMNP, LNNP, RANP, SNAP</td>
<td>BNP: site specific. Changes in local water balance (inflow/outflow, P-O) BUNP, KMNP: “Water balance deficit (expressed as difference between precipitation and runoff)” RANP: “There may be significant difference among the different projections, the maximum indicating an increase in the meteorological water balance up to 500 mm in 2050, while the minimum pointing to a decrease of about the same entity. This corresponds to the high joint uncertainty of precipitation and temperature/evapotranspiration projections, further magnified by the averaging of results over seasons. Although the expected value of variations tends to be zero, the range highlighted above indicates the possible local extremes of variations to be expected under climate change.” BR VTF: “CWBs of the growing season”</td>
<td></td>
</tr>
<tr>
<td>Pressure E, R, S</td>
<td>Hydrologic cycle</td>
<td>Surface water</td>
<td>Surface water temperature</td>
<td>(Changes within a specific period)</td>
<td>Monitoring gauges at relevant river reaches</td>
<td>°C</td>
<td>-</td>
<td>CC</td>
<td>Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4.5.1_selected_indicators_final.pdf, 4.6.3, Indikatoren._novelle_5._2nd_Vers.doc</td>
<td>BNP, BR VTF, BUNP, DDBR, FHNP, KMNP, LNNP, RANP, SNAP</td>
<td>BNP: Water warmer than average may affect metabolism in many species.</td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Hydrologic cycle</td>
<td>Surface water</td>
<td>Runoff/river discharge</td>
<td>(Changes within a specific period)</td>
<td></td>
<td>m³/s</td>
<td>-</td>
<td>CC, non CC</td>
<td>Consolidated_indicators_PK_2011-05-31.doc, Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td>BNP</td>
<td>BNP: Information on the rate of water loss from wetlands.</td>
<td></td>
</tr>
<tr>
<td>Pressure R, S</td>
<td>Hydrologic cycle</td>
<td>Surface water</td>
<td>Disselation by drainage channels</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>FHNP, LNNP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure R</td>
<td>Hydrologic cycle</td>
<td>Surface water, Coastal lagoons</td>
<td>Modification of hydrographic functioning, general, Channelization</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>non-CC, CC</td>
<td>1150</td>
<td>BR FEB, DDBR, KMNP</td>
<td>HABIT-CHANGE_3.2.2_CC_induced-end-related-pressures_2011-05-05.pdf</td>
<td>Conservation value: 4 (1-5 scale); Because of the impact produced by hydro-technical works, the characteristic lagoon conditions are modified (salinity, transparency and sedimentation). The salinity (“demarcation line” between fresh and salt water) can fluctuate daily due to wind conditions, which is similar to lagoon tide.</td>
</tr>
<tr>
<td>Pressure S</td>
<td>Hydrologic cycle</td>
<td>Surface water, Groundwater</td>
<td>Water level of rivers, canals, streams, lakes and Groundwater level</td>
<td>(Changes within a specific period, monthly, annual), (Caused by climate change or/and by water level management (Univ))</td>
<td>Height above/ below average water level, Groundwater: Observation well (Weekly to Monthly)</td>
<td>m, dm, ca</td>
<td>-</td>
<td>CC, non CC</td>
<td>BR VTF: “9100”, “9150” LNNP: 1530, 3140, 3150, 7210, 7230</td>
<td>BNP, BR VTF, BUNP, FHNP, KMNP, LNNP</td>
<td>HABIT-CHANGE_3.2.4_physical_forest_habitat_changes_2011-09-30.pdf</td>
<td>BR VTF: “Special expertise regarding this habitat and a large proportion of this habitat is within the BR VTF” KMNP: Water level of the Sieben-Körös River (pumped towards Biharungra, Szo-ri area to avoid its drying out). LNNP: In dry years the “Lacken” run dry early because of declining groundwater level. (Univ)</td>
</tr>
</tbody>
</table>

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[22]
<table>
<thead>
<tr>
<th>DPSIR category</th>
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<th>Habitat types relevant for HABIT-CCHANGE</th>
<th>Investigation area**</th>
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<th>Remarks</th>
</tr>
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<tbody>
<tr>
<td>Pressure S</td>
<td>Hydrologic cycle</td>
<td>Surface water, Groundwater</td>
<td>Flooding/inundation zone by inland water (Changes of size and duration within a specific period)</td>
<td>Area/number of days covered by inland water in habitats where it is undesirable</td>
<td>[m², ha, m, days, (height)]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BR FEB, BunNP, DDBR, KNMP, NP SES, SSNP</td>
<td>HABIT-CCHANGE; poster Flusslandschaft Elbe BR FEB 2005.pdf, Consolidated_indicators_PK_2011-05-31.doc, Tabelle_Indikatoren_DPSIR.xls, HABIT-CCHANGE_4_5_1_selected_indicators_final.pdf, HABIT-CCHANGE_5_5_2_CC_incurred-and-related-pressures_2011-05-09.pdf</td>
<td>BR FEB: “Extreme precipitation, as was experienced in August 2002 with locally more than 400 mm rainfall within 48 hours, will cause summer flooding events more frequently.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Hydrologic cycle</td>
<td>Groundwater</td>
<td>Depth of groundwater table (annual, monthly, weekly)</td>
<td>Permanent piezometers in cross- transects</td>
<td>[cm]</td>
<td>-</td>
<td>CC</td>
<td>BR FEB, BunNP, DDBR, KNMP</td>
<td>HABIT-CCHANGE_4_5_1_selected_indicators_final.pdf, HABIT-CCHANGE_3_2_2_CC_incurred-and-related-pressures_2011-05-09.pdf</td>
<td>BNP: Provides information on water availability/water deficit for plant communities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Hydrologic cycle</td>
<td>Groundwater</td>
<td>Underflooding</td>
<td>[ha (area), dm, m (height)]</td>
<td>-</td>
<td>CC</td>
<td>SSNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
<td>SSNP: “Underflooding reinforces swamp and salinization”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Hydrologic cycle, Land use</td>
<td>Rivers, Water management</td>
<td>Canalization, impoundment, dykes, walls, artificial barriers and other constructions for water regulation (Changes within a specific period)</td>
<td>(number, m (length), %)</td>
<td>-</td>
<td>non CC</td>
<td>RANP (Canalization) 3150, 3220, 3360, DBBR, RANP</td>
<td>Tabelle_Indikatoren_DPSIR.xls, HABIT-CCHANGE_4_1_3_1_alpine_habitats.pdf, HABIT-CCHANGE_poster Rheinfluenz AllNP EURAC.pdf, HABIT-CCHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>BR FEB: “Loss of natural floodplains. Effective land drainage in large sections of the river basin on the landward side of the dike deprives the groundwater level of the natural fluctuation and causes the drying out of habitat types dependent on groundwater.”</td>
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<tr>
<td>Pressure S</td>
<td>Hydrologic cycle, Land use</td>
<td>Rivers, Water management</td>
<td>Drainage/Melioration, water regime and accessible water quantity, Drainage and modification of the water courses by extracting gravels (BunNP), Dredging (DDBR) (Changes within a specific period)</td>
<td>[m³]</td>
<td>-</td>
<td>non CC</td>
<td>BNP, 7110, 7140, 7230, 91DI, 91BO, RANP 7140, 7240, BNP, BR FEB, BunNP, DDBR, KNMP, RANP, SSNP, TNP</td>
<td>HABIT-CCHANGE_delt_Habitatlist_matrix_2011-03-24.de, Tabelle_Indikatoren_DPSIR.xls, HABIT-CCHANGE_poster Rheinfluenz AllNP EURAC.pdf, HABIT-CCHANGE_4_5_1_selected_indicators_final.pdf, HABIT-CCHANGE_3_2_2_CC_incurred-and-related-pressures_2011-05-09.pdf</td>
<td>LNNP: Desalinization by several drainage channels. The ‘Lacken’ and marsh areas are drained by channels – thus they are not able to accumulate water in high-rainfall winter half-years for dry summer month (UnV)</td>
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<tr>
<td>Pressure S</td>
<td>Hydrologic cycle, Land use</td>
<td>Water management, Habitat</td>
<td>Management of aquatic and bank vegetation for drainage purposes</td>
<td>[ha]</td>
<td>-</td>
<td>non CC</td>
<td>RANP</td>
<td>HABIT-CCHANGE_delt_Habitatlist_matrix_2011-03-24.de</td>
<td>LNNP: Desalinization by several drainage channels. The ‘Lacken’ and marsh areas are drained by channels – thus they are not able to accumulate water in high-rainfall winter half-years for dry summer month (UnV)</td>
<td></td>
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<tr>
<td>Pressure S</td>
<td>Hydrologic cycle, Land use</td>
<td>Sea, Rivers</td>
<td>Management of water levels, Sea level rise</td>
<td>[cm (height)]</td>
<td>-</td>
<td>non CC</td>
<td>BNP, 3270, DBBR 3150, NP SES: 1410, 1420</td>
<td>BNP, DBBR, FHNP, LNNP, NP SES</td>
<td>DDBR: Conservation value: 5 (1-5 scale); existence of DH2 plant species NP SES: lack of more regular inflow of fresh seawater (nutrients, humidity) Management of water levels is not sufficient.</td>
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<tr>
<td>DPSIR category</td>
<td>General phenomenon</td>
<td>Indicator area</td>
<td>Indicator</td>
<td>Measuring instruction</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for HABIT-CHANGE</td>
<td>Investigation area**</td>
<td>Source</td>
<td>Remarks</td>
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<tr>
<td>Pressure S, R, S</td>
<td>Soil</td>
<td>Water</td>
<td>Soil moisture index (BUNP, KMNIP), Hygrophyllous vegetation type (BUNP), Maximal water holding capacity (MIWC), Field water capacity (FWC), Water availability to plants (WAP)</td>
<td>In situ measurement (every 2-5 years), Observation wells, it is recommended to localize piezometers along transects cutting through ecotones – Weekly to Monthly measurement of water table depth</td>
<td>Changes in % share of vegetation occurrence according to soil moisture class, m/m³</td>
<td>-</td>
<td>CC, non CC</td>
<td>BNP, BUNP, KMNIP, TNP</td>
<td>Consolidated_indicators_PK_2011-05-31.doc, Table_tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, 4_3_3_Indicatoren_minikarte_2010, HABIT-CHANGE_4_3_2_monitoring_techniques_2011-01-31.pdf</td>
<td>TNP: Changes of humidity, soil moisture and vegetation patterns, in particular in bogs are expected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Soil</td>
<td>Water</td>
<td>Water carrying capacity of soils (BUNP, KMNIP)</td>
<td>[]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BUNP, KMNIP</td>
<td>Table_tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Strength of indicator (assignment to climate change): very low in relation to climate change but high in relation to forest habitat vulnerability by storm.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pressure S</td>
<td>Soil</td>
<td>Terrain, Relief</td>
<td>Slope, Aspect, Altitude, Exposition</td>
<td>ArcGIS/ESRI-routines in the digital elevation model</td>
<td>[]</td>
<td>-</td>
<td>non CC</td>
<td>BR, VTF</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, HABIT-CHANGE_4_1_3_indicators_forest.pdf</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pressure R</td>
<td>Soil</td>
<td>Erosion</td>
<td>Aeolian erosion</td>
<td>Evaluation of aerial images, site inspection</td>
<td>[m², t, m³, ha], Number of sand dunes, erosion gullies, etc. features per area unit</td>
<td>-</td>
<td>non CC, CC</td>
<td>BNP, BucNP</td>
<td>Consolidated_indicators_PK_2011-05-31.doc, Table_tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pressure R</td>
<td>Soil</td>
<td>Erosion</td>
<td>Aquatic erosion</td>
<td>Evaluation of aerial images, site inspection</td>
<td>[Number of gullies, share of land deprived of vegetation]</td>
<td>Change in soil and water coloration according to Munsell scale, Transportation of soil material in thea</td>
<td>non CC, CC</td>
<td>BNP, BucNP, BUNP, DDBR, FHNP, LNNP, TNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011, CHANGE_4_1_3_Indicators_forest.pdf</td>
<td></td>
<td></td>
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<tr>
<td>Pressure S</td>
<td>Soil</td>
<td>Erosion</td>
<td>Frequency of mountain bikers on paths and passes, Frequency of cars on paths and passes</td>
<td>Site inspection</td>
<td>[number per day]</td>
<td>-</td>
<td>non CC</td>
<td>RAMNP</td>
<td>HABIT-CHANGE_3_1_1_2_Stakeholder_Dialogue.pdf</td>
<td></td>
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<tr>
<td>Pressure S</td>
<td>Soil</td>
<td>Composition</td>
<td>Soil organic matter (Quantitative and qualitative-changes within a specific period), annual, Peat decay – mowing process (every 5 years)</td>
<td>Chemical and physical analyses, From plots and soil profiles: In-situ measurement; laboratory – chemical analysis: ash content by dry combustion</td>
<td>[g/kg, Peat decay decomposition ash content g/kg]</td>
<td>-</td>
<td>CC</td>
<td>BUNP, KMNIP</td>
<td>Table_tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, HABIT-CHANGE_4_3_3_monitoring_techniques_2011-01-31.pdf</td>
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</tbody>
</table>

BUNP: Rate of erosion (esp. on overgrazed pastures), DDBR: Conservation value: 4 (1-5 scale), this type of habitat is continue diminished by the erosion of sea waves, LLNP: “Hillside position of vineyards”
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Parameter</th>
<th>Measuring instruction</th>
<th>Unit</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types (relevant for HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure S</td>
<td>Soil</td>
<td>Extraction</td>
<td></td>
<td></td>
<td>[m³, m², ha]</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>BUNP, RANP, TNP</td>
<td>HABIT-CHANGE_dpf_Habitatlist_matrix_2011-03-24.xls, HABIT-CHANGE_3_3_2_CC_included-and-related-pressures_2011-05-05.pdf</td>
<td>3160, 7230, bauxite mining, 7210, pebble mining</td>
<td></td>
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<tr>
<td>Pressure S</td>
<td>Soil</td>
<td>Silt-slip</td>
<td></td>
<td></td>
<td>[m³, cm, m]</td>
<td></td>
<td>-</td>
<td>non CC, CC</td>
<td>1160</td>
<td>DDBR, RNXP, LNXP</td>
<td>HABIT-CHANGE_dpf_Habitatlist_matrix_2011-03-24.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Conservation value: 4 (1-5 scale); this habitat is very abundant in species. Due to habitat position in DD (at the mounds of the Danube) the alluvial sedimentation is the main process.</td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Soil</td>
<td>Carbon storage</td>
<td>Carbon discharge</td>
<td>[]</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>CC</td>
<td>BNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
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</tr>
<tr>
<td>Pressure R</td>
<td>Land use</td>
<td>Fishing, Navigation</td>
<td>Fish-farms, Fishery, Navigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>DDBR, LNXP, TNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
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<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Water, Agriculture</td>
<td>Reed-management</td>
<td>[ha, %]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>FNXP, LNXP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
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<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Arable land within the protected area (Changes in the share of arable land within a specific period)</td>
<td>[ha, %]</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>CC, non CC</td>
<td>BUNP, DDBR, KMNXP</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
<td></td>
<td>DDBR: Agricultural (52,846 ha, 8, 95 %) of which 16,069 ha (2, 72 %) are abandoned (arable land, pastures, vineyards and orchards)</td>
</tr>
<tr>
<td>Pressure R, S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Intensification (esp. BUNP + BucNP): Area of overgrazed habitats (BUNP, KMNXP, SNNXP), Rate of intensified grassland (esp. pasture) management, Rate of degradation around stable drinking-troughs (BUNP, KMNXP), Number of sheep, cows and horses/ha of grassland, Quantity of medicinal plants and berries collected (BunNP), Amount of mushroom collected by local people, Area of former dry grassland and sand bieckes transformed to vineyards, Levelling, removal of stones, land consolidation (RANAP) (Changes within a specific period)</td>
<td>[ha, m³, %, numbertha, kg/ha]</td>
<td></td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>TNP: 5960</td>
<td>BUNP, BUXP, KMNXP, LNXP, SNNXP, TNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
<td></td>
<td>Linked pressures or their reduction to Alpine Habitats:</td>
</tr>
<tr>
<td>Pressure R, S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Grazing, Antagonism with domestic animals, Overgrazing of alpine grasslands (sheep, cows, horses) associated with</td>
<td>[ha]</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>BUNP: 6390, 4070, 6150, 6170, 8230, 8120, 8210, BUXP: 6190, 6240</td>
<td>BUNP, DDBR, KMNXP, RANAP, TNP</td>
<td>HABIT-CHANGE_dpf_Habitatlist_matrix_2011-03-24.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>HABIT-CHANGE_4_4_1_5_alpine_habitats.pdf</td>
</tr>
<tr>
<td>DPSIR category</td>
<td>General phenomenon</td>
<td>Indicator area</td>
<td>Indicator</td>
<td>Measuring instruction</td>
<td>Unit</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types (relevant for HABIT-CHANGE)</td>
<td>Investigation area**</td>
<td>Source</td>
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<tr>
<td>R, S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Fragmentation, land use intensification, isolation of the natural and semi natural ecological systems (BucNP) (Changes within a specific period)</td>
<td>[ha, fragmentation index]</td>
<td>-</td>
<td>non CC</td>
<td>LNNP: 45, 6210, 6240, 6260, 6430, 6510</td>
<td>BucNP, Univ/ LNNP</td>
<td>HABIT-CHANGE_poster Latius Neusaid Fortl- HenschagNP_ Univ/pdf, HABIT-CHANGE_4.5_5_selected_indicators_final.pdf</td>
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<tr>
<td>R, S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Modification of cultivation practices (Changes within a specific period)</td>
<td>[ha, %]</td>
<td>-</td>
<td>non CC, CC</td>
<td>6150, 6170, 6230, 6430, 6510</td>
<td>RANP</td>
<td>HABIT-CHANGE_poster Rheinfelder AhrnNP_EURAC.pdf</td>
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<tr>
<td>S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Change from moving to pasturing, Time/frequency of moving/pasturing, Density of livestock (RANP) (Changes within a specific period)</td>
<td>[ha, %, dd.mm.yyyy]</td>
<td>-</td>
<td>non CC</td>
<td>TNP: 62100, 6510, 6520</td>
<td>BNP, BuchNP, FHN, KMNP, LNNP, RANP, TNP</td>
<td>HABIT-CHANGE_4.1_4.4_1.5_alpine_habitats.pdf, HABIT-CHANGE_4.5_5_selected_indicators_final.pdf</td>
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<tr>
<td>R, S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Biomass production/biogas plants cultivation, Agricultural structures (Changes within a specific period)</td>
<td>[ha, km²]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BR FEB, TNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_3.2_2_CC-included-related-pressures_2011-05-05.pdf</td>
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<tr>
<td>S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>Fertilisation by intensive agriculture: Nitrogen load of river/groundwater/habitat, Phosphate load of river/groundwater/habitat, Pesticide load of river/groundwater/habitat (Load/Changes of load within a specific period)</td>
<td>field observations</td>
<td>[N, N/month, %, other]</td>
<td>-</td>
<td>non CC</td>
<td>DDBR: 1110, NP SES: 1130, 1320</td>
<td>TNP: 6110, 6150, 6170, 6210, 6260</td>
<td>Tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_poster Kalkalpe, HABIT-CHANGE_4.6_5_selected_indicators_final.pdf</td>
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<tr>
<td>R, S</td>
<td>Land use</td>
<td>Agriculture</td>
<td>the natural over fertilization of the soil with organic material, increase of the soil density and ruderalisation (BucNP) (Changes within a specific period)</td>
<td></td>
<td></td>
<td></td>
<td>DDBR: 1530, 2130, 6420</td>
<td>TNP: 6110, 6210, 6510, 6520</td>
<td>91K0</td>
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</tbody>
</table>

