

## HABIT-CHANGE

# Climate Change-Adapted Management Strategies and Measures

Recommendations for the adaptation of management of protected habitats of the  
Habitats-Directive (92/43/EEC) to climate change

Outputs 6.1.1 and 6.1.2

January 2013

<b>Output Number:</b>	6.1.1 and 6.1.2	<b>Date:</b>	24.01.2013
<b>Title:</b>	Climate Change-adapted Management Strategies and Measures		
<b>Author:</b>	Christian Wilke (TUB), Melanie Bilz (TUB)		

<b>Project:</b>	HABIT-CHANGE – Adaptive management of climate-induced changes of habitat diversity in protected areas		
<b>Programme:</b>	CENTRAL EUROPE	<b>Project Number:</b>	2CE168P3
<b>Start date:</b>	3/2010	<b>End date:</b>	2/2013
<b>Lead Partner:</b>	Leibniz Institute of Ecological and Regional Development (IOER), Germany		
<b>Project Partner:</b>	<ul style="list-style-type: none"> <li>▪ University of Vienna, Austria</li> <li>▪ National Academy of Sciences, Scientific Centre for Aerospace Research of the Earth, Ukraine</li> <li>▪ Thuringian State Institute for Forestry, Game and Fishery, Germany</li> <li>▪ Potsdam Institute for Climate Impact Research, Germany</li> <li>▪ Technische Universität Berlin, Germany</li> <li>▪ Balaton Uplands National Park Directorate, Hungary</li> <li>▪ Szent Istvan University, Hungary</li> <li>▪ Biebrza National Park, Poland</li> <li>▪ Environmental Protection Institute, Poland</li> <li>▪ Triglav National Park, Slovenia</li> <li>▪ University of Bucharest, Romania</li> <li>▪ Central Institute for Meteorology and Geodynamics, Austria</li> <li>▪ Danube Delta National Institute for Research and Development, Romania</li> <li>▪ SOLINE Pridelava soli d.o.o., Slovenia</li> <li>▪ University of Maribor, Slovenia</li> <li>▪ European Academy Bolzano, Italy</li> </ul>		
<b>Contact:</b>	Marco Neubert, m.neubert@ioer.de, +49 351 4679-274 Sven Rannow, s.rannow@ioer.de, +49 351 463-42359		
<b>Further information</b>	www.habit-change.eu		

## Contents

<b>1. Introduction, objectives and method</b>	<b>4</b>
1.1. Introduction	4
1.2. Objectives	6
1.3. Recommending Management Measures: Main Challenge	7
1.4. Methods	8
1.4.1. Definitions	8
1.4.2. Identification and categorisation of management measures	8
1.4.3. Criteria for evaluation of management measures	9
1.4.4. Combining evaluation results to a list of recommendations	10
<b>2. Main results of the evaluation of already implemented management measures</b>	<b>12</b>
<b>3. Main results of the evaluation of suggested adaptation measures from literature</b>	<b>14</b>
<b>4. Literature and sources</b>	<b>15</b>
<b>5. Recommended management measures and strategies for adaptation to climate change</b>	<b>16</b>
5.1. Recommended management measures and strategies for land and water protection and management and adaptations to climate change	17
5.2. Recommended management measures and strategies for monitoring and planning and adaptations to climate change	34
5.3. Recommended management measures and strategies for law and policy and adaptations to climate change	41
5.4. Recommended management measures and strategies for stakeholder and land user, public relation and awareness and adaptations to climate change	47
5.5. Recommended management measures and strategies for knowledge and research, science and technology and adaptations to climate change	57