**Investigation area**: DL: Danube Delta, HABIT: HABIT-CHANGE_pressures_2011, N: Upper Neusiedl, NP: Niederoberösterreich, RANP: Rheintaler Auen-Naturpark, TNP: Tiroler Naturpark, W: Waldviertel, Z: Zentralalpen. **Notes**: small areas in DDBR marine perimeter. Also, there is an intense grazing activity due to illegal released domestic herbivores in the wilderness. 2130: Horse grazing is the main activity that can modify the structure of habitat. 6150: Overgrazing 6230: The high number of animals and sheepfolds can destroy the Nardus grasslands. 6420: Small areas in DDBR marine perimeter. Also, there is an intense grazing activity due to illegal released domestic herbivores in the wilderness. Changing migratory patterns, Trampling, Overuse; Soil/road/abandonment, Agriculture/forestry activities (interfertilisation), Grazing, upheaval, ploughing | | |

The table outlines various indicators and their related pressures and impacts associated with land use changes, with specific emphasis on agricultural activities and their effects on habitats and ecosystems across different regions and scales. It highlights the need for monitoring and managing these pressures to maintain ecological balance and conserve biodiversity.
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Measuring instruction</th>
<th>Parameter</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>Habitat types (relevant for HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure R, S</td>
<td>Land use Forestry</td>
<td>Afforestation</td>
<td>[ha, km²]</td>
<td>-</td>
<td>non CC</td>
<td>2330, 4030, 6120, 6240, 6410, 6510, 6520</td>
<td>BNP: 6430</td>
<td>BUNP: 6510</td>
<td>TNP: 6170</td>
<td>Table: Indikatoren_DPSIR.xls, HABIT-CHANGE_high_habitat_matrix_2011-03-24.xls, HABIT-CHANGE_4_4_1_selected_indicators_final.pdf</td>
<td>BNP, BuchNP, BR NP, PR NP, KNP, LNP, BUNP, KMNP, RANP, TNP</td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use Forestry</td>
<td>Forest clearing</td>
<td>[ha, km²]</td>
<td>-</td>
<td>non CC</td>
<td>BusNP: 9110, 91V0, 9410, 7140, 7230</td>
<td>BR FEB</td>
<td>BusNP, TNP</td>
<td>TNP: 6170</td>
<td>Table: Indikatoren_DPSIR.xls</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use Forestry</td>
<td>Domestication</td>
<td>[ha, km²]</td>
<td>-</td>
<td>non CC</td>
<td>BusNP: 9110, 91V0, 9410, 7140, 7230</td>
<td>BR FEB</td>
<td>BusNP, TNP</td>
<td>TNP: 6170</td>
<td>Table: Indikatoren_DPSIR.xls</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use Forestry</td>
<td>Modification of cultivation practices (Changes within a specific period)</td>
<td>[ha, %]</td>
<td>-</td>
<td>non CC</td>
<td>9410, 9420</td>
<td>RANP</td>
<td>RANP</td>
<td>HABIT-CHANGE_poster Rieserferner Ahrnm_EURAC.pdf</td>
<td>HABIT-CHANGE_3_2_2_CC_included-and-related_pressures_2011-03-09.pdf</td>
<td>Potential pressures and impacts of climate change: (Succession sequences) – natural and anthropogenic</td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use Forestry</td>
<td>Intensiﬁcation, Quantity of wood gathered (BusNP), Privatisation of formerly public forests and increased intensity of forestry (TNP)</td>
<td>[ha, km²]</td>
<td>-</td>
<td>non CC</td>
<td>2010, 8910</td>
<td>TNP: 5910</td>
<td>BusNP, RANP,</td>
<td>TNP: 6170</td>
<td>Table: Indikatoren_DPSIR.xls, HABIT-CHANGE_high_habitat_matrix_2011-03-24.xls, HABIT-CHANGE_4_4_1_selected_indicators_final.pdf</td>
<td>HABIT-CHANGE_4_4_1_5_alpine_habitats.pdf</td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use Forestry</td>
<td>Use of chemicals: Pesticide/fungicide load of river/groundwater/habitat (Load/Changes of load within a specific period)</td>
<td>field observations, mapping</td>
<td>[ha, %/month, %, other]</td>
<td>non CC</td>
<td>3220, 3340</td>
<td>RANP: 3220, 3340</td>
<td>RANP</td>
<td>HABIT-CHANGE_4_4_1_5_alpine_habitats.pdf</td>
<td>HABIT-CHANGE_4_4_1_5_alpine_habitats.pdf</td>
<td>RANP: - Intensiﬁcation: o optimisation of accessibility (new roads, paving earth roads), o more frequent logging, o use of chemicals (pesticides, fungicides) (EURAC)</td>
</tr>
</tbody>
</table>

This project is implemented through the CENTRAL EUROPE Programme co-ﬁnanced by the ERDF
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Measuring instruction</th>
<th>Unit</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types (relevant for \textit{Habitat-Change})</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Forestry</td>
<td>Fire (Burning), Wildfire</td>
<td>Number, Frequency, Area</td>
<td>[number (year), ha, km²]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BuchNP, BUNP, KNP, RNP</td>
<td>HABIT-CHANGE_dwell_Habitat_matrix_2011-03-24.xls, HABIT-CHANGE_4_1_4_1_5_skjene_habitats.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>BuchNP: Threat for fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Forestry</td>
<td>Extensification/Conversion to potential natural forest types (RANP), Extensification of coppice: No more logging, no measures against forest fires (RANP), Quantity of wood gathered (BucNP)</td>
<td>Mapping of removal of dead wood and of storage of storm damage</td>
<td>[ha, km²]</td>
<td>-</td>
<td>non CC</td>
<td>BuchNP, RNP, TNP</td>
<td>HABIT-CHANGE_4_1_4_1_5_skjene_habitats.xls, Tabelle_indikatoren_DPSIR.xls</td>
<td>RANP: Extensification/conversion to potential natural forest types</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Forestry</td>
<td>Deforestation</td>
<td>[ha, km²]</td>
<td>-</td>
<td>non CC</td>
<td>BuchNP</td>
<td>HABIT-CHANGE_dwell_Habitat_matrix_2011-03-24.xls</td>
<td>BuchNP: Deforestation has a significant negative impact.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pressure R, S</td>
<td>Land use</td>
<td>Change</td>
<td>Changes in land use and land cover: Rate of area with changed land use (BUNP), Changes in the fraction of specific land uses (BUNP), Changes in vegetation cover (KMNP), Percentage of changes of the natural and semi natural ecological systems to the anthropogenic ecosystems (BuchNP), Area of abandoned traditional (landscape) management (compared to 10 years before) (BUNP), Changes in vegetation cover (NDVI, LAI, SAVI – Soil Adjusted Vegetation Index is used for areas with sparse vegetation) (GNINP), Land cover diversity indices (GEM, EVI, NDVI, VM, SAVI, SRI, Tasseled Cup Transformation, LAI) (GEM - Global Environment Monitoring Index, EVI - Enhanced Vegetation Index, LAI - Leaf Area Index, VM - Vegetation Mixture)</td>
<td>Mapping for first year of evaluation. For the successive evaluations a vegetation-Remote sensing intercalibration system can be developed and used. Phytosociological survey/satellite image Field survey (e.g. relevés or transects). The field survey methods are different for different types of vegetation! Plot examination, Remote sensing</td>
<td>[ha, m², %]</td>
<td>-</td>
<td>non CC, CC</td>
<td>BuchNP, BNP, BUNP, DBBR, KNP, RNP, SNINP</td>
<td>Tabelle_indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, 4-3-3_Indikatoren_skjene_habitats.xls, HABIT-CHANGE_4_3_1_Indikatoren_landscape_and_habitat_2011-03-14.pdf, CHANGE_draft_Habitatlist_matrix_2011_4_5_1_Indikatoren_landscape_and_habitat_2011-03-14.pdf</td>
<td>BuchNP: Land use changes according to the national policy concerning the development of the territory and the decisions of the local administrations. Changes to anthropogenic ecosystems like: agri-ecosystems, forest plantations, farms for animals, pisciculture farms, artificial lakes, artificial wetland s.o.. Required temporal resolution: A first evaluation need to be done on the maximum developed period of the vegetation. This will be the reference. Next evaluation can be done every 5 or 10 years, according to the amplitude of the abiotic parameters changes; annual.</td>
<td></td>
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<tr>
<td>Pressure R, S</td>
<td>Land use</td>
<td>Structure, pattern</td>
<td>Changes in the mosaic-like patterns (BUNP), Changes of vegetation composition</td>
<td>Land cover analysis, Remote sensing – satellite imagery, aerial photographs</td>
<td>[Number of elements, M per area unit; e.g. m²/ha, Number of]</td>
<td>-</td>
<td>non CC, CC</td>
<td>BuchNP, BNP, BUNP, DBBR, KNP, RNP, SNINP</td>
<td>Change draft Habitatlist_matrix_2011_4_5_1_Indikatoren_landscape_and_habitat_2011-03-14.pdf</td>
<td>Tabelle_indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, 4-3-3_Indikatoren_skjene_habitats.xls, HABIT-CHANGE_4_3_1_Indikatoren_landscape_and_habitat_2011-03-14.pdf</td>
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<td>DPSIR category</td>
<td>General phenomenon</td>
<td>Indicator area</td>
<td>Indicator</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for HABIT-CHANGE</td>
<td>Investigation area**</td>
<td>Source</td>
<td>Remarks</td>
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<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Infrastructure</td>
<td>Compact of road network (TNP), Building of forestry roads, using of motorised vehicles (BucNP), Intensification of traffic, optimisation of accessibility (New roads, paving earth roads), more frequent logging (RANP)</td>
<td>Sealed soil, Noise, particulate matter, ozone and other pollutants, Use of road salt</td>
<td>[ha, m², decibel, ...]</td>
<td>-</td>
<td>non CC</td>
<td>BucNP, LNNP, RANP, TNP</td>
<td>Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, HABIT-CHANGE_4_4_1_1_5_alpine_habitats.pdf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure R, S</td>
<td>Land use</td>
<td>Infrastructure</td>
<td>Effective mesh size (EMS) (The effective mesh size measures fragmentation caused by linear elements like technical infrastructure. EMS is based on the probability that two randomly chosen points in a region will be in the same patch. The indicator measures landscape fragmentation in ha, ranging from 0 ha (totally fragmented) to the area size of the largest patch investigated for the region.)</td>
<td>Land cover analysis – land use maps, remote sensing</td>
<td>[ha]</td>
<td>-</td>
<td>non CC</td>
<td>all</td>
<td>HABIT-CHANGE_4_3_1_indicators_landscape_and_habitat_level_2011-03-14.pdf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Settlement, Constructions</td>
<td>Increase of built-up areas (TNP), Construction of new buildings (BucNP), Expansion of settlements, single construction projects (LNNP/LunI), New barns (RANP)</td>
<td>Sealed soil, fragmentation</td>
<td>[ha, m², fragmentation index]</td>
<td>-</td>
<td>non CC</td>
<td>BucNP, FHN, LNNP, RANP, TNP</td>
<td>Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure S</td>
<td>Land use</td>
<td>Landfill</td>
<td>Landfill, Land reclamation</td>
<td>[ha, m²]</td>
<td>-</td>
<td>non CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_shelf_habitat_matrix_2011-03-24.xls</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pressure S</td>
<td>Tourism</td>
<td>Visitor</td>
<td>Density frequency of day visitors/tourists in certain areas (lakes, river banks) (BUNP), Density frequency of sport centre</td>
<td>Count number of people</td>
<td>[number per day/period and area]</td>
<td>-</td>
<td>non CD</td>
<td>4090, 4070, 6170, 8120, 8210</td>
<td>BucNP, BUNP, FHN, LNNP, RANP, SNIP, TNP</td>
<td>HABIT-CHANGE_3_1_2_Stakeholder_Dialogue.pdf, Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
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</tbody>
</table>

Potential pressures or reduction of pressure in Alpine Habitats in general:
- Summer tourism
- Buildings of infrastructure (roads, buildings, ...), Traffic,

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<th>Measuring instruction</th>
<th>Unit</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types relevant for (HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Visitor</td>
<td>Trampling, overuse, Mountain biking (RANP)</td>
<td>[m², ha]</td>
<td>-</td>
<td>non CC</td>
<td>TNP: 6150*, 6170, 6210*, 6510, 6520, 9190</td>
<td>RANP, TNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Remarks: Damage to soil and vegetation by tourist (walking, picking plants, ...), Increase of pressure by new activities (mountain biking, paragliding, canyoning)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Visitor, Mass tourism</td>
<td>Pollution of springs, Garbage</td>
<td>field observations</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>BuchNP, TNP</td>
<td>Taistles_handeln_DPSIR.xls</td>
<td><strong>Habitat list for the period 2009-2011</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Visitor</td>
<td>Mountaineering, rock climbing, Speleology, Hunting</td>
<td>[m², km²]</td>
<td>-</td>
<td>non CC</td>
<td>TNP: 6150*, 6210*, 6170, 6210, 6510, 8120, 8130, 8160, 8210, 8220, 8240, 9190</td>
<td>BuchNP: 8120</td>
<td><strong>BucNP, TNP</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Visitor</td>
<td>Sailor and oarsmen, Water sport activities, Leisure fishing</td>
<td>(Changes of) size of area</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>BUNG, FHN, LNP, RANP, TNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Remarks: Especially during breeding season adverse effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Visitor</td>
<td>Gliding, delta plane, paragliding, ballooning, bailing, canyoning</td>
<td></td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>6170, 6210*, 6520</td>
<td>TNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Remarks: Especially during breeding season adverse effects</td>
<td></td>
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<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Visitor</td>
<td>Noise nuisance</td>
<td>[number, location, time]</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>6110*, 6190, 8120, 8130, 8160, 8210, 9190</td>
<td>LNP, RANP, TNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Remarks: Especially during breeding season adverse effects</td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Visitor</td>
<td>Land use for skiing (inside protected area – RANP), Alpine skiing, ski touring</td>
<td>Areal images, site inspection, evaluate planning documents</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>TNP: 6170, 6130, 8120, 8130, 8160</td>
<td>RANP, TNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Remarks: Especially during breeding season adverse effects</td>
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<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Infrastructure</td>
<td>Artificial snowing</td>
<td>[number/season, ha]</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>6210*, 6520</td>
<td>RANP, TNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Remarks: Especially during breeding season adverse effects</td>
<td></td>
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<tr>
<td>Pressure</td>
<td>Tourism</td>
<td>Infrastructure</td>
<td>Levelling of ski slopes, Increase of free riding and tour skiing</td>
<td>[number/season, ha]</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>RANP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Remarks: Especially during breeding season adverse effects</td>
<td></td>
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<tr>
<td>DPSIR category</td>
<td>General phenomenon</td>
<td>Indicator area</td>
<td>Indicator</td>
<td>Measuring instruction</td>
<td>Unit</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for HABIT-CHANGE</td>
<td>Investigation area**</td>
<td>Source</td>
<td>Remarks</td>
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<tr>
<td>Pressure S</td>
<td>Tourism</td>
<td>Infrastructure</td>
<td>Paths, tracks, cycling tracks, ski trails, new constructions (houses, roads, skiing trails/slopes, ski lifts, Nordic-skiing tracks, snow canoes), Camps, Sanatoriums (SNNP), Public transport in direct vicinity (exhaust gases, wintering killing)</td>
<td>[number/period, ha, m²]</td>
<td>-</td>
<td>non CC</td>
<td>8120, 8130, 8160, 91K0</td>
<td></td>
<td>BucNP, RANP, SNNP, TNP</td>
<td>HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td>Tabelle_indikatoren_DPSIR.xls, HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td></td>
</tr>
<tr>
<td>Pressure R, S</td>
<td>Local inhabitants and politics</td>
<td>Participation, Support</td>
<td>Rate of participation of local inhabitants in decision-making (BUNP)</td>
<td></td>
<td>[%]</td>
<td>-</td>
<td>non CC</td>
<td>BUNP, TNP</td>
<td></td>
<td>Tabelle_indikatoren_DPSIR.xls, HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td>TNP: So, the private interest is often put prior to public interest (HABIT-CHANGE, Questionnaire, 2010)</td>
<td></td>
</tr>
<tr>
<td>Pressure R, S</td>
<td>Local inhabitants and politics</td>
<td>Composition, Structure</td>
<td>Demography in smaller mountain villages (TNP)</td>
<td></td>
<td>[%]</td>
<td>-</td>
<td>non CC</td>
<td>TNP</td>
<td></td>
<td>Tabelle_indikatoren_DPSIR.xls</td>
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<tr>
<td>Pressure R, S</td>
<td>Energy</td>
<td>Hydropower</td>
<td>Walls and other constructions for water regulations, Water extraction</td>
<td>[number, m³/d]</td>
<td>-</td>
<td>non CC, CC</td>
<td>RANP</td>
<td></td>
<td></td>
<td>HABIT-CHANGE_4.1.4.4.1.5_sjohe_habitats.pdf, Tabelle_indikatoren_DPSIR.xls</td>
<td>Water extraction affecting the natural water balance in the park</td>
<td></td>
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<tr>
<td>Pressure R, S</td>
<td>Habitats and Species</td>
<td>Evolution</td>
<td>Biocenotic evolution, Progressive succession</td>
<td>Habitat types, Species</td>
<td></td>
<td>CC, non CC</td>
<td>8160</td>
<td>BNP</td>
<td></td>
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</tr>
<tr>
<td>Pressure R, S</td>
<td>Habitats and Species</td>
<td>Evolution</td>
<td>Invasive neophytes, Invasive species (DDBR, SNNP) (Number and coverage of new i. s.), Changes in phylogeny (Comparisons of multi-temporal data sets relating seasonal variations in vegetation phenological phases within a year or over more years)</td>
<td>[number, Species, Normalized Difference Vegetation Index – NDVI]</td>
<td>-</td>
<td>CC, non CC</td>
<td>8160</td>
<td>RANP</td>
<td></td>
<td>HABIT-CHANGE_steil_Habitatlist_matrix_2011-03-24.pdf, HABIT-CHANGE_4.5.1_selected_indicators_final.pdf, 4.5.2_Indikatoren_outline_5_2nd_Vers.doc</td>
<td>DDBR: From the list of the alien plants identified in Danube Delta, the species with the highest impact index (competitive ability index) have been extracted on the basis of ecological features. Furthermore, species such as Amorpha fruticosa, Robinia pseudoacacia, Acer negundo, Menis alba, Fraxinus pennsylvanica, Alnus altilisssima, Lycium barbarum, Glechoma hynanthea and Elaeagnus angustifolia are considered the most widespread invasive plant species from DDBR. LNNP: Oleaster for windbreak -&gt; leads to shrub encroachment. Increase of wild pig population (destruction of orchid habitats). Immigration of stocking fish from the Neusiedler See into the habitat Wulka (Eel and carp)</td>
<td></td>
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</table>
### 3.2. Indicators for impacts

<table>
<thead>
<tr>
<th>Impact</th>
<th>Habitats and Species</th>
<th>Habitat</th>
<th>Parameter</th>
<th>Measuring instruction</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types relevant for (HABIT-CHANGE)</th>
<th>Investigation area**</th>
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</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of natural floodplains</td>
<td>Site inspection [ha, m²]</td>
<td>-</td>
<td>non-CC, CC</td>
<td>BR FEB</td>
<td>HABIT-CHANGE_poster Flusslandschaft Elbe/BR_FEB.pdf</td>
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<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Smothering of bed, alteration of invertebrate assemblage, Change in water table, loss of wetlands, loss of spawning areas, Altered flow regime and habitat</td>
<td>[ ]</td>
<td>-</td>
<td>non-CC, CC</td>
<td>DDDBR</td>
<td>Tabelle_indikatoren_DPSIR.xls</td>
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<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Disturbance of river banks</td>
<td>Site inspection [km, number]</td>
<td>-</td>
<td>non CC</td>
<td>RANP</td>
<td>HABIT-CHANGE_3.1.2_Stakeholder_Dialogue.pdf</td>
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<td>DPSIR category</td>
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<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for (HABIT-CHANGE)</td>
<td>Investigation area**</td>
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</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of adverse effect on habitat</td>
<td>(Drying out or flooding, Drought stress or water stress). Fields, natural grasslands used for grazing or haying and forest in depressions turn into swamps (SNNP)</td>
<td>[ha, m²]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BR FEB: 3260, 9190, DDBR: 1310</td>
<td>NP SES: 1140, 1310</td>
<td>HABIT-CHANGE_poster Flusslandschaft Elbe BR_FEB BR.pdf</td>
<td>BR FEB 3260: Changes in number of species and community structure. Changes in discharges in both directions: flood and drying out, weirs, dams; beside CC: River maintenance. BR FEB 9190: Changes in community structure, in flooding regime of large rivers, loss of space for this habitat type (problems: changes in the ground water level; beside cc: Unclear oak-cut, forest economy).</td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of adverse effect on habitat</td>
<td>(Drying out, accumulation of organic material, antagonism arising from introduction of species (conflict: grazing))</td>
<td>[ha, m²]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BNP, BUNP, DDBR, KMN</td>
<td>DDBR</td>
<td>HABIT-CHANGE_poster Danube DeltaR_DDN5.pdf</td>
<td>HABIT-CHANGE_3_2_2_CC_included-and-related_pressures_2011-05-09.pdf</td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of adverse effect on habitat</td>
<td>(reduction of ground water level)</td>
<td>[]</td>
<td>-</td>
<td>CC, non CC</td>
<td>DDBR</td>
<td>2190</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.dc</td>
<td>Other natural processes, Conservation value 5 (1-5 scale); Affected by reduction of ground water level.</td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of aquatic habitat</td>
<td>(management of aquatic and bank vegetation for drainage purposes)</td>
<td>[number, ha]</td>
<td>-</td>
<td>CC, non CC</td>
<td>DDBR</td>
<td>3150</td>
<td>HABIT-CHANGE_poster Danube DeltaR_DDN5.pdf</td>
<td>Existence of DH2 plant species</td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of aquatic habitat</td>
<td>(management of aquatic and bank vegetation for drainage purposes)</td>
<td>[% ha, m²]</td>
<td>-</td>
<td>3160</td>
<td>DDBR</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.dc</td>
<td>Conservation value 4 (1-5 scale); this type of habitat was diminished by the desiccation activities.</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Shift of water habitats to an eutrophic status. Reduction of mesotrophic clear water habitats</td>
<td>Site inspection</td>
<td>[km, number]</td>
<td>-</td>
<td>non CC</td>
<td>BR FEB, DDBR, KMN, NP SES, TNP</td>
<td>Tabelle_indikatoren_DPSIR.dc, HABIT-CHANGE_3_2_2_CC_included-and-related_pressures_2011-05-09.pdf</td>
<td>After the flooding period there are accumulated on the sand deposits and decomposing organic matter that is favourable for the appearance of colonial plant species in dry season.</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of moors and wetlands</td>
<td>Site inspection</td>
<td>[ha, m²]</td>
<td>-</td>
<td>non CC, CC</td>
<td>BR FEB</td>
<td>HABIT-CHANGE_poster Flusslandschaft Elbe BR_FEB BR.pdf</td>
<td>Rising the sea level will decrease the present abundance of this habitat type. Shift to 1310 HT is possible (1420); Low levels of nutrients are causing poorly developed plants in the habitat type (1310, 1420);</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of adverse effect on habitat</td>
<td></td>
<td>[ha, m²]</td>
<td>-</td>
<td>CC</td>
<td>NP SES</td>
<td>HABIT-CHANGE_poster Salzland.fi-Salinefi_P_UrAmb_SESN5.pdf</td>
<td>Human interference (trampling, boats anchoring etc.)</td>
<td></td>
</tr>
</tbody>
</table>

**Investigation area** indicates the geographic area where the investigation was carried out.
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types relevant for (HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
</tr>
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<tbody>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of habitat</td>
<td>[%, ha, m²]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BUNP: 3160, 6410, 7210, 7230, 91E0</td>
<td>BUNP, DDBR, SNNP</td>
<td>HABIT-CHANGE_matrix_Habitatlist_matrix_2011-03-24.xls, HABIT-CHANGE_poster_3_impacts_BUNP.pdf, HABIT-CHANGE_poster_Danube_DeltaBR.pdf, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Drying out, decreasing level of water table), (e.g. decrease of sandy dunes because of desertification)</td>
<td>(SNNP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss of habitats</td>
<td>[km², ha]</td>
<td>-</td>
<td>CC, non CC</td>
<td>FHNP, LNNP</td>
<td>FHNP, LNNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Loss/reduction of habitat: Due to changed precipitation pattern and water supply.</td>
<td>[ha, m²]</td>
<td>-</td>
<td>CC, non CC</td>
<td>FHNP, LNNP</td>
<td>FHNP, LNNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
</tr>
</tbody>
</table>