# 1. Introduction, objectives and method

## 1.1. Introduction

One of the main objectives of the HABIT-CHANGE project is to provide recommendations for the adaptation of management of protected habitats, especially for Natura 2000 habitats but also for the adaptation of management plans for protected areas. In this report we present recommendations for climate change-adapted **management measures** that shall be implemented to obtain a favourable conservation status of protected habitats and to achieve conservation objectives of protected areas under changing climatic conditions. The recommendations are based on the evaluation of the existing management practices in protected areas (HABIT-CHANGE investigation areas) and on an extensive review and evaluation of available guidance literature for adaptation to climate change. The focus of this report is on management measures for protected habitats that are defined and described specific and precise enough for management planning. Recognising the competences and responsibilities of protected area managers, the recommendations include only management measures and strategies that can be initiated, prepared and implemented by protected area management. Recommendations are given for the management of most habitat type groups of the EU-Habitats-Directive and for all management tasks of protected areas. Adaptation measures and strategies that have to be planned and implemented by other institutions in nature conservation (regional and national administrations, NGOs, ministries etc.) are not subject of this report; they will be discussed in output 6.1.3 of the HABIT-CHANGE project.

According to the widely recognized definition provided by the IPCC, adaptation to climate change is ‘any adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities’ (IPCC 2007). Adaptation in nature conservation is thus about decreasing the vulnerability of ecosystems and habitats to harmful climatic impacts while at the same time, enhancing the capability to seize potential benefits of climate change. For the purpose of this report, management adaptation in nature conservation is understood as set of management measures and strategies that help to increase the resilience of species and habitats and to mitigate the impacts of climate change on them. Adaptation must aim to provide opportunities for species and habitats to adjust to a novel situation by e.g. shifting their ranges, by eliminating or reducing other harmful pressures known to interact with climate effects and by protecting or restoring habitats.

National strategies, guidelines and programmes for the conservation of habitats protected under the Habitats Directive (92/43/EEC) already exist in several EU member states. However, the implementation of methodological and theoretical advice from guidelines and strategies into concrete management actions in protected areas is still unsatisfactory. One reason might be that factors that impede effective and systematic habitat management in protected areas – like conflicts with land users or lack of data - are not considered sufficiently in those guidelines and strategies. Another reason may be that most strategies and adaptation options do not refer to specific habitat types and the individual situation of respective protected areas, but stay at a general and programmatic level of concretisation that does not allow direct implementation on site level. To obtain a favourable conservation status of protected habitats under climate change, protected area managers need specific and practice-oriented advice for climate change adapted management

measures that are described as detailed as possible and that can be transferred directly into management planning and implementation. With the recommendations presented in this report we consider all aspects of conservation management, starting from management measures for land and water protection, planning and monitoring to law and policy, stakeholder involvement and research. Addressing all aspects of habitat and protected area management will enable planners and managers to improve the adaptation process and to establish an effective management under climate change.

Although there is considerable technical and methodological guidance for management adaptation in Europe, it is mostly of general character, and only single documents tackle the question of management measures and define criteria for identifying best practices (Prutsch et al. 2010; Laaser et al. 2009; Heller and Zavaleta 2009). So far only few guidelines rank different management strategies and practices regarding their effectiveness to reach management goals in protected areas such as the maintenance of structure and function of habitats. The presented recommendations aim to reduce the identified deficits by offering a choice of adaptation options that have been evaluated by experienced protected area managers and scientific partners of the HABIT-CHANGE project.

Measures for a climate change adapted management are described in this report. They must be incorporated into a wider concept of adaptation planning as it is described e.g. in guidelines provided by the HABIT-CHANGE project (Wilke et al. 2011b: Toolset for Adaptation of Management - A Manual for the CAMP Process; Wilke et al. 2013: Management Handbook) or by the European Environmental Agency EEA (Bouwma et al. 2012). Those guidelines offer a framework that can be specified to the situation and demands of an individual protected area.

## 1.2. Objectives

This report contains outputs 6.1.1 and 6.1.2 of the HABIT-CHANGE project. It focuses on management measures that aim to mitigate the effects of climate change on habitats listed in Annex 1 of the Habitats Directive (92/43/EEC), located in protected areas in Central Europe. The lists with recommended management measures contain those measures that were evaluated positively within the HABIT-CHANGE project (see Wilke et al. 2012a) because they seem to be promising to obtain a favourable conservation status under changing climatic conditions and lie in the competence of protected area management.

The aim of this report is to **support the development of climate change adapted management plans** for protected habitats and the protected areas they are located in. The lists with recommended adaptation measures shall help protected area managers and designers of management plans to choose and implement those kind of measures that are expected to be effective under climate change. The lists with recommended management measures will enable them to select and implement adequate options to mitigate the effects of climate change impacts in habitats and to reduce non-climatic pressures.