3160: I decreasing level of water table, drying out.  
P: bauxite mining  
6410: I decreasing level of water table, dying out, mineralization of peat, increasing net primary production, canopy closure, accumulation of litter, spread of reed, invasion of alien species, increasing abundance of generalist plant species at the expense of specialists (disappearance of specialists)  
I: decreasing level of water table, drying out, invasion of alien species, increasing abundance of generalist plant species at the expense of specialists...  
P: bauxite mining, invasion of alien species, development of draining canal system/Sásdi meadow.  
91E0: I decreasing level of water table, drying out, invasion of alien species, increasing abundance of generalist plant species at the expense of specialists (disappearance of specialists)...  
P: bauxite mining, invasion of alien species, development of draining canal system/Sásdi meadow.  
91F0: Drying out because of low level of ground water, species die-back, presence of alien ligneous species and horse grazing.  
DDBR: Drying out because of low level of ground water, species die-back, presence of alien ligneous species and horse grazing.  
SNNP: In the park sandy dunes are habitat for endemic species and are very sensitive to the CC changes.
### DPSIR category | General phenomenon | Indicator area | Indicator | Threshold | Key indicator | CC related | Habitat types relevant for [HABIT-CHANGE] | Investigation area** | Source | Remarks
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
Impact | Habitats and Species | Habitat | Problems of water supply of the reed-belt (due to the occasional low water level, silting and macrophytes-overgrowing of channels), Silting in Fertőrákos bay and in southern part of the lake due to the dominant wind-direction, Reduction of periods with permanent ice cover which heavily impairs reed-harvest activities, Significant growth of algae |  |  | |
Impact | Habitats and Species | Habitat | Loss of adverse effect on habitat (Underflooding) | [ha, m²] |  | CC | SSNP | Table_Indikatoren_DPSIR.xls | Underflooding reinforces swamping and salinization
Impact | Habitats and Species | Habitat | Polluted Habitats | [km², ha] |  | non CC | 1130, 1320 | NP SES | HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls | 1130: pollution caused by intensive agriculture in the Dragonja valley 1320: pollution by agriculture - inflow of pesticides and nutrients
Impact | Habitats and Species | Habitat | Loss of grassland (due to renewable energy law) | Site inspection | [ha, m²] | CC, non CC | BR FEB | HABIT-CHANGE_poster_Fluuslandschaft Elbe-BR_FEB_BF.pdf |
Impact S | Habitats and Species | Habitat | Decrease of species richness and ruderalisation of habitat (number of species/habitat) (BucNP) | [ha, m²] |  | non CC, CC | 6430 | BucNP | HABIT-CHANGE_poster_BucegiNP_UniB.pdf, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf | ►Touristic activity (high intensity) ▼Waste accumulations (medium influence) ▲Heavy rains associated with floods ▲Warm and dry summers
Impact S | Habitats and Species | Habitat | Changes in Shrub richness: (No. of plants in shrub layer (shrubs and small trees less than 3 m in height)) % shrubs (No. of shrubs/total no. of plants) × 100), % cover of Phalaris ( % cover of Phalaris/number of plots) | [number, %, ha, m²] |  | CC, non CC | BNP, RANP | Table_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf |
Impact S | Habitats and Species | Species, Habitats | Changes of the plant communities (associations, alliances, ... diversity), Changes of the proportion of species belonging to different ecological categories due to climate change effects and expressed in the reduction or amplification of their contribution to the plant community structure |  |  | CC, non CC | BucNP | HABIT-CHANGE_4_5_1_selected_indicators_final.pdf |
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Measuring instruction</th>
<th>Measuring threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types (relevant for HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Species, Habitats</td>
<td>Changes of plant communities by increasing tree cover which will diminish bryophyte cover</td>
<td>(%)</td>
<td>-</td>
<td>non CC, CC</td>
<td></td>
<td>Transition mires and quaking bogs, Alpine fens, Active raised bogs</td>
<td>TNP</td>
<td>HABIT-CHANGE_poster TriglavNP_TNP.pdf</td>
<td>Cutting of forests close to fens, skid roads, changing hydrology, eutrophication, erosion, human disturbances, like noise, trampling, paths, tracks, cycling tracks etc., Lower water levels</td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Changes in forest development, habitat types and quality (favouring the thermophytes species with an invasive potential)</td>
<td>(%)</td>
<td>-</td>
<td>CC, non CC</td>
<td>9110, 91V0, 9410</td>
<td>BucNP</td>
<td>HABIT-CHANGE_poster BucegiNP_UniB.pdf</td>
<td>► The general forest management (medium intensity) ► Roads and private constructions (medium intensity) ► Touristic activity (high intensity) ► Waste accumulation (medium intensity) ► Heavy rains, storms, torrents associated with erosion, land slides and forest damages ► The spring “thermic shock” affecting the vitality of the buds</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Adverse effect on habitat (by game species)</td>
<td>(%)</td>
<td>-</td>
<td>non CC</td>
<td>7230</td>
<td>BUNP</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls</td>
<td>Damage by game species</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Species, Habitats</td>
<td>Shift of habitat type (TNP), New vegetation on rocks and glacier fore fields (RANP)</td>
<td>(%)</td>
<td>-</td>
<td>CC, non CC</td>
<td>Blyscan Fagus Sylvatica forests (Aremonio-Fagion)</td>
<td>RANP, TNP</td>
<td>HABIT-CHANGE_poster TriglavNP_TNP.pdf, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>TANP: Carpinion forests (currently restricted to the colline altitudinal belt) will expand into areas which are currently occupied by submontane and lowmontane Fagus forests Changes in wood stock, Fagus: - 76 %; acceleration of succession will allow Fagus to establish and increase in higher altitudes Pressures: increase of mean temperatures for 2.2–2.75 °C climate warming, recreation and sport, mountaineering, collection of mushrooms and other activities, skid roads, changing hydrology</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Adverse effect on forest habitat (by increase of alien species)</td>
<td>(%)</td>
<td>-</td>
<td>CC, non CC</td>
<td>92A0, 92D0</td>
<td>DDBR</td>
<td>HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Antagonism arising from introduction of species: Conservation value: 2 (1-5 scale); pioneer vegetation with alien species Conservation value: 5 (1-5 scale); presence of alien species and illegal wood cutting activities Conservation value: 4 (1-5 scale); Emerald habitats relatively common in Romania’s wetlands. The specific habitats are formed by pioneer, cosmopolite and some alien ligneous species. It is noticed that wood exploited habitats are sparsely distributed and rich in alien plant species</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Simplification of vegetation composition and structure affect the self-regulation capacity of the ecosystems, associated with reduction of stability, Reduction of habitats quality, integrity and diversity (% of ruderalised grass-</td>
<td>(%)</td>
<td>-</td>
<td>CC</td>
<td></td>
<td>BucNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Changes of the vegetation composition induced changes in goods (genetic reserve, natural resource) and services (nutrients retention, regulation of water quality, improvement of the microclimate, touristic attraction) generated by the ecosystems</td>
<td></td>
</tr>
<tr>
<td>DPSIR category</td>
<td>General phenomenon</td>
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<td>Indicator</td>
<td>Measuring instruction</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for (HABIT-CHANGE)</td>
<td>Investigation area**</td>
<td>Source</td>
<td>Remarks</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitats, Species</td>
<td>Habitats degradation expressed in terms of reduction of species number, Reduction of habitats quality, integrity and diversity associated with the reduction of their productivity, Reduction of their with stand capacity and the increase of their vulnerability, Richness and range of wetland communities</td>
<td>Remote sensing - satellite imagery, aerial photographs, land photographs, in situ observations, ground validation</td>
<td>[Number of wetland communities per area unit, Size of wetland vegetation patches (in kg proportion of small wetland patches), Changes in ranges of selected communities]</td>
<td>-</td>
<td>CC, non CC</td>
<td>1410, 3150, 6410, 7210</td>
<td>BNP, BucNP, BUNP, DDBR</td>
<td>HABIT-CHANGE_draft_Habitat_matrix_2011-03-24.xls, Table_indicators_DPSIR.xls, HABIT-CHANGE_RE_4_5_1_selected_indicators_final.pdf, 4-3-1 Selected landscape and habitat cc indicators in the Biastrafional Park.docx</td>
<td>DDBR: Conservation value: 4 (1-5 scale); for this type of habitat we can mention along with dry out/accumulation of organic matter, the flooding phenomena and grazing. There is an alternation between dry and flooding periods. After the flooding (spring) period there are accumulated on the sand soil decomposing organic matter (mostly vegetal remnants brought by floods) that intensify the nitrogen processes, favourable for the appearance of colonial (opportunist) plant species (mostly Gramineae – cereals) in dry (summer) season. Apart from this &quot;natural phenomena&quot; there is an intense grazing activity due to illegal released domestic herbivores in the wilderness.</td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat, general</td>
<td>Reduction of habitats quality, integrity and diversity associated with the reduction of their productivity</td>
<td>Site inspection</td>
<td>[]</td>
<td>-</td>
<td>non CC</td>
<td>RANP</td>
<td>HABIT-CHANGE_3_1_2_Stakeholder_Dialogue.pdf</td>
<td>Pressures: Garbage next to hiking trails Trampling, damages course to hiking trails, noise</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat, general</td>
<td>Disturbance and habitat reduction by density and alignment of air cables</td>
<td>Areal images, site inspection, evaluate planning documents</td>
<td>[]</td>
<td>-</td>
<td>non CC</td>
<td>RANP</td>
<td>HABIT-CHANGE_3_1_2_Stakeholder_Dialogue.pdf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Habitat</td>
<td>Reduction of habitat area, dispersed habitaton</td>
<td>[%, ha, m²]</td>
<td>-</td>
<td>non CC</td>
<td>2110</td>
<td>DDBR, TNP</td>
<td>HABIT-CHANGE_draft_Habitat_matrix_2011-03-24.xls, HABIT-CHANGE_poster Danube DeltaBR_DDNI.pdf, HABIT-CHANGE_3_2_2_CC_included-and-related_pressures_2011-05-05.pdf</td>
<td>Conservation value: 5 (1-5 scale); touristic arrangements and grazing are the main activities that can reduce the habitat.</td>
<td></td>
</tr>
<tr>
<td>Impact R</td>
<td>Habitats and Species</td>
<td>Habitats, Species</td>
<td>Changes in composition of fish fauna</td>
<td>Field survey</td>
<td>[%]</td>
<td>-</td>
<td>non CC</td>
<td>DDBR</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Regarding the fish fauna, in the fresh water of the DDBR’s territory, a recent inventory showed the presence of about 53 native species, and 6 introduced ones. The Giebel carp’s invasion in the whole Danube River basin, after 1970, caused changes in the composition of the fish fauna. This species became dominant through a very efficient strategy of invasion, which had an impact on native species.</td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitats, Species</td>
<td>Changes in the occurrence of boreal species and glacial relics such as e.g.: Betula humilis, Calamagrostis stricta, Carex chordorrhiza, Carex secalina, Empetrum ruginum, Pedicularis scrophularioides, Pinguicula vulgaris, Polemonium caeruleum, Salix lapponum, Saxifraga arcuata</td>
<td>Select and monitor several populations Count plant individuals or shoots that occur in observed plots Every 3 - 5 years</td>
<td>[%, number of species]</td>
<td>-</td>
<td>CC</td>
<td>BNP</td>
<td>3-14_PL_IOS_LKucharski_Raport i EN.doc</td>
<td></td>
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This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF
<table>
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<th>Indicator</th>
<th>Measuring instruction</th>
<th>Unit</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types relevant for HABIT-CHANGE</th>
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<th>Remarks</th>
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<tbody>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitats, Species</td>
<td>Changes in the occurrence of forests with large participation of spruce Picea abies stands, Changes in the occurrence of mesotrophic species in wet alder forests e.g. hazel Corylus avellana in riparian forest communities</td>
<td>Remote sensing, aerial photographs along established selected transects Every 3–5 years</td>
<td>[% number of species]</td>
<td>-</td>
<td>CC</td>
<td>BNP</td>
<td>3.1.4 PL IOS_UKucharski_Raport I EN.doc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitats, Species</td>
<td>Changes in the indigenous aquatic vegetation because of alien species Pits in transects should be placed in vegetation types: Ribes nigrum-Alnetum, Populus-Alnetum, moss swamp of Carex rostrata, sedge meadow of Alnoirocaricion and reed swamp of Phragmites.</td>
<td>Many-year long monitoring at permanent plots. Localized in places where management direct influence is strictly minimized and should not be located in a direct neighbourhood of the river.</td>
<td>[% number of species]</td>
<td>-</td>
<td>CC</td>
<td>BNP</td>
<td>3.1.4 PL IOS_UKucharski_Raport I EN.doc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitats, Species</td>
<td>Changes in species composition and abundance (dominance/habitat): 1. Species richness 2. Cenotic categories 3. Endemic and rare species 4. Ecological categories (ecological structure of the vegetation). Withdrawal of boreal species/marsh &amp; aquatic species (BNP)</td>
<td>Field survey, 3 times/year, during the vegetation season, sampling plots, in situ observations (annually)</td>
<td>[Decrease in ran- ges itabundance/ population numbers of boreal species/marsh &amp; aquatic species]</td>
<td>-</td>
<td>X (BusNP)</td>
<td>CC; non CC</td>
<td>BNP, BusNP, BUNP, DDBR, Habit-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>HABIT-CHANGE_draft_Habitatlis t_matrix_2011-03-24.xls, Tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>High, because the significant changes of climate parameters as temperature or humidity can advantage or disadvantage different plant species, according their ecological plasticity. Based on their species composition, different habitats can be more or less vulnerability to climate changes effects. The indicator reflects the habitat state, induced by the extern driver and the site specific driver.</td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitat, general</td>
<td>Change in general vegetation cover (%) of one habitat. Field survey (large relevées or transects). The field survey methods are different for different types of vegetation – (grasslands, forests, wetlands …). A first evaluation need to be done on the maximum developed period of the vegetation. This will be the reference. Next evaluation can be done every 5 or 10 years, according to the amplitude of the changes of the abiotic parameters.</td>
<td></td>
<td>[%]</td>
<td>-</td>
<td>CC</td>
<td>BusNP</td>
<td>Consolidated_indicators_PK_2011-05-31.doc, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
<td>High, because reflect the vegetation answer to climate change effects (extern driver) and anthropic activities (site specific driver).</td>
<td></td>
</tr>
<tr>
<td>Impact R</td>
<td>Habitats and Species</td>
<td>Habitat, general</td>
<td>General vegetation cover (%) of each vegetation type from the protected area. Mapping for the first year of evaluation. For the successive evaluations a vegetation – Remote sensing intercalibration</td>
<td></td>
<td>[%]</td>
<td>-</td>
<td>CC</td>
<td>BusNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
<td>High, because reflect quickly the direct answer of the vegetation type from the protected area to extern driver and site specific driver.</td>
<td></td>
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</tbody>
</table>
This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF.
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Measuring instruction</th>
<th>Unit</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types (relevant for HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| Impact         | Habitats and Species | Habitats, Species | Abundance of specific species (amphibia) | Monitoring, counting, observation. Concrete methods:  
- complete species inventories  
- visual encounter surveys  
- audio strip transects  
- quadrat sampling  
- transect sampling  
- patch sampling  
- straight-line drift fences and pitfall traps  
- surveys at breeding sites  
- drift fences at breeding sites  
- quantitative sampling of amphibian larvae. | | | | | | HABIT-CHANGE_poster_Vesseval_BR_BR_VTF_TLWJF.pdf | BR, VTF | CC | | |
| Impact         | Habitats and Species | Habitats, Species | Shifts and loss of species relevant for habitat status  
(caused by temperature increase and changes in precipitation pattern) | Site inspection  
(n = number) | [n/ha, n/m², n] | - | | 9110, 9130, 9410, 9480* | | | BR, VTF | | 4-3-3 _Indicators_outline_5_2nd-Vers.doc | | |
| Impact         | Habitats and Species | Habitats, Species | Linear shift of all remaining vegetation belts upslope,  
(because mountain tops are smaller than its bases, present vegetation belts in high elevations will occupy smaller areas, while corresponding species will suffer from population declines and thus may become more vulnerable to genetic and environmental pressure) | - | | | | Calcium rocky slopes with chasmophytic vegetation  
Siliceous rocky slopes with chasmophytic vegetation  
Limestone pavements | TNP | | HABIT-CHANGE_poster_TripelNP_TNP.pdf | | | |
| Impact         | Habitats and Species | Habitat, general | Displacement of habitat by higher temperature and shrubs,  
Change of tree line | | | | | 4060, 6150, 6170, 7240, 8110, 8120 | | | RANP | | HABIT-CHANGE_draft_Habitatlist_matrix_2011-03-24.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf | | | |

**Habitats and Species**

- Shifts and loss of species relevant for habitat status (caused by temperature increase and changes in precipitation pattern).
- Linear shift of all remaining vegetation belts upslope (because mountain tops are smaller than its bases, present vegetation belts in high elevations will occupy smaller areas, while corresponding species will suffer from population declines and thus may become more vulnerable to genetic and environmental pressure).
- Displacement of habitat by higher temperature and shrubs, change of tree line.

**Impact**

- Habitats and Species
- Habitats, Species
- Habitats, general

**CC**

- Changes in populations of temperophilic and hygrophilous butterflies.
- Changes in ranges of mesophitic tree and shrub species (e.g. Corylus avellana in alder woods).

**Key indicator**

- Monitoring, counting, observation. Concrete methods:  
  - complete species inventories  
  - visual encounter surveys  
  - audio strip transects  
  - quadrat sampling  
  - transect sampling  
  - patch sampling  
  - straight-line drift fences and pitfall traps  
  - surveys at breeding sites  
  - drift fences at breeding sites  
  - quantitative sampling of amphibian larvae.

**Remarks**

- Deficits in the natural regeneration because of excessive wild animal stocks.
- Changing mean temperature and precipitation, and damages by storms or pests.
- Loss of the colder climatic zone at higher altitudes; mountaineering, rock climbing, speleology, damage of plants in rocky fissures.
- These vegetation types will be displaced upwards (higher altitude) by increasing temperatures and competition of other vegetation types (from lower altitude); Displacement by shrub invasion.
<table>
<thead>
<tr>
<th>DPSIR category</th>
<th>General phenomenon</th>
<th>Indicator area</th>
<th>Indicator</th>
<th>Measuring instruction</th>
<th>Threshold held</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types relevant for (HABIT-CHANGE)</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitats, Species,</td>
<td>Changes in zonal distribution of plant communities, assessment of its scale, effect and causes (Data of Oświt (1973) may be used)</td>
<td>Permanent monitoring on fixed transects Aerial and satellite photographs, every 10 years at least</td>
<td>[% ha, km²]</td>
<td>-</td>
<td>CC</td>
<td>BNP</td>
<td>3.1.4 PL_IOS_Ukucharew_Raport_EN.doc</td>
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</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, Habitats,</td>
<td>Changes in Species richness/diversity and evenness in respective communities covered by Habitat Directive (BNP), Changes in species diversity, community composition and structure, species richness and evenness according to physiological procedures, Changes in abundance of species according Ellenberg’s indicator values (K – continentalism, F – moisture, temperature – T). Loss (or degradation) of the state of species and habitats targeted by Habitat Directive (BNP, KMNP)</td>
<td>Phytoecological sampling procedures according to Braun-Blanquet standardized by Dengler (2009), every 2-3 years, Site inspection, Total no. of spp. at a site, Shannon- Wiener diversity index (H)</td>
<td>[% number]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BNP, BUNP, KMNP</td>
<td>Tabelle_indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
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</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, Habitats,</td>
<td>Boreal/glacial relics plant richness (No. of boreal plants in herbaceous layer) Changes in % of boreal/glacial relics plants: Betula humilis, Calamagrostis stricta, Carex chodatii, Carex secalina, Empetrum nigrum, Pedicularis scotica-carolinum, Pinguicula vulgaris, Polenonum caeruleum, Saxifraga (No. of boreal/total no. of plants) x100</td>
<td>[%number]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BNP</td>
<td>Tabelle_indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
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<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Disappearance of species depending on vernalization and simplification of the biocenosis structure</td>
<td>[]</td>
<td>-</td>
<td>CC, non CC</td>
<td>6060</td>
<td>BucNP</td>
<td>HABIT-CHANGE_poster_BucegiNP_UNIB.pdf</td>
<td></td>
<td></td>
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<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Disappearance of sensitive species to drought, high temperature and Eutrophication</td>
<td>[]</td>
<td>-</td>
<td>CC, non CC</td>
<td>6150, 6170, 6230*</td>
<td>BucNP</td>
<td>HABIT-CHANGE_poster_BucegiNP_UNIB.pdf</td>
<td></td>
<td></td>
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</tbody>
</table>

This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF
### DPSIR category: Impact, General phenomenon: Habitats and Species, Indicator area: Species, general

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Measuring instruction</th>
<th>Unit</th>
<th>Threshold</th>
<th>Key indicator</th>
<th>CC related</th>
<th>Habitat types relevant for HABIT-CHANGE</th>
<th>Investigation area**</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disappearance of species depending on vernalization</td>
<td>-</td>
<td>-</td>
<td>CC, non CC</td>
<td>BucNP</td>
<td>HABIT-CHANGE_poster_BucegiNP_19.pdf</td>
<td>Touristic activity (high intensity)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Decreasing fitness of plants flowering at summertime, inappropriate fruit set of plants flowering at summertime, Decreasing regeneration potential of populations flowering at summertime</td>
<td>field observations</td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td>Dry summers leads to: s. left</td>
<td></td>
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</tr>
<tr>
<td>Disappearing plant species sensitive to the lack of precipitation (e.g. shallow rooters, chamaephytes), Increasing abundance of plant species more tolerant to the lack of precipitation (e.g. deep rooters, geophytes, tussock grasses, trees, therophytes)</td>
<td>field observations</td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td>Longer rainless periods leads to: s. left</td>
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</tr>
<tr>
<td>Disappearing plant species intolerant of long lasting water cover, Disappearing plant species from the soil surface and their translocation up to the tussocks, Structural changes of insect assemblages (disappearing species laying eggs in the soil), Physiognomic restructuring of vegetation (increasing height and ratio of tussock grasses and sedges), Increasing frequency and abundance of therophytes and ephemer, Increasing frequency and area of gaps, Increasing frequency and abundance of Typha latifolia, Phragmites australis</td>
<td>field observations</td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td>Seasonal high water table leads to: s. left</td>
<td></td>
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<tr>
<td>Leaf burning, Increasing mortality of butterflies (desiccation intolerant insect species)</td>
<td>field survey on plot</td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4.5.1_selected_indicators_final.pdf</td>
<td>Heat waves leads to: s. left</td>
<td></td>
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<td>DPSIR category</td>
<td>General phenomenon</td>
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<td>Measuring instruction</td>
<td>Threshold</td>
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<td>CC related</td>
<td>Habitat types relevant for (HABIT-CHANGE)</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Productivity of vegetation</td>
<td>Sampling plots, measurements in situ (every 2-3 years)</td>
<td>CC</td>
<td>-</td>
<td>BNP</td>
<td>4-3-1 Selected landscape and habitat cc indicators in the Biebrza National Park.docx</td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Increasing nutrient availability, Decreasing plant litter mass, Increasing net primary production, Decreasing fitness of plants flowering at summertime, Extinction of insect populations strongly related to vegetation, Increasing frequency and abundance of hermaphrodites and ephemerals</td>
<td>field observations</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4_S_1_selected_indicators_final.pdf</td>
<td>Wildfires (bushfires) leads to: s. left</td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Habitats, Species</td>
<td>Increasing erosion – increasing proportion of nutrient surface, Higher water flow on the surface supporting dispersal of propagules, Increasing leaf damage in case of broad-leaved plant species, Increasing mortality of flying insects, Spread limitation of flying insect</td>
<td>field observations</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4_S_1_selected_indicators_final.pdf</td>
<td>Heavy rains leads to: s. left</td>
<td></td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Disappearing plant species intolerant of long-lasting water cover, Disappearing plant species from the soil surface and their translocation up to the tussocks, Increasing range and abundance of invasive species and weeds</td>
<td>field observations</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4_S_1_selected_indicators_final.pdf</td>
<td>Floods leads to: s. left</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species</td>
<td>Decline of typical species such as the pike, tench, and others (shift of water habitats to an eutrophic status)</td>
<td>field survey on plot</td>
<td>CC</td>
<td>DDBR</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, Habitats</td>
<td>Increasing probability of long-distance dispersal (LDD) of plant species, Increasing wind damage in tree stands, Increasing probability of long-distance dispersal (LDD) of insect species, Decreasing pollination success in case of insect pollinated flowers</td>
<td>field observations</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4_S_1_selected_indicators_final.pdf</td>
<td>Strong wind blows leads to: s. left</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, Habitats</td>
<td>Change in pollination capacity</td>
<td>field observations</td>
<td>-</td>
<td>-</td>
<td>CC</td>
<td>BUNP, KMNP</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, Habitats</td>
<td>Desiccation of plant species photosynthesis active during winter, Increasing mortality of plant species due to frosts, Decreasing winter survival of insect species hibernated in imago stage</td>
<td>field observations</td>
<td>-</td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
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<td>Impact S</td>
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<td>Species, Habitats</td>
<td>Increasing mortality of plant species due to frosts, Decreasing survival of insect species in imago stage</td>
<td>field observations</td>
<td>-</td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
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<td>Impact S</td>
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<td>Species, general</td>
<td>Increasing range of insects laying eggs in the soil</td>
<td>field observations</td>
<td>-</td>
<td>-</td>
<td>CC, non CC</td>
<td>BUNP</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Appearance of drought tolerant species, Disappearing specialist species with preference to wet meadows, Invasion of weeds, Inappropriate fruit set of plants flowering at summertime, Changing interspecific relations (e.g. competition) among dominant species, Changing trophic relations between plants and herbivores, Increasing frequency and abundance of drought tolerant plant species</td>
<td>field observations</td>
<td>-</td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Abundance of invasive species (BUNP, KMNP), Arrival of thermophilic/invasive species, Rate of Andropogon ischaemum causing degradation (driven by CC – as a C4 type plant species, proper indicator of CC in dryer areas) (BUNP), Coverage of invasive species (especially Solidago spp.) and its rate compared with past (ten) years</td>
<td>in situ measurement: visual encounter surveys and inventories, plot sampling, transect sampling, patch sampling, surveys at breeding sites, ha, m², number, %, Changes in ranges/abundance of thermophilic/invasive species: Invasive richness: No of invasive species, % invasive species (No. of invasive species/total number of plants) × 100</td>
<td>-</td>
<td>CC</td>
<td>BNP, DDBR, KMNP, SNNP, TNP</td>
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<td>Indicator</td>
<td>Thres-hold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types (relevant for HABIT-CHANGE)</td>
<td>Investigation area**</td>
<td>Source</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>(BUNP, KMNP), Change in species diversity and density (BUNP, KMNP), Number and coverage of new alien species (BUNP, KMNP), Invasive species (growing number of naturalized alien species) (DDBR), Number and coverage of new alien species (KMNP), Expansion of invasive species (SNNP), Arise of invasive/thermophilic species (BNP), Changes in phenology (SNNP), Invasion and the expansion of the range of alien species (TNP), Loss of habitat (SNNP)</td>
<td>Larvae counts, etc.; Remote sensing/ phenological observations</td>
<td>invasive species/ total number of plants × 100, Normalized Difference Vegetation Index – NDVI</td>
<td>[]</td>
<td>[CC]</td>
<td>[BNP]</td>
<td>4-3-1 Selected landscape and habitat cc indicators in the Biebrza National Park.docx</td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Species shifts (caused by temperature increase and changes in precipitation pattern), Increasing range and abundance of xerophilous insect species (BUNP)</td>
<td>Sampling plots, in situ observations (annually)</td>
<td>[]</td>
<td>[CC]</td>
<td>[BNP]</td>
<td>[DDBR]</td>
<td>[VTF]</td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Non-native richness (No. of non-native species (excluding ambiguous genera)) % non-natives (No. of non-native species/total no. of plants (excluding ambiguous genera) × 100), % cover of non-native spp. (% cover of non-native spp./no. of plots), % of dominant plants that are non-native (No. of non-native plants with cover &gt; 5 %/total no. of plants with cover &gt; 5 %)</td>
<td>[]</td>
<td>[CC, non CC]</td>
<td>[BNP]</td>
<td>[DDBR]</td>
<td>Tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Presence of alien species</td>
</tr>
<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, general</td>
<td>Antagonism arising from introduction of species (Alien species plantation and illegal wood cutting activities)</td>
<td>[]</td>
<td>[non CC]</td>
<td>[DDBR]</td>
<td>[DDBR]</td>
<td>HABIT-CHANGE_poster Danube DeltaFI_DDN4.pdf</td>
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<th>CC related</th>
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<td>Habitats and Species</td>
<td>Species, general</td>
<td>Changes in phenology, length of vegetation season (Shifts in length of respective phenological phases/shifts in duration of phenological phases – numbers of days; shifts in duration and start/end of phenological season)</td>
<td>Remote sensing/phenological observations</td>
<td>[Normalized Difference Vegetation Index – NDVI]</td>
<td>-</td>
<td>CC</td>
<td>6510, 6520</td>
<td>BR VTF, BUNP</td>
<td>HABIT-CHANGE_poster Vessertal BR_BRTVT_TLWJ.pdf, HABIT-CHANGE_4.5.1_selected_indicators_final.pdf, 4.3.2_indicators_outline_5_2nd_Vers.doc</td>
<td>Abandonment of pastoral systems &amp; consequential natural succession</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, Habitats</td>
<td>Altering phenology (RANP, BUNP), inappropriate pollination by insect vectors (BUNP), Increasing vulnerability by early frosts (BUNP), Increasing number of generation of insects (BUNP), Increasing abundance of insects (BUNP)</td>
<td>field observations, Remote sensing/phenological observations, Field survey on plots, nets</td>
<td>[Normalized Difference Vegetation Index – NDVI]</td>
<td>-</td>
<td>CC</td>
<td>BUNP, RANP</td>
<td>HABIT-CHANGE_4.5.1_selected_indicators_final.pdf, 4.3.2_indicators_outline_5_2nd_Vers.doc, HABIT-CHANGE_4.3.3_selected_applicable_indicators.pdf</td>
<td>Increasing length of vegetation period leads to: s. left</td>
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<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Species</td>
<td>Pinus mugo (mezo-mezohigrophyte and psychothermophyte) can be affected</td>
<td></td>
<td></td>
<td></td>
<td>CC, non CC</td>
<td>4070*</td>
<td>BucNP</td>
<td>HABIT-CHANGE_poster BucegiNP_Unib.pdf</td>
<td>➤Touristic activity (high intensity)</td>
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<tr>
<td>Impact</td>
<td>Habitats and Species</td>
<td>Species</td>
<td>Changes in species composition: increase of scrub abundance, in particular expansion of Pinus mugo; accordingly many alpine species will lose major parts of their habitats Replacement of currently dominant species by a more thermophile species, Invasion and expansion of alien species with a wider environmental tolerance, short juvenile periods, and long distance dispersal, Warming-induced upward migrations of alpine grassland species (restricted to “stepping stones” at stable and rocky ridges), Changes in geoelement structure: Loss of arctic and alpine plant species, increase of cosmopolites and Mediterranean species; changes in phenology (Late successional plant communities, like Carex curvula alpine grasslands, may resist climatic changes for long periods due to clonal growth strategy), Changes in biomass and productivity: increase of C/N ratio in the biomass, would lead to reduced food quality for herbivores and to alterations in decomposition processes.</td>
<td></td>
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<td>CC, non CC</td>
<td>Alpine and subalpine calcareous grasslands Rupicolous, calcareous or basophilic grasslands of the Alysso-Sedicion albi Siliceous alpine and boreal grasslands</td>
<td>TNP</td>
<td>HABIT-CHANGE_poster TriglavNP_TNP.pdf</td>
<td>Temperatures will increase for +2 °C and precipitation decrease for -30 (-60) mm in August climatic warming-earlier snow melt in spring; warmer and wetter weather conditions elevated CO2 concentration Mountaineering, erosion, intensive grazing, trampling, fertilization</td>
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<td>DPSIR category</td>
<td>General phenomenon</td>
<td>Indicator area</td>
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<td>Measuring instruction</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types (relevant for HABIT-CHANGE)</td>
<td>Investigation area**</td>
<td>Source</td>
<td>Remarks</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species, Land use</td>
<td>Species</td>
<td>Changes in ecosystem services (BUNP, KMINP), Changing ecosystem processes may have impacts on ecosystem services, like pollination, hay production, grazing regimes (TNP), Missing amount of hay (for feeding the livestock) (BUNP, KMINP)</td>
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<td>BUNP, KMINP, TNP</td>
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<tr>
<td>Impact S</td>
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<td>Species</td>
<td>Changes in vegetation structure, pattern and type (BUNP, KMINP), Changes in state (and esp. species composition) of forests (BUNP), Plant ecological numbers (Ellenberg system transformed for Hungarian conditions): temperature, moisture, continentalism (BUNP, KMINP), Increasing extinction of perennial grasses (BUNP), Decreasing mortality rate due to lowering pathogenic fungi infection in insect populations (BUNP)</td>
<td>field survey on plot</td>
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<td>CC, non CC</td>
<td>BUNP, KMINP</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species, Land use</td>
<td>Species</td>
<td>Numbers of moisture loving diurnal butterflies (Umbrella species (examples): Lepidoptera (butterflies) on peatlands – Vicinia opaltea, Bilboa apivora, on meadows – Lycaena dispar, Melitaea axia, M. teleius, M. nausis, Melitaea diamina, Euphydryas aurinia and Heteropterus Minyus). (No. of moisture loving butterflies per transect), Numbers of warm loving and xerophilic diurnal butterflies, (No. of xerophilic diurnal butterflies per transect), Changes in species composition of coenoses of diurnal butterflies, (Change in species composition per observation plots)</td>
<td>field survey on plot</td>
<td>[Number, %]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BNP</td>
<td>Tabelle_indikatoren_DPSIR.xls, Consolidated_indicators_PIK_2011-05-31.doc, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, 31-4 PL_03_AGawronski_Report_EN.doc</td>
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This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF
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<td>Odonata - Naiadinae species, Aeshna ciarula, A. juncoa, A. suberecta, Somatochlora arctica, S. apoleo, Libellula fulva,</td>
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<td>Leucorina albitrons, L. caudalis, L. dubiae and L. pectoralis</td>
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<td>Vaginaria opalinus and Bethoria aquilonaris</td>
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<td>Lycas dispar - Lycaena dispar, Maculinea alcon, M. teleius, M. nausithous, Melitaea damnea</td>
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<td>C. trilobatum</td>
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<th>Source</th>
<th>Remarks</th>
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<td>Impact, S</td>
<td>Habitats and Species</td>
<td>Species</td>
<td>Shifts in numbers/dominance of species referring to the desired habitat type (BUKNP, KMNP)</td>
<td>field survey on plot</td>
<td>number, %</td>
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<tr>
<td>Impact, S</td>
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<td>Species</td>
<td>Species composition of the entire breeding bird community, Species composition of the breeding bird community occurring in the respective habitat types, such as woodland, mines or in selected portions, Number of bird populations of individual species or species groups (e.g. waterbirds, woodbirds, rare bird species, common birds in rural landscape), Density and domination of individual bird species on selected plots</td>
<td>Observation, counting</td>
<td>number, %</td>
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<td>BNP</td>
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<td>Natural succession (Water level), Water level changes caused by temperature increase and changes in precipitation pattern</td>
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<td>Impact</td>
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<td>Changes of humidity, soil moisture and vegetation patterns, in particular in bogs are expected. The same is expected for terrestrial habitats, in particular forest ecosystems and alpine grasslands above tree-line.</td>
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<td>Decreasing biodiversity due to fertilisation</td>
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<td>Semi-natural dry grasslands &amp; scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites) Lowland hay meadows (Alpines of pratensis, Sanguisorba officinalis)</td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species, Habitats</td>
<td>Vegetation types would not exist anymore, if cultivation practices change (e.g. stop of cutting the grass or pasturing)</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>6323, 6520</td>
<td>RANP</td>
<td>HABIT-CHANGE_draft_Habitatli st_matrix_2011-03-24.xls</td>
<td></td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species</td>
<td>Species</td>
<td>Increasing probability of wildfire (BUNP)</td>
<td></td>
<td>-</td>
<td>CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
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<tr>
<td>Impact S</td>
<td>Habitats and Species, Land use</td>
<td>Species</td>
<td>Absorption CO₂ rate by vegetation cover (SNNP), Carbon storage capacity of vegetation (carbon balance) (BUNP, KUNP)</td>
<td>CO₂ = f (PRI x NDVI), PRI = Photochemical Reflectance Index, NDVI = Normalized Difference Vegetation Index</td>
<td>-</td>
<td>CC, non CC</td>
<td>BUNP, KUNP, SNNP</td>
<td>Tabelle_lndikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
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<tr>
<td>Impact S</td>
<td>Soil Processes, Composition</td>
<td></td>
<td>Decreasing litter decomposition, Decreasing volume of nutrient cycle, Decreasing N mineralization, Decreasing soil respiration (BUNP)</td>
<td></td>
<td>-</td>
<td>CC, non CC</td>
<td>BUNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Decreasing mean precipitation leads to:</td>
<td></td>
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<tr>
<td>Impact S</td>
<td>Soil Processes, Substrate</td>
<td></td>
<td>Sediment disposal (Smothering of bed, alteration of invertebrate assemblage), Removal of substrate (Loss of habitat)</td>
<td></td>
<td>-</td>
<td>non CC</td>
<td>DDBR</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td>Caused by dredging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Soil Processes, Substrate</td>
<td></td>
<td>Soil organic matter mineralization and CO₂ emission (Investigation plots, monthly, every 5 years)</td>
<td>In situ (plots) measurement of CO₂-emission, laboratory automatic analyser</td>
<td>[mg/m²/time unit]</td>
<td>-</td>
<td>CC</td>
<td>4-3-3_indicators_alltime_5_2nd_Viera.doc, HABIT-CHANGE_4_5_3_monitoring_techniques_2011-01-31.pdf</td>
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<td>Measuring instruction</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for (HABIT-CHANGE)</td>
<td>Investigation area**</td>
<td>Source</td>
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<tr>
<td>Impact S</td>
<td>Soil</td>
<td>Processes, Composition</td>
<td>Soil quality indicators/procedures as in soil monitoring</td>
<td>Sampling plots, as in soil monitoring</td>
<td>0</td>
<td>-</td>
<td>CC, non CC</td>
<td>BNP</td>
<td>4-3-1 Selected landscape and habitat cc indicators in the BiebrzaNational Park.docx</td>
<td></td>
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</tr>
<tr>
<td>Impact S</td>
<td>Soil</td>
<td>Soil water</td>
<td>Changes in plant communities as indicators of unfavourable changes in soil hydrographic conditions.</td>
<td>Permanent plots in best preserved patches of the plant communities Each of selected ranges has to occupy area of no less than 500 m². Every 5 years at least</td>
<td>[% number of species]</td>
<td>-</td>
<td>CC</td>
<td>BNP</td>
<td>3.1.4_PL_IOS_UKucharski_Raport I EN.docx</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Impact R</td>
<td>Hydrologic cycle</td>
<td>Surface water, Habitats</td>
<td>Presence of water</td>
<td>% share of water bodies per area unit</td>
<td>Land cover analysis, Remote sensing - satellite imagery, aerial photographs</td>
<td>[%]</td>
<td>-</td>
<td>CC, non CC</td>
<td>BNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf, HABIT-CHANGE_4_3_1_indicators_landscap_e_and_habitat_level_2011-03-14.pdf</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Impact S</td>
<td>Hydrologic cycle</td>
<td>Surface water, Habitats</td>
<td>Change in water table (Loss of wetlands, loss of spawning areas)</td>
<td></td>
<td>[m, %, ha]</td>
<td>-</td>
<td>CC, non CC</td>
<td>DDBR</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf,</td>
<td></td>
<td>Caused by dredging</td>
<td></td>
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</tr>
<tr>
<td>Impact S</td>
<td>Hydrologic cycle</td>
<td>Surface water, Habitats</td>
<td>Increasing of moisture deficiency in sites which are located besides river valley (Loss of wetlands)</td>
<td></td>
<td>[m, %, ha]</td>
<td>-</td>
<td>CC</td>
<td>BNP</td>
<td>3.1.4_PL_IOS_UKucharski_Raport I EN.docx</td>
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<tr>
<td>Impact S</td>
<td>Hydrologic cycle</td>
<td>Surface water, Habitats</td>
<td>Change of water-level of lake (occasional low water level as well as high water level during rainy periods) During rainy periods the discharge through the sluice gate causes flooding and inundation problems continually along the Hanság-channel (area) Water quality problem especially in the reed belt area</td>
<td></td>
<td>[m, ca, %, ha, km²]</td>
<td>-</td>
<td>CC, non CC</td>
<td>DDBR</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
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<td></td>
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</tr>
<tr>
<td>Impact S</td>
<td>Hydrologic cycle</td>
<td>Surface water, Habitats</td>
<td>Altered flow regime and habitat (Variation in flow characteristics (volume, velocity, depth)) (DDBR)</td>
<td></td>
<td>[]</td>
<td>-</td>
<td>non CC</td>
<td>DDBR</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
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<td>DPSIR category</td>
<td>General phenomenon</td>
<td>Indicator area</td>
<td>Indicator</td>
<td>Measuring instruction</td>
<td>Unit</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for (HABIT-CHANGE)</td>
<td>Investigation area**</td>
<td>Source</td>
<td>Remarks</td>
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<tr>
<td>Impact S</td>
<td>Hydrologic cycle</td>
<td>Surface water, Habitats</td>
<td>Change in water regime of habitats (less snow cover and less water in summer). Less snow cover in winter season (TNP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RANP, TNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Hydrologic cycle</td>
<td>Surface water, frozen</td>
<td>Decline and ongoing retreat of the Triglav glacier. Retreat of the permanent glaciers by increasing temperatures and melting of the permanent ice (RANP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RANP: 8340</td>
<td>RANP, TNP</td>
<td>Consolidated_indicators_PK_2011-05-31.doc, HABIT-CHANGE_staff_Habitatlist_matrix_2011-03-24.doc</td>
</tr>
<tr>
<td>Impact</td>
<td>Hydrologic cycle</td>
<td>Surface water, Pollution</td>
<td>Increased pollution of springs due to the impact of visitors and mass tourism in the mountains (TNP), Concentration of water pollutants and organic matters (followed by algal bloom) in fresh waters may be caused by decreasing water level of lakes and other water bodies (TNP)</td>
<td></td>
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<td></td>
<td></td>
<td>TNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
<td></td>
</tr>
<tr>
<td>Impact S</td>
<td>Landscape, Tourism</td>
<td>Landscape</td>
<td>Changes in the landscape view (positive/negative)</td>
<td></td>
<td></td>
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<td></td>
<td>BUNP, KUNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls, HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
<td></td>
</tr>
<tr>
<td>Impact R</td>
<td>Landscape, Tourism</td>
<td>Landscape</td>
<td>Area visually affected by disturbance (% of area classified as visually disturbed per area unit)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>BNP</td>
<td>HABIT-CHANGE_4_5_1_selected_indicators_final.pdf</td>
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<tr>
<td>Impact</td>
<td>Landscape, Tourism</td>
<td>Tourism</td>
<td>Changing capacity for tourism, Since the end of 80's and the beginning of 90's the decrease of the winter season (snow cover) has reduced the income from winter tourism, Changes of income of people living from tourism and/or management</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>BUNP, TNP</td>
<td>Tabelle_Indikatoren_DPSIR.xls</td>
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<tr>
<td>DPSIR category</td>
<td>General phenomenon</td>
<td>Indicator area</td>
<td>Indicator</td>
<td>Measuring instruction</td>
<td>Unit</td>
<td>Threshold</td>
<td>Key indicator</td>
<td>CC related</td>
<td>Habitat types relevant for HABIT-CHANGE</td>
<td>Investigation area**</td>
<td>Source</td>
<td>Remarks</td>
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<tr>
<td>Impact</td>
<td>Landscape; Tourism; Farming</td>
<td>Tourism</td>
<td>Decrease of the winter season (snow cover); Impacts on mountain farming and ecotourism Increasing subventions following extreme weather events for farmers are expected</td>
<td>[]</td>
<td>-</td>
<td>CC</td>
<td>TNP</td>
<td>Table_Indikatoren_DPSIR.xls</td>
<td></td>
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<tr>
<td>Impact</td>
<td>Power supply</td>
<td>Water power; Electricity</td>
<td>Changes in production of electricity power; greater prices of electricity power (due to changed water regime of running waters are expected)</td>
<td>[]</td>
<td>-</td>
<td>CC</td>
<td>TNP</td>
<td>Table_Indikatoren_DPSIR.xls</td>
<td></td>
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</tbody>
</table>