The lists with recommended adaptation and management measures contain habitat specific measures and - to a wider extent - measures that support adaptation in all habitat types and protected areas in general.

The objectives of this report are:

- To present the most effective and promising adaptation measures and strategies to obtain the goals of habitat conservation under topical and changing climatic conditions;
- To support the development of climate change adapted management plans by offering a list of possible response options to adapt protected area management to climate change;
- To combine experience and expertise from topically implemented management measures in protected areas with suggested adaptation measures and strategies from literature into one comprehensive list of measures;
- To give a comprehensive overview over necessary and requested adaptations that can be planned, initiated and implemented by protected area management and that cover all aspects of conservation management in protected areas;

---

### 1.3. Recommending Management Measures: Main Challenge

The intention of this report is to give practice-oriented advice and support to planners and protected area managers that meets the demands and competences of planners and practitioners and that can be used directly for adaptation planning and management. The main challenge of this approach is to define management measures detailed enough for implementation, and describe them on a level of generalisation that allows application in as many different and specific management situations as possible. If adaptation measures are suggested on a generalised and strategic level, like “increase resilience” protected area managers usually do not know what to do and how to do it. They need more specific information on adaptation measures that can be linked to topical management measures and activities. To be of practical value for protected areas, advice and guidance must be very specific and must allow direct application in the area. But if information is too detailed and specific it becomes too extensive and makes orientation and application difficult.

Management measures must be very site specific and must take geographical, climatic, ecological, economical, historical, and other circumstances into consideration and fit into the specific conservation objectives of the site. Which management measures are appropriate in a respective protected area depends also on local stakeholder interests and the social and economic setting. All these requirements make it difficult to define appropriate management measures that can be recommended generally for all protected areas and still be specific enough for direct implementation. As a result of this paradox, some generalisation and categorisation is necessary.

The lists in this report are the result of such a balancing act between general applicable recommendation that are of use for as many protected areas as possible and still is specific enough for practical implementation in specific management situations. The lists contain generalised definitions of management strategies as well as specific examples for management measures and adaptations of existing management practices.

## 1.4. Methods

### 1.4.1. Definitions

Management measures are defined as activities which need to be performed to achieve conservation objectives and goals. Management measures describe activities that are mentioned either in protected area management plans or other conservation programs and plans. They are implemented by the management authorities of the protected area or by land users inside the area. Examples of measures are: “Mowing pastures twice a year at fixed dates”, “Mechanical removal of invasive plants before flowering stage”, “Installation of nesting boxes for an endangered bird species” etc.

Different management measures can be subsumed under one strategy. In this report a management strategy is defined as a systematic plan of action to accomplish a specific objective. Concerning the management of protected areas a strategy is an instrumental or methodical approach that stands between specific objectives and the detailed and implementation-orientated management measures. A management strategy defines a methodical approach on how to reach given objectives. In contrast to management measures, strategies are somewhat more generalised and may be implemented by a set of different management measures.

### 1.4.2. Identification and categorisation of management measures

Management measures for habitat conservation that are already implemented today in protected areas have been identified and compiled in the HABIT-CHANGE report for output 3.3.1 ‘Report on existing and climate change adapted management practices’ (Wilke et al. 2011a). The measures have been analysed and evaluated in the report for output 3.4.1 ‘Impacts of different management practices’ (Wilke et al. 2012a). Those reports are the basis for the present lists with recommendations in this report.

The lists with management practices are based on planned and implemented management practices of HABIT-CHANGE investigation areas. That means that they do not cover the whole spectrum of possible and potential management activities and they do not cover all protected habitats of the EU-Habitats-Directive but only those that can be found in HABIT-CHANGE investigation areas. To supplement the lists with management measures and strategies presented in this report, a more extensive list of management options for protected areas and habitats is also available as a HABIT-CHANGE report: Output 3.4.1 C: Management Measures to Maintain the Conservation Status of Protected Habitat Types (Wilke et al. 2012b).