* E = External, R = Regional, S = Site specific (Pressure/Impact)

** BNP = Biebrza National Park, Poland; BR FEB = Flusslandschaft Elbe - Brandenburg Biosphere Reserve, Germany; BR VTF = Vessertal - Thuringian Forest Biosphere Reserve, Germany; BUNP = Balaton Uplands National Park, Hungary; BucNP = Natural Park Bucegi, Romania; DDBR = Danube Delta Biosphere Reserve, Romania; FHNP = Fertő - Hansag National Park, Hungary; KMNP = Koros-Maros National Park, Hungary; LNNP = Lake Neusiedl National Park, Austria; NP SES = Sečovlje Salina Nature Park, Slovenia; RANP = Rieserferner - Ahn Nature Park, Italia; SNNP = Shatsk National Natural Park, Ukraine; TNP = Triglav National Park, Slovenia.
4. Referencing and Citation

4.1. Literature, Maps and Plans


This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF


Studii, metode și ecotechnici de gospodărire durabilă a pășunilor din Parcul Natural Bucegi (Studies, methods and ecotechnics for the sustainable management of grazing lands in Bucegi Natural Park), contract no 318/2004, ICDPP, Brașov.

Szegedi S, Karácsonyi Z, Tar K, Kircsi A 2006. Possible impacts of climate change on lakes and wetlands in Hungary. *Department of Meteorology, **Centre for Environmental Management and Policy, University Of Debrecen.


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Frischbier N and Profft I 2011. Report and maps with potential forest habitat changes, Output 3.2.4, HABIT-CHANGE Report [HABIT-CHANGE_3_2_4_potential forest habitat changes_2011-09-30.pdf].

Frugile A G 2010. Estimating usefulness of faunistic indicators for the assessment of habitat vulnerability to climate change within a protected area – List of potential faunistic indicators related
to climate change within the area of the Biebrza National Park, unpublished HABIT-CHANGE Expertise within Output 3.1.4 [3.1.4_PL_IOS_AGFrugile_Raport I EN.doc].


Kucharski L 2010. Indicators of habitat and landscape changes in protected areas (on example of the Biebrza National Park) in view of climate changes, unpublished HABIT-CHANGE Expertise within Output 3.1.4 [3.1.4_PL_IOS_LKucharski_Raport I EN.doc].


Sienkiewicz J and Ostrowska A 2010. Selected landscape and habitat level indicators of climate change in the Biebrza National Park (BNP), unpublished HABIT-CHANGE Contribution within Output 4.3.1 [4-3-1 Selected landscape and habitat cc indicators in the Biebrza National Park.docx].

Sienkiewicz J and Ostrowska A (IOS), IOER, PIK, UniV, SIU, BUNP, EURAC, NPSES 2010. Report on indicators for change on landscape and habitat level – draft, Output 4.3.1, HABIT-CHANGE Report [HABIT-CHANGE_4_3_1_Indicators_landscape_and_habitat_level_2011-03-14.pdf].


Vohland K 2011. Table 1-Consolidated Indicators, impacts, small collection of indicators, responses, land use, unpublished HABIT-CHANGE Contribution within Output 3.1.4 [Consolidated_indicators_PIK_2011-05-31.doc].


This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF

Sârbu A, 2010. Adaptive management – a significant challenge for protected areas, in conditions of climate change [focus on Bucegi Natural Park], unpublished Poster from 3rd HABIT-CHANGE partner meeting in Portorož [HABIT-CHANGE_poster BucegiNP_UniB.pdf].
5. Appendix
Arkadiusz Gawroński FRUGILE

Estimating usefulness of faunistic indicators for the assessment of habitat vulnerability to climate change within a protected area

List of potential faunistic indicators related to climate change within the area of the Biebrza National Park

Expertise under the Project EU INTERREG IV B CENTRAL EUROPE HABIT CHANGE (2CE 168P3) WP3 3.1.4 No IOŚ: 80-OP-BO-8032

Contract No 10/BO/PE/2010

Complex description of biodiversity and its changes is perceived as basic challenge, now and in the future, for both ecologists and people involved in nature conservation. Attempts at estimating biodiversity and variability of communities of various organisms have been focusing interests of scientists representing various disciplines for some tens of years. Scientific efforts so far resulted in the development of numerous indices which better or worse illustrate variability in the nature. The most popular so far have been the Simpson index taking into account the relative abundance of a species, the Shannon index, determining the probability of finding two different species in a sample of two taken from the sampled population, and the Margalef index of species richness. The development of computer techniques allows for the construction of new mathematical models, however, both complexity of problems and limited number of standardised data render impossible the fully satisfying achievement of the state of the art.

Invertebrates, in contrast to a much better recognised group of vertebrates, are a group for which the research enabling to acquire comparable qualitative or even quantitative data is still in the primordial development stage. Exceptions are certain groups of diurnal insects which conduct an active life style, such as diurnal butterflies or dragonflies for which it is fairly easy to achieve quite well standardized results. Moreover, these two groups are pretty well recognised as concerns their ecology and environmental requirements, while sensitivity of many a species to environmental changes makes them excellent indicatory organisms. The Biebrza valley is fairly well recognised with respect to the occurrence of diurnal butterflies though comparison data from the period prior to 1990 are lacking. A comprehensive elaboration by Frąckiel, providing a summary of studies from the years 1991-1998 appeared in

This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF
1999. The subsequent elaboration of the same data was published in the monograph of the Biebrza National Park (Frąckiel 2005). Apart from those there are no published data which enable any analysis of the abovementioned group from the area of the Biebrza valley. Interesting data will be published in the Atlas of distribution of diurnal butterflies in Poland now under preparation. This is a continuation of the edition summing up all the information on the occurrence of diurnal butterflies in Poland in the years 1986-1995 (Buszko 1997).

On the basis of the above data the analyses will be carried out with the aim to determine changes in the groupings of diurnal butterflies in various types of ecosystems. Analyses will be concentrated first of all on the following issues:

- Changes in the occurrence of moisture loving species of diurnal butterflies in the Biebrza valley;
- Changes in the occurrence of warm and drought loving species of diurnal butterflies in the Biebrza valley;
- Shifts in species composition of diurnal butterfly associations in fen habitats in the Biebrza valley.

The analyses will consist in comparisons of the percent proportions and in verification of significance of the changes that occurred over a ten-year period. Bearing in mind that local ecosystems undergo considerable transformations, these analyses shall enable to determine the scale of changes from the angle of the group examined. The contribution of climatic component in the processes observed needs to be considered in a wider scale, taking into account not only the results obtained in the Biebrza valley but also the supra-regional trends of changes in ranges of individual species, dynamics of metapopulations, intraspecific interactions as well as changes in ecology of respective species due to changes in the environment.

Based on the results of analyses and data collected during the following stages of the Project, when preparing and testing the monitoring assumptions an attempt will be made to elaborate indices for determination of climate induced habitat changes in the Biebrza valley. Such indices may be described with the use of parameters both quantitative (concerning species composition and proportions of respective ecological groups) and qualitative based upon numbers and/or domination structure.
In view of the fact mentioned earlier that reliable data for diurnal butterflies can be easily obtained, the above group constitutes an object of interests of numerous scientists studying the impact of climate change on wildlife. The results of these works suggest a considerable effect of climate change on this group (Fleishman et al. 2009, Gilman et al. 2010). The studies in question deal with shifts in occurrence ranges (Carroll et al. 2009, Foristera et al. 2010), changes in vertical ranges (Virtanen and Neuvonen 1999), and species richness (Kivinen et al. 2007). To the other aspects examined which also undergo accelerated evolution due to climate change belongs: behaviour (Papaj et al. 2007) dynamics and species ecology, and especially, phenology of the respective developmental stages of organisms (Feehan et al. 2009). There are also attempts at describing the above issues in the light of study of genetic variability of respective species (Schmitt and Seitz 2001, DeChaine et al. 2004).

The above observations will also be taken into account when elaborating indices for the purpose of the Project.

List of potential faunistic indicators related to climate change within the area of the Biebrza National Park

Umbrella species

Among the groups of fauna, insects are of special importance for monitoring changes in wetlands, especially, the so called umbrella species amongst insects which are very useful as indicators in small wetlands. Depending upon site type, species of various taxonomic groups will be used as umbrella species for monitoring. Most typical insect species which may be used as umbrella species for monitoring aquatic and wetland environments in the Biebrza valley include:

Running waters, example of species:

Odonata - dragonflies, including Calopteryx virgo, Gomphus flavipes, Onychogomphus forcipatus, Ophiogomphus cecilia, Cordulegaster boltontii, C. coeruleascens

Heteroptera - Aphelocheirus aestivalis

Trichoptera - Allogamus starmani, Ithytrichia lammelaris, Oligoplectrum maculatum

Hydropsyche ornatula and H. saxonica

Coleoptera - Platambus maculates
Lakes, oxbows:

**Odonata** - Cercion lindeni, Epitheca bimaculata, Leucorrhinia albitrons and L. caudalis

**Trichoptera** - Erotesis baltica

**Coleoptera** - Dytiscus latissimus and Ilybius fenestratus

Various ponds in peatlands:


**Heteroptera** - Notonecta lutea

**Coleoptera** - Graphoderus bilineatus and Dytiscus lapponicus

**Trichoptera** - Hagenella clathratha

Raised bogs and swampy pine forests:

**Lepidoptera** butterflies including Vacciniina optilete and Boloria aquilonaris

Meadows:

**Lepidoptera** - Lycaena dispar, Maculinea alcon, M. teleius, M. nausithous, Melitaea diamina

**Euphydryas aurina** and **Heteropterus morpheus**

Various ponds:

**Odonata** - Coenagrion armatum and C. lunulatum
References


Leszek Kucharski

Indicators of habitat and landscape changes in protected areas (on example of the Biebrza National Park) in view of climate changes

Expertise under the Project EU INTERREG IV B CENTRAL EUROPE HABIT CHANGE (2CE 168P3) WP3 3.1.4 No IOŚ: 80-OP-BO-8032
Contract No 12 /BO/2010

Introduction
Geobotanic and landscape indicators provide bases for assessing the state and changes in the environment. Particularly valuable elements in this assessment are plant communities. At present, use is being made of indicatory role of vegetal cover and plant communities to an ever growing extent, both in practice and in scientific considerations regarding, among other things, global changes in the natural environment, including climate warming (Roo-Zielińska 2004; Roo-Zielińska, Solon, Degórski 2007). Below there are presented several indicators based on plant species that may be used in assessing changes which occur in the environment of the Biebrza National Park. Despite that there is a comprehensive literature concerning the Biebrza National Park (over 1600 items) our knowledge about the past vegetation conditions is limited. The biggest problem is the lack of research conducted on permanent plots, results of which would be an excellent material for diagnosing the changes in the Park’s vegetation and flora. This work presents options for an established system of permanent plots which can help in providing lacking information in the existing study on vegetation.

1. Assessment of climate change impact on indigenous flora composition of the Biebrza National Park
The flora of the Biebrza National Park, composed of almost 1,000 species, is characterized not only by richness but also by a significant diversity. One of characteristic features is the occurrence of boreal species and glacial relicts such as e.g.: Betula humilis, Calamagrostis stricta, Carex chordorrhiza, Carex secalina, Empetrum nigrum, Pedicularis sceptrum-carolinum, Pinguicula vulgaris, Polemonium caeruleum, Salix lapponum, Saxifraga hirculus and numerous bryophyte species (Werpachowski 2000). These species can be a very good indicator of changes that occur in the Biebrza National Park vegetation. To assess these changes, several
populations of the species listed above should be selected and monitored. The monitoring would consist in counting plant individuals or shoots that occur in observed plots. Studies should be repeated in 3 - 5 years.

One of the Biebrza National Park’s characteristic features is the occurrence of forests with large participation of spruce *Picea abies* stands. This species can be another vegetation element that can be used as bioindicator of changes occurring in the Park as a result of climate changes. In order to assess changes in the share of spruce stands, aerial photographs could be used in selected forest stands.

An increasing occurrence of mesotrophic species in wet alder forests can inform about negative changes that take place in wetlands of the Biebrza National Park. An increased share of this kind of species, as e.g. hazel *Corylus avellana* is already noted in riparian forest communities. The presence of hazel shrub could be monitored by using remote sensing. Aerial photographs should be taken every three to five years along the established selected transects.

2. Invasive alien species as moisture change indicators

Invasive alien species are a real threat to indigenous biological diversity. Plants that penetrate new habitats can dominate indigenous flora and cause environmental damages. Climate changes (Simberloff 2000, Nawrot 2009) can stimulate their expansion to the north. This may be observed even in the far northern areas (Tatur 2007; Integrating Climate Change ... 2008).

*Impatiens parviflora* is one of the most invasive herb species in the Polish forests. The phenomenon of expansion of this species in wet woodlands and in riparian forest communities was repeatedly described (Obidziński, Symonides 2000; Sudnik-Wójcikowska, Lipka 1998; Sokołowski 1996, 1997). In recent years, the invasion of this species into alder wood communities is observed. It was recently noted in a wet alder wood in the “Kopanicha” reserve located near to Skierniewice, central Poland.

*Solidago serotina* is also an invasive species that penetrates natural and semi-natural communities that occur in moist and swampy habitats. This species penetrates most often the abandoned meadows or pastures where surface peat layer decays because of impaired hydrological conditions. This phenomenon is observed in both Central Poland in the Kampinoski National Park (Otręba 2008) and in the Mazury Lakeland. On the alluvial plain of the Biebrza National Park the American newcomer *Bidens frondosa* has been observed. It is another invasive species that
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prefers swampy habitats. *Echinocystis lobata* is a common element of the reed bed zone; it occupies locations nearest to the river bed. Participation of this species in the reed bed vegetation in the Biebrza National Park probably increased in the past several years.

The assessment of intensity and scale to which the flora of the Biebrza National Park is endangered because of alien species penetration of indigenous aquatic vegetation is possible during many-year long monitoring at permanent plots. They should be localized in places where meadow management direct influence is strictly minimalized. Plots in transects should be placed in the following vegetation types: *Ribeso nigri-Alnetum*, *Fraxino-Alnetum*, moss swamp of *Caricion lasiocarpace*, sedge reed swamp of *Magnocaricion* and reed swamp of *Magnocaricion*. Phytocoenoses that are under monitoring should not be located in a direct neighbourhood of the river.

3. Plant communities as indicators of unfavourable changes in soil hydrographic conditions

The succession of swampy alder wood vegetation based on increased site eutrophicity and decreased moisture conditions has been observed in Poland since several years. Most often a transformation into the oak-hornbeam phytocoenose has been noted.

*Ribeso nigri-Alnetum* or alder wood swamp community belongs to the most exposed to the process of transforming into the riparian forest and the oak-hornbeam phytocoenoses. The processes of alder wood transformation into the riparian forest were described in the second half of the past century in the Gostynińsko-Włocławski Landscape Park area (the “Olszyny Rakutowskie” nature reserve). In the period of 1969-2002, the share of species typical of the swamp alder wood decreased significantly while the vegetation cover of species typical of riparian forests increased (Rejewski, Olesińska 1974; Cyzman, Rejewski 1992; Cyzman, Kannenberg 2008). This phenomenon happens in several stages. During the first one it is visible that the participation of aquatic and marsh plants that are characteristic of flooded terraces decreases. Their places are taken by plants typical of dryer habitats, as e.g. the species of wet meadows communities. One of the succession stages that lead to the riparian forest is the stage of *Poo-Alnetum*, where grasses have a significant share (i.a. *Poa trivialis*) (Olaczek 1972). The riparian forest can be the next stage; further
soil drainage causes transformation of ground vegetation to the one typical of moist forest while shrubs of hazel *Corylus avellana* took more place in the undergrowth.

The influence of changes in hydrological conditions can be observed in other plant communities. Forest research conducted in the nature reserve Wilcze Marshes (in the Augustów Forest) showed that plant community *Betula pubescens-Thelypteris palustris* (*Thelypteridi-Betulum typicum*), which is also recorded in the Biebrza National Park, reacts to the decreased soil surface moisture by the increased participation of species typical of eutrophic forests communities such as those of riparian forests (Chojnacki 2003).

At present, the largest contribution in the forest vegetation of the Biebrza valley have birch forests having a character of alder birch swamp forests (so-called wetland birch grove) *Salici-Betuletum* (Czerwiński 1991, 1999). The plant community develops on deep and semi-deep peat soils derived from rushes and sedges. These woods overgrow the areas with spring-summer flooding, periodically drying up, where inundation water plays a vital role in the hydrographic conditions. *Salici-Betuletum* in the Biebrza National Park is not a uniform community. In the forest stand there dominates *Betula pubescens* with a small admixture of *Alnus glutinosa* and *Salix pentandra*, without *Picea abies* and *Pinus sylvestris*. In the undergrowth there prevail the species of classes: *Alnetea glutinosae*, *Molinio-Arrhenatheretea* and *Phragmitetea*, and to smaller degree the species of *Vaccinio-Piceetea* and *Scheuchzerio-Caricetea nigrae* can be found (Czerwiński 1972, 1991). In the area with unstable hydrological conditions, e.g. in the Brzeziny Ciszewskie range (Central Basin of Biebrza valley), a degenerated form of birch grove with nettle *Betula-Urtica* can be found, which has a character of dense birch brushwood with a small share of *Salix cinerea* and *Salix rosmarinifolia*. Its undergrowth is dominated by nitrophile species, among them are: *Urtica dioica*, *Galium aparine*, *Rubus idaeus* (Pałczyński 1975, Banaszuk 2004).

Bog moss communities of *Ledo-Sphagnetum* and *Vaccinio uliginosi-Pinetum* are bound with raised bogs. Despite the small area which they take in the Biebrza National Park, they may be a valuable indicator of the Biebrza National Park environment. Preliminary assessment of the bog moss wood condition indicates that unfavourable changes are taking place in them. An increased participation of plant components that are characteristic of *Molinio-Pinetum* moist forest are observed, among them such species as: *Betula pubescens*, *Frangula alnus* and *Molinia*
caerulea, while the area occupied by Vaccinium uliginosum, Ledum palustre and by the species characteristic of the Class Oxycocco-Sphagnetea diminishes.

The forest communities mentioned above that can be found in the Biebrza National Park may serve as indicators of climate changes, a result of which are changes in hydrological conditions in soils of the Park. To detect these changes, it is necessary to set up permanent plots in the best preserved patches of the above listed plant communities and to conduct a systematic monitoring. Each of the selected ranges has to occupy the area of no less than 500 m². Phytosociological relevés should be made on them every five years at least.

4. Changes in zonal distribution of plant communities in the Biebrza valley caused by climate change

Zonal distribution of plant communities that has been preserved in the Biebrza valley with its nearly original composition is a unique on the Europe scale. It may serve as a model to which the naturalness of other lowland river valleys may be compared.

The major part of the Biebrza valley area is occupied by peat bogs, among which fens dominate. The vegetation that covers them shows a distinctly zonal distribution. The transversal and longitudinal zonal distribution is observed here. Transversal zonation of vegetation is determined by the reach of flooding waters that often remain on a surface for a couple of months. In the areas directly adjacent to the river bed vegetation zone with a majority of high reed beds (Phragmition) can be found, including Glycerietum maximae, Phragmitetum australis and Oenantheo-Rorippetum. Beyond it there spreads the zone of immersion-emmersion plants with a majority of high sedge meadows (Magnocaricion), including Caricetum gracilis, Caricetum appropinquatae, Caricetum elatae. In the next strip there dominate emmersional sedge-moss and grass-moss communities; they are rarely subject to flooding from the Biebrza River. Among them are: Caricetum appropinquatae Caricetum diandrae and Carici-Agrostietum communities. Beyond it there is the zone of emmersional communities with a majority of sedges and brown mosses: Caricetum diandrae and Caricetum lasiocarpace. Flooding waters do not reach this zone. At the edge of the Biebrza Valley, the farthest from the river, there occur the alder swamps communities (Oświt 1968, 1973; Pałczyński 1975).
Changes in hydrological and habitat conditions are also observed along the valley axis (longitudinal zonal distribution). This zonal distribution is connected with development stages of the river valley, so with the forming of particular hydrological, soil and plant conditions that are closely related to each other. Okruszko (1969) distinguished three basic development stages of the river valley: peat, mud and alluvial soil.

One of the effects of climate change may be the withdrawal from the Biebrza valley of vegetation that is characteristic of ombrophilous habitats, and thus changes in the zonal distribution of plant communities. This phenomenon is observed already at present. It affects the zones which support emmersional communities, whereas no significant changes in zones covered by immersional and immersion-emmersional vegetation were noted. It seems that the main cause of changes in the emmersional vegetation strip is land management, including negative effects of drainage. To the purpose of assessment of its scale, speed rate and causes, a permanent monitoring is needed. It may be conducted on fixed transects. To achieve this aim, data contained in the work of Oświt (1973) may be used. For the monitoring, aerial and satellite photographs that are made at time intervals of at least 10 years may be helpful. The analysis of the reach of particular vegetation types that are characteristic of respective plant zones will make it possible to capture the dynamics of this process.

5. Influence of climate changes on the land management in the Biebrza valley

One of the phenomena that have been observed in the area of the Polish lowlands for many years is moisture deficiency in sites which are located beside river valleys. This phenomenon is caused by an increase of intensity of agricultural production, and perhaps by climate changes. One of the visible symptoms of this process is the encroachment of fields into river valleys. It is already visible in the middle part of the Poland. Conversion of meadows that cover marshy valley bottoms into cultivated fields is observed among others, in the Warsaw-Berlin Old Glacial Valley (Bzura and Ner valley) and in the middle Warta valley (Kucharski, in press). This occurs also, at a smaller scale, in the Biebrza river valley. A monitoring of this phenomenon may be conducted by using aerial or satellite photographs, taken every 5-6 years.
References


Report under Contract No. 7/BO/2010

Tasks:

1. Review of the Polish literature on climate scenarios and projections.
2. Participation in preparatory works on cc impact indicators on ecosystems.

Work elaborated in frame of the Project

*Adaptive management of climate-induced changes of habitat diversity in protected areas*

Subsidy Contract signed between the Managing Authority and the Lead Partner Leibniz Institute of Ecological and Regional Development of the project No 2CE168P3, acronym HABIT-CHANGE

WP3 3.1.4

Author: Małgorzata Liszewska

July 2010
Task 1. Review of the Polish literature on climate scenarios and projections.

Review:

Polish literature on climate projections or climate scenarios for Poland is not very abundant, especially in the Polish language. Mainly publications concern the impact of climate change on various domains of life, water resources, or natural environment including ecosystems. Often such publications are of educational and informational character, addressed to a wide group of people, promoting general knowledge on climate change.


In the publication *Jak chronić klimat na poziomie lokalnym?* (How to protect climate at local level?) (2008) there can be found indications on how to effectively implement in Poland pro-climatic projects in order to protect climate.

The paper *Antropogeniczne zmiany klimatu: mit czy rzeczywistość?* (Anthropogenic climate changes: myth or reality?) (2001) by Różański is an attempt to summarize the state of our knowledge on mechanisms influencing the climate of the Earth in different time scales, the author-physicist considers and discusses potential anthropogenic climate changes.

In frame of the Eko-Herkules project a few publications considering the impact of various climate scenarios for Poland on selected sectors of Polish economy can be found.
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The publication of Karaczun and Wójcik: *Dobry klimat dla rolnictwa (Climate good for agriculture)* (2009) describing climate changes concerning agriculture, is an approach to show present and future challenges of agriculture in consequence to climate changes in a way understandable for different groups of customers. In the paper some estimation on future precipitation amounts and thermal conditions in Poland are indicated.

Okruszko and Kijańska in *Zmiany klimatu a gospodarowanie wodami (Climate changes and water management)* (2009) deal with impact of climate change on hydrological conditions. Publication discusses the problem of reaching and maintaining the good state of water and water ecosystems nevertheless modifications of hydrological cycle due to changes in atmosphere. Issues such as groundwater, floods and droughts, quality of water, water demand, Baltic and climate changes, reaction and adaptation are considered.

In the work edited by J. Leśny *I Ty masz wpływ na klimat (You can have impact on climate)* (2010) the IPCC AR4 assessments as well as analyses of thermal conditions using the HadRM3-PRECIS model have been used (Szwed, Graczyk, 2007). Potential adaptation of agriculture to climate change is examined, especially deficit in water resources and plant protection are discussed. An impact of agriculture on climate changes is shown. And finally a relationship between a daily life style and climate changes is illustrated.

Kundzewicz in many publications gives general statistics on climate change in global and European scale based mainly on the IPCC AR4 report and tries to interpret these changes indicating the adaption and mitigation techniques. E.g. *Ciepło, coraz cieplej (Warm, more and more warmer)* (2001) is a short lecture on recent results of climate change research: facts, evidences, forecast for Europe, and trying to answer what is better to react or to adapt? *Zmiany klimatu – projekcje i rzeczywistość (Climate changes – projections and reality)* (2010) is a short description of some evidences of climate changes and presentation of results of climate projections based on simulations. A lecture on global climate changes (observations and scenarios) and their consequences can be found in the paper *Konsekwencje globalnych zmian klimatu (Impacts of global climate change)* (2008). A book by Kundzewicz and Kowalczak (2008) covers again such topics as evidences of climate changes (decrease of kriosphere in the world, sea level rise, or increase of frequency of occurrence of extreme meteorological and hydrological events) and their possible impacts on the environment.
In the paper *Konsekwencje zmian klimatu dla zagospodarowania przestrzennego kraju (Consequences of climate change for spatial organization of Poland)* by Starkel L., Kundzewicz Z. (2008) we can find estimations of climate scenarios based on numerical models for temperature and precipitation in Poland and their impacts on spatial organization of Poland.