The assessment of existing management measures and practices for habitat conservation and protected area management was based on the extensive expertise from project partners of the HABIT-CHANGE project, who evaluated planned and implemented management practices in HABIT-CHANGE investigation areas regarding their suitability and potential to support adaptation to climate change. This part of the evaluation considered only management activities that can be implemented and tested directly in protected areas because they have the competence and means for them.

Besides the already implemented management practices that were reported from our HABIT-CHANGE investigation areas, suggested adaptation of management practices for habitat and

protected area management from literature and guidelines were compiled and evaluated. The wide choice of suggested response options for adaptation to climate change was extracted from different publications and journal articles and are compiled in the tables in output 3.3.1, chapter 4. Suggested adaptations were evaluated with different criteria by scientific partners and protected area managers of the HABIT-CHANGE project.

The main aim of the evaluation was to single out those management practices that have the biggest potential to be effective and easy to implement by protected area management. This evaluation process led to the lists with recommended management practices for adaptation in this report (see chapter 5).

In addition to habitat specific management activities that are suitable only for certain habitat types, a wide choice of suggested and topically implemented management activities for the adaptation of conservation management are considered in this report. To obtain a favourable conservation status of protected habitats, not only the management measures in those habitats have to be adapted but also management activities that can be subsumed under the strategies related to monitoring and planning, related to law and policy, related to stakeholders and land users, public relation and awareness, as well as those related to knowledge and research, science and technology. To facilitate the work with the lists in chapter 5, all measures and strategies relevant for habitat and protected area management are assigned to one of the following **categories**:

1. Strategies and measures related to land and water protection and management
2. Strategies and measures related to monitoring and planning
3. Strategies and measures related to law and policy
4. Strategies and measures related to stakeholder and land user, public relation and awareness
5. Strategies and measures related to knowledge and research, science and technology

Only measures and strategies in the first category, i.e. related to land and water protection and management are specified for different groups of habitat types that were found in HABIT-CHANGE investigation areas. All other measures and strategies can be generally applied in all protected areas and for all protected habitat types. They are expected to improve and preserve not only the habitat types but the entire protected area.

#### *1.4.3. Criteria for evaluation of management measures*

The **evaluation of topically implemented management measures** was done by experts from protected areas of the HABIT-CHANGE project. Protected area managers were asked to evaluate only those management practices they have actual experience with. Because of the lack of a systematic evaluation of implemented management practices the degree of uncertainty in judgements had to be indicated by evaluating the measures with the categories “very likely; likely; and unlikely”.

The main questions for the evaluation of management practices were:

1. Can the strategy or measure be maintained effectively under the expected climate changes?
2. Are (minor) changes or adaptations necessary to make sure that the strategy or measure will be effective under climate-change conditions? What adjustments are considered necessary?
3. Are additional strategies and measures (absolutely) necessary to maintain and improve the conservation status of the respective habitat types under changing climatic conditions? Please describe required measures and strategies in detail.

A total of 400 actually implemented management measures were evaluated by the experts in HABIT-CHANGE investigation areas. The results of the evaluation are summarised in chapter 2 of this report.

The **evaluation of suggested new and additional strategies and measures** for adaptation from literature had the objective to identify those adaptation options that lie in the competence and tasks of protected area managers and may be implemented by them. The evaluation of suggested new strategies for adaptation had to use a methodological approach that is different from the approach applied for the evaluation of already implemented management practices. In a first step the evaluation was done by scientific partners from IOER and TUB. In a second round HABIT-CHANGE project partners from investigation areas were asked to evaluate the suggested measures and strategies and point out, which they consider the most promising and appropriate adaptations for their area.

The first criterion for evaluation was the target group. We checked if the suggested adaptation lies in the competences and task of protected area management and if it may be implemented directly in the protected area. The second criterion was the feasibility, considering the expected efforts, necessary for implementation. We checked if the strategy or measure may be implemented without changes in the legal framework, without long planning and preparation procedures, and without further scientific evaluation. Regarding the feasibility we assessed if suggested adaptations may be implemented easily because they are detailed and specific enough for implementation and if management measures can be directly derived from suggested adaptation strategies. The main question was whether obstacles may exist that could hinder the implementation of the strategy or measures and their integration into an adapted management plan. The results of the evaluation of suggested adaptations from literature are summarised in chapter 3 of this report.

For more details on the evaluation process and detailed results please refer to the report for output 3.4.1 D: "Impacts of different management practices" (Wilke et al. 2012a).

#### *1.4.4. Combining evaluation results to a list of recommendations*

The evaluations of topically implemented management measures and of suggested adaptations from literature enabled us to identify those management practices that are expected to be effective under climate change and to identify necessary adjustments and complementary measures and strategies that can be implemented by protected area managers and planners of management plans. Although the suggested adaptations in literature were often described as general strategies and not as precise

---

and detailed as the management measures reported from the HABIT-CHANGE investigation areas, they can be assigned to each other and combined.

The lists with recommended, adapted management measures and strategies combines the experience and expertise from protected area managers who joined the HABIT-CHANGE project with results and suggestions from research as it is presented in publications.

Management measures and strategies that are expected to be effective under climate change as well as required adjustments of those measures and additional adaptation measures and strategies are presented in chapter 5 in 5 different lists. The lists are categorised by the five different management practices (land and water protection and management; monitoring and planning; law and policy; stakeholder and land user, public relation and awareness; knowledge and research, science and technology). They were once more reviewed in order to obtain the right balance of specific measures that are still realisable by different protected areas. The measures, “Visitor centre in Fertőújlak, Csapody István Nature School” and “Separation of single land uses from small areas of wetlands”, for example, were excluded as they were too site specific or too general. The specific measures and their suggested adaptations or additional measures were clustered under more general strategies such as “combat invasive species” to ensure manageability of the long lists of recommendations. In a second step, those measures from the literature that were deemed feasible by protected area managers and scientific project staff, were added to the list under the appropriate strategies. It needs to be noted that very few of the measures already in place in the protected areas actively focus on climate change adaptation. The main question was whether they would still work under a changed climate. The literature recommendations on the other hand, contain suggestions on how to actively increase the resilience and adaptation capacity of protected areas to climate change. Many of the literature recommendations have therefore been added as suggestions of how to proactively design and implement climate change adaptation measures.

## 2. Main results of the evaluation of already implemented management measures

The evaluation of typically implemented management measures regarding their potential to be effective under climate change showed that protected area managers of HABIT-CHANGE investigation areas expect only about 6 % of all management practices assigned to specific habitat types not to be effective under changing climatic conditions. Together with practices not assigned to specific habitat types only 3 % of all management practices in protected areas are expected not to be effective any more. Only in coastal and halophytic habitats and in raised bogs, mires and fens the share of practices expected not to be effective any more was significantly higher. One possible explanation may be that those habitats are especially sensitive to changes in temperature and precipitation patterns that lead to sea-level rise and the drying out of bogs and fens.

Uncertainties about the effectiveness of measures (expressed in an evaluation as “likely”) are higher for habitat-specific management measures than for measures that were not assigned to specific habitat types. The later include measures for planning and monitoring, law and policy, stakeholder involvement or research which are expected to improve or maintain the management effectiveness of the protected area irrespective of climate change.

**Table 1: Expected effectiveness of management measures under climate change**

1) Can the strategy or measure be maintained effectively under climate change?				
	number of measures	very likely	likely	unlikely
Habitat-specific management measures	<b>211</b>	<b>58,8 %</b>	<b>35,5 %</b>	<b>5,7 %</b>
Measures not assigned to Habitat types	<b>189</b>	<b>88,9 %</b>	<b>10,6 %</b>	<b>0,5 %</b>
<b>Sum total</b>	<b>400</b>	<b>73,0 %</b>	<b>23,8 %</b>	<b>3,2 %</b>

Almost 31 % of all evaluated measures were assigned to strategies for land and water protection and management, 26 % to stakeholder dialogue, public relation and awareness, 18 % to law and policy, almost 15 % to monitoring and planning and only 10 % to knowledge, research, science and technology. Measures and strategies for land and water protection and management seem to be the most important management practices in HABIT-CHANGE investigation areas, followed by communication activities with stakeholders and visitors.

Although most management measures are expected to be effective in the future, adjustments regarding the timing, intensity and extent of measures were considered necessary for 44 % of the practices assigned to specific habitat types. For 38 % of the measures not assigned to specific habitat

types the need for adjustments was expressed. Almost 62 % of management practices not assigned to specific habitat types are expected to be effective under climate change without any changes. 89 suggestions for adjustments were made.

**Table 2: Required adjustments of topically implemented measures**

2) Are adjustments of implemented measures necessary to ensure effectiveness under climate change?					
	number of measures	very likely	likely	unlikely	No. of suggested adjustments
Habitat-specific management measures	<b>211</b>	<b>6,7 %</b>	<b>37,6 %</b>	<b>55,7 %</b>	<b>51</b>
Measures not assigned to Habitat types	<b>189</b>	<b>13,2 %</b>	<b>25,4 %</b>	<b>61,4 %</b>	<b>38</b>
<b>Sum total</b>	<b>400</b>	<b>9,8 %</b>	<b>31,7 %</b>	<b>58,3 %</b>	<b>89</b>

For 28 % of all 400 management practices **additional management practices** were considered necessary to maintain the conservation status under climate change. The suggested additional management measures and strategies are a valuable basis for the adaptation of existing management practices in the process of the development of climate change adapted management plans (CAMPs) and were integrated into the lists with recommended management measures and adaptations in chapter 5.

The suggestions for additional management practices to support existing conservation management in protected areas showed that adaptation to climate change requires increased activities to reduce non-climatic (land use) pressures in protected areas. Also, more cooperation and collaboration with scientists, administrations and land users are requested to establish a sustainable land use management to enhance resilience to climate change. And finally a systematic monitoring of biodiversity, climate change impacts and management effectiveness has to be established to enable protected area management to track changes and react with appropriate management activities.

Summing up, the results of the evaluation of topically implemented management practices in protected areas prove that an overwhelming majority of the implemented management practices are expected to be successful even under climate change. For one third of the practices some uncertainties exist concerning their effectiveness.

### 3. Main results of the evaluation of suggested adaptation measures from literature

The evaluation of new and additional strategies and measures suggested in literature, namely to adapt nature conservation and protected area management to climate change showed that 57 of the suggested 82 different adaptations can be implemented or at least initiated by protected-area managers (see Wilke et al. 2012a). Only 25 suggestions (30 %) address target groups and protagonists in governmental, scientific or administrative institutions that are responsible for the political and legal framework of nature conservation or for the provision of sufficient knowledge about climate change and its impacts on ecosystems.

Regarding the feasibility of suggested strategies and measures, 10 of the 57 strategies proposed are considered not to be feasible without disproportional efforts. Although the feasibility depends very much on the individual situation of the protected area (human and financial resources, existing collaborations, research activities etc.), the national legislative framework and existing conflicts or cooperation with stakeholders and land users, the suggestions from literature were evaluated by scientific partners and by protected area managers of the HABIT-CHANGE project regarding the expected workload and necessary efforts for the implementation. The assessment was based on the extensive expertise gathered in the project.

As a result of the evaluation 47 different suggested adaptation strategies are considered relevant and suitable for an implementation by protected area managers. Not every strategy may be suitable for all areas, some aim at specific habitat types like coastal or marine or forest habitats. The list with 47 generally appropriate response options to manage the impacts of climate change (see Appendix 1 of output 3.4.1 D, Wilke et al. 2012a) is an important input for the development of climate change adapted management plans (CAMPs) and they were integrated in the lists with recommendations in chapter 5.

The comparison between the suggested new strategies and already implemented management practices proves that some of the suggested management practices are already in the focus of protected-area managers and even partly implemented, although not all management practices are implemented in all HABIT-CHANGE investigation areas. Most suggestions related to monitoring and planning are part and content of the HABIT-CHANGE project which includes the use of climate-change scenarios, the sensitivity and impact analysis and the development of adapted management plans. The intensification of stakeholder involvement is part of the CAMP process, too, but it has to be admitted that it is not a well-established management strategy in all investigation areas so far.

Suggestions for adaptations from literature are mostly general strategies that need further specifications to be “translated” into concrete management measures. Management practices reported from HABIT-CHANGE investigation areas are more specific and detailed. Many practices for land and water protection and management are assigned to specific habitat types.

## 4. Literature and sources

Bouwma, I.M., Vos, C., Biemans, M., McIntosh, N., van Apeldoorn r., Verdonschot P., 2012. Draft Guidelines on Climate Change and Natura 2000. Draft Guidelines on dealing with the impact of climate change on the management of Natura 2000' (ENV B.3./SER/2010/0015r).

Habitats-Directive (92/43/EEC). Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora). Download at:

[http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index\\_en.htm](http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm).

Heller N.E., Zavaleta E.S., 2009. Biodiversity management in the face of climate change: A review of 22 years of recommendations. *Biological Conservation* 142 (2000), 14-32.

IPCC 2007, *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Parry, M. L. et al. Eds., Cambridge University Press, 996 pp.

Laaser, C., Leipprand, A., de Roo, C., Vidaurre, R. 2009. Report on good practice measures for climate change adaptation in river basin management plans EEA/ADS/06/001 - Water ETC/Water Task: 1.5.4 Water and climate change. Subtask: 1.5.4.2 Measures for climate change adaptation.

Prutsch, A., Grothmann, T., Schauser, I., Otto, S., McCallum, S. 2010. The Guiding principles for adaptation to climate change in Europe ETC/ACC Technical Paper 2010/6 November 2010.

Wilke, C, Rannow, S., Stratmann, L., Heiland, S., Bilz, M. 2013. Management Handbook. 'report for output 5.3.2 of the HABIT-CHANGE project. Download at: <http://www.habit-change.eu/index.php?id=33>

Wilke, C., Rannow, S., Rittel, K., Janauer, G., Schabuss, M., Wagner, I., Pöll, C. 2011b. Toolset for adaptation of management - A manual for the CAMP process. 44 pp. Report for output 3.3.2 of the HABIT-CHANGE project. Download at: <http://www.habit-change.eu/index.php?id=33>

Wilke, C., Rittel, K., Sturm, U. 2011a. Report about existing management practices in protected areas and climate-change related changes of management practices. Report of output 3.3.1 of the HABIT-CHANGE project. 125 pp. Download at: <http://www.habit-change.eu/index.php?id=33>

Wilke, C., Wübbe, I., Sturm, U., Rannow, S., Heiland, S., Pöll, S., Wohlrapp, S. 2012a. Report on impacts of different management practices. 44 pp. Report for output 3.4.1 (D) of the HABIT-CHANGE project. Download at: <http://www.habit-change.eu/index.php?id=33>

Wilke, C., Wübbe, I., Sturm, U., Wohlrapp, I., Janauer, G., Schabuss, M. 2012b: Management Measures to Maintain the Conservation Status of Different Habitat Types. 18 pp. Report for output 3.4.1 (C) of the HABIT-CHANGE project. Download at: <http://www.habit-change.eu/index.php?id=33>

## 5. Recommended management measures and strategies for adaptation to climate change

### How to use the lists

The lists provided below shall help protected area managers and designers of management plans for protected areas and protected habitats to adapt plans and management to climate change. The process of adaptation includes different working steps that are described in the management handbook (output 5.3.2) of the HABIT-CHANGE project. The selection of effective management strategies and measures is one of the main results and components of the adaptation process.

The strategies and measures listed in the tables below offer planners and protected area managers a wide choice of recommended and effective adaptation options to choose from. Even if the situation in each protected area may be different from other protected areas and natural assets require very specific management, the lists present a wide spectrum of adaptation options that should be taken into account when planning climate change adapted management plans (CAMPs). The lists with evaluated management practices presented in this report are complemented by the extensive lists of general applicable management options for protected habitats in Wilke et al. 2012b. For the development of climate change adapted management plans both reports should be used.

Five different lists contain adaptation strategies and measures. Each list contains general strategies in the first column and examples for concrete measures in the second column. In most cases the listed measures are based on well-established and already implemented conservation practices. If these measures can be maintained in principle but have to be adapted in detail