Also short publications on specific problems related to climate change projections can be found e.g. *Agglomerations will heat more than neighbourhood* (2010), a short note showing the problem of warmer micro climate in towns and metropolitan areas in comparison with rural areas and the effect of urban heat island.

Projections of future climate conditions in Poland based on simulations of global and regional climate models have been carried out by Liszewska. In (Liszewska, Osuch, 1997, 1998, 1999, 2000) empirical-statistical downscaling methods were utilized to estimate local climate variables, mainly temperature and precipitation, which were then used for hydrological applications. Example analyses of general circulation models results for Central Europe and Poland can be found in Liszewska (2000), Liszewska, Osuch (2002) and Liszewska (2004).

In (Sadowski et al. 2009) the regional simulations based on the projection of the global model HadAM3H (Hadley Centre) for emission scenario SRES A2 were analysed for north-eastern part of Poland for the purposes of assessing the impact of climate change on agriculture in that region. Two regional climate models were considered: RegCM (developed and improved at the International Centre for Theoretical Physics, Italy) and CLM (used by the German Weather Service GKSS). Both scenarios projected a substantial and similar increase in the mean temperature, but were distinctly different in their assessment of the future precipitation and moisture content. The mean annual temperature for the period 2071-2100 for the area of north-eastern Poland under the scenario simulation by ICTP-RegCM was 10.8°C, in contrast to 9.5°C under GKSS-CLM; for comparison for the reference period 1961-1990 the models showed, respectively, 6.9°C and 6.0°C. The simulated annual precipitation was completely different between the two models, with the ICTP-RegCM model producing a higher annual precipitation total than the GKSS-CLM model. In the case of the ICTP-RegCM model, it could be seen that precipitation increased for the period 2071-2100 with respect to the period 1961-1990, whereas the opposite situation occurred under the GKSS-CLM model. Both scenarios projected ample winter precipitation, with ICTP-RegCM predicting it for summer, too. In the scenario under GKSS-CLM, the summer precipitation fell to a much lower level than the present one, bringing the annual cycle closer to the present Mediterranean
At the present regional climate simulations for Poland are carried out in frame of the program *Impacts of land use and water resources management on hydrological processes under varying climatic conditions LUWR* (http://luwr.igf.edu.pl). The objective of the study is to assess the consequences of climate change versus land use change in a specific catchment of the Upper Narew with rich wetland ecosystems located in the NE Poland. Preliminary results of estimations of variability in precipitation, temperature, evaporation and discharge under different land use parameterizations show that simulated climate responds to changes in land use (Liszewska M et al., 2010).

**References with abstracts:**

*Czwarty raport rządowy dla konferencji stron Ramowej Konwencji Narodów Zjednoczonych w sprawie zmian klimatu*, 2006, wydawca IOŚ, 96s.

*Fourth report of the Polish government for the Framework Convention of United Nations on Climate Change*, Polish conditions concerning emission and absorption of greenhouse gases are described: management of the state, population, power industry, economy, transport, building industry, agriculture, forestry, waste management, environment. The report contains information on inventory of emission and absorption of greenhouse gases in Poland, trends and changes, and uncertainties in data, also projections for future. Evaluation of vulnerability, climate change impacts and adaptation in the following sectors are presented: agriculture, forestry, water resources, and coastal zone. Research and observations, education and social awareness are discussed.


*You can have impact on climate*, An introduction presents climate system, greenhouse effect, observed and projected climate changes and their consequences. Problems concerning climate and law are also introduced. Potential adaptation of agriculture to climate change is examined, especially deficit in water resources and
plant protection are discussed. An impact of agriculture on climate changes is shown. And finally a relationship between a daily life style and climate changes is illustrated.


Activities of EU against climate changes, Adaptation to climate changes, Global climate changes are discussed, evidences of climate changes in Europe are presented, areas for actions needed for adaptation are indicated.


How to protect climate at local level? A guide showing how to implement in Poland pro-climatic projects in order to protect climate.


Climate good for agriculture, publication on climate changes concerning agriculture, an approach to show, in a way understandable for different groups of customers, present and future challenges of agriculture in consequence to climate changes.


Warm, more and more warmer, A short lecture on recent results of climate change research: facts, evidences, forecast for Europe, and trying to answer what is better to react or to adapt?


Impacts of global climate change, The warming of the climate of the Earth has been unequivocal, most notably due to the man-caused increase of atmospheric concentration of greenhouse gases, leading to intensification of the greenhouse effect. Projection for the future explain that we are committed to further, possibly even more intense, warming, whose rate depends on the scenario of socio-economic development and effective climate change mitigation policy. If the global emissions
grow in uncontrolled way and carbon sequestration potential decreases, the warming can attain a dangerous dimension. Global warming induces change in all variables of hydro climatic systems. As demonstrated in the present contribution, the impacts of global climate change – both advantageous and (more often) adverse can be noted in all regions of the globe and in all systems and sectors, some of which are particularly vulnerable. Yet, many of these impacts can be avoided, reduced, or delayed, by effective climate change mitigation.


*Climate changes – projections and reality.* A short description of some evidences of climate changes and presentation of results of climate projections based on simulations.


*Climate changes and impacts*, The authors show persuasive evidences of climate changes, among others, decrease of kriosphere in the world, sea level rise, or increase of frequency of occurrence of extreme meteorological and hydrological events. Since, such tendencies are very likely to continue, it is necessary to introduce suitable mitigation actions. And in the same time it is very important to understand climate changes and their possible impacts on the environment.


A semi-empirical approach to the statistical climate inversion problem was applied. The Polish surface air temperature and precipitation were related to the large scale circulation over Central Europe represented by mean sea level pressure, geopotential height of 500 hPa and 500/1000 hPa thickness, by means of canonical correlation analysis. The results of verification of the method for an observed independent data subset are presented. The procedure was then applied to the output of the three runs of the ECHAM1/LSG model: control and two perturbed integrations. Results are discussed. Also, the hydrologic assessment of the responses of three Polish catchments to climate change is presented. In order to evaluate the water balance elements CLIRUN3 watershed model was used.
Regional climate scenarios and their applications, Geographia Polonica, vol. 71, 39-56.

Regional climate scenarios and their applications, In the first part of the paper various approaches to the formulation of regional climate scenarios are described. In the second part an example of a climate scenario for Poland based on results from the ECHAM/LSG general circulation transient model is presented. Two perturbed runs of the model are considered: A - “business as usual” and D - “accelerated policies”. The hydrological regime of Polish catchments in changed climate conditions is evaluated using CLIRUN 31 watershed model. Results are discussed.

Analiza wyników globalnych modeli klimatu dla Europy Środkowej i Polski, [w:] Zmiany i zmienność klimatu Polski. Ich wpływ na gospodarkę, ekosystemy i człowieka. Materiały Ogólnopolskiej Konferencji Naukowej, Łódź, 4-6 XI 1999, ss. 129-142.


Examples of reconstructions of Polish climate by GCMs and projections for future, Great efforts have been made to develop climate modelling. The most sophisticated tools to simulate the behaviour of the ocean and atmosphere over time are general circulation models. The new centre IPCC DDC has been recently established to coordinate the distribution of data resulting from many climate simulation experiments provided by the world climate centres. The paper contains analysis of simulations for Poland.

Analysis of results of global climate models for Central Europe and Poland, Geographia Polonica, vol.73, no.2, 49-63.

Analysis of results of global climate models for Central Europe and Poland, The paper presents an evaluation of climate simulations by the ocean and atmosphere general circulation models from the IPCC DDC for two regions: the Central European area and Poland. The comparisons have concerned air surface temperature, precipitation and wind speed. Control runs of the models for the period 1960-1989 and the results of the “Greenhouse Gas plus Sulphate” experiment for the
next century 2000-2099 have been analysed. Re-analysed observed data have been used as the reference distributions for climate parameters.


**Climate Changes in Central Europe Projected by General Circulation Models**, The paper is based on recent climate simulations provided by the leading world climate centres and available through the Data Distribution Centre of the Intergovernmental Panel on Climate Change. Seven models have been considered. Three experiments: control and two integrations for different greenhouse gases emission scenarios have been analysed. Assessments have been made for the European window defined as 5-40°E, 40-60°N. The paper presents selected results for the air surface temperature and precipitation. The intention of the authors was to show examples of analyses made specifically for the Central European region.


**Climate Changes, new IPCC report**, The paper summarizes information on climate changes presented in the recent IPCC report (“Summary for Policymakers”; February 2007). The changes until now have been described, such as the 0.8°C increase of global average temperature in a few recent years (compared to 1850-2000 years); sea level rise and an increase in frequency of hot days. Next, climate forecasts for XXI century derived from various scenarios of future global economy and technology development have been reported.
Okruszko T., Kijańska M., 2009, **Zmiany klimatu a gospodarowanie wodami**, Publikacja projektu Eko-Herkules, 47s.

**Climate changes and water management**, publication discusses the problem of reaching and maintaining the good state of water and water ecosystems nevertheless modifications of hydrological cycle due to changes in atmosphere. Issues such as underground waters, floods and droughts, quality of water, water demand, Baltic and climate changes, reaction and adaptation are considered.


**Agglomerations will heat more than neighborhood**, a short note showing the problem of warmer microclimate in towns, metropolitans areas in comparison with rural areas and the effect of urban heat island.


**Anthropogenic climate changes: myth or reality?**, lectures for the XXXVI conference of Polish Physicists, author considers natural climate changes, climate observed during recent 150 years, role of greenhouse gases and aerosols, climate tomorrow.


**Adaptation of agriculture in north-eastern Poland to expected climate change.**


**Consequences of climate change for spatial organization of Poland**, Climate Changes have been observed in Poland in the recent decades and more pronounced climate changes are projected for the future. They impact on the natural and built environment of Poland, which has been shaped by both circulation of energy and matter, typical for moderate latitudes, and the properties of the landscape, inherited from the geological past. In the present paper, consequences of climate change
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(corresponding to model-based projections) for spatial organization of Poland have been reviewed.


Szwed M., Graczyk D., 2007, **Thermal seasons in Poland – the present and the future, based on HadRM3-PRECIS results**. Global Change.


**Climate protection and climate policy, educational-informational publicity**, publication covers such topics as climate research, consequences of climate changes, CO\textsubscript{2} emissions, climate protection, climate scenarios.
Task 2. Participation in preparatory works on cc impact indicators on ecosystems.

The following examples of Climate Change Indicators used in Europe have been found in literature:

UK (CRU)  [http://www.cru.uea.ac.uk/cru/info/iccuk/](http://www.cru.uea.ac.uk/cru/info/iccuk/)

response indicators from the natural environment
- arrival date of swallows
- egg-laying date of robins

response indicators from the economy
- area of productive vineyards
- use of irrigation water for agriculture
- the Scottish skiing industry

response indicators of behaviour – no of outdoor fires

UK (defra) [http://www.ecn.ac.uk/ICCUK/](http://www.ecn.ac.uk/ICCUK/)

Climate, hydrology, sea level, air pollution
- air temperature in Central England
- seasonality of precipitation
- precipitation gradient across the UK
- predominance of westerly weather
- dry and wet soil conditions in Southern England
- river flows in NW and SE Britain
- frequency of low and high river flows in NW and SE Britain
- groundwater storage in the chalk in SE Britain
- sea level rise
- risk of tidal flooding in London
- atmospheric ozone levels in summer in rural England
Agriculture and forestry
use of irrigation water for agriculture
proportion of potato crop area that is irrigated
warm-weather crops: grapes
warm-weather crops: forage maize
late summer grass production
date of leaf emergence on trees in Spring
health of beech trees in Britain

Insects and birds
dates of insect appearance and activity
insect abundance
arrival date of the swallow
egg-laying dates of birds
small bird population changes
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<th>Global and European Temperature</th>
<th>Marine Phenology</th>
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<td>Sea surface temperature</td>
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<td>Atmospheric greenhouse gas concentrations</td>
<td>Mountain permafrost</td>
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<td>Greenhouse gas emission projections, trends</td>
<td>European precipitation</td>
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<td>Production and consumption of ozone depleting substances</td>
<td>Northward movement of marine species</td>
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<td>Direct losses from weather disasters</td>
<td>Freshwater biodiversity and water quality</td>
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<td>Timing of the cycle of agricultural crops (agrophenology)</td>
<td>Crop yield variability</td>
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<td>Lake and river ice cover</td>
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<td>Storms and storm surges in Europe</td>
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<td>Plant phenology</td>
<td>Soil organic carbon</td>
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<td>Coastal areas</td>
<td>Distribution of plant species</td>
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<tr>
<td>Forest growth</td>
<td>Heat and health</td>
</tr>
<tr>
<td>Water and food-borne diseases</td>
<td>Water requirement</td>
</tr>
<tr>
<td>Forest fire danger</td>
<td>Normalised losses from river flood disasters</td>
</tr>
<tr>
<td>Snow cover</td>
<td>Sea level rise</td>
</tr>
<tr>
<td>Water retention</td>
<td>Vector-borne diseases</td>
</tr>
<tr>
<td>Agriculture and forestry</td>
<td>Distribution of animal species</td>
</tr>
<tr>
<td>Arctic sea ice</td>
<td>Temperature extremes in Europe</td>
</tr>
<tr>
<td>Precipitation extremes in Europe</td>
<td>Soil erosion by water</td>
</tr>
<tr>
<td>Air pollution by ozone</td>
<td>Greenland ice sheet</td>
</tr>
</tbody>
</table>
Other:

http://www.climate-leaders.org/climate-change-resources/climate-change/climate-change-indicators

- Surface temperature (annual mean)
- Ice melt
- Extreme weather events
- Length of growing season
- Acidification of the oceans
Moeciu de Sus
2351 m
vf. Gorganii
p. Dumbrava
p. Rosca
p. Secatura
v. Izvorul Jugureanu
p. Moiecel
pr. lui Lom Simon
m. Lacului
muchia Băr bulețului
p. Cretu
pisc. Crețului
p. Visen
v. Bangaleasa
158=1,3K
v. Nitoiu
p. Unguru M
C u l m e a R a c i u
FE030=D 9 9=1,8Km
h orii
v. Raciu
aghia
v. Grohotisului
Fruntea
pășunea
muchia Guțanului
pr. Rudărita
1660m
vf. Gogu
p. lui Opris
a
m. Rea
culului
p. Izvoarele
1704m
pr. lui Opris
u
v. Bolboace
pr. Poarta
Guțanu
1940 m
Piciorul Tătarului
p. Valea Mircii
u
Colţii Tătarului
i
creasta muntilor Bucegi
v. Ialomita
p. Lucacila
DA F 146D, 4,6ha , L = 5,5 Km
Cabana Scropoasa
l = 9 m.
vf. Brânduşa
1446,1 m
clm
vf. Culmea Surl cele
v. Coteanului
pr. Tinoasa Mica
v. Laptici
TR.PĂNICER
275D=FE036=2,0km
Muntele Văcăriei
v. Nucetului
1713,1 m
v. Bănei
Colţii Obârşiei
1859,6 m
1704m
Pr. Negru
v. Vulpăria
Pădure în afara
grădini
Casa
N
Casa de
r. Prahova
DN1
DN1
Scara:
Protosol antropic tipic
Protosol antropic argiloiluvial
Coluvisol salinizat
Sol aluvial gleizat
Sol aluvial litic
Psamosol molic
Vertisol cromic
Soloneţ cambic
Solonceac vertic
Lăcovişte tipică
Andosol tipic
Sol brun acid umbric
Sol brun acid tipic
Sol roşu tipic
Sol brun eumezobazic andic
Sol brun eumezobazic pseudorendzinic
Sol brun eumezobazic pseudogleizat
Sol brun eumezobazic tipic
Luvisol albic planic
Luvisol albic litic
Sol brun luvic pseudogleizat
Sol brun luvic litic
Sol brun argiloiluvial litic
Pseudorendzină tipică
Rendzină litică
Rendzină cambică
Rendzină tipic
Sol cenuşiu tipic
Cernoziom argiloiluvial tipic
Cernoziom litic
Sol bălan tipic
Reţele electrice de înaltă tensiune
Teleferic
Cale ferată simplă
Drum comunal
Canale
PARCUL NATURAL BUCEGI
Suprafata Parc Natural Bucegi:  32.497,6 ha

Food and Water Management - Remote sensing PARCUL NATURAL BUCEGI

v. Ialomita
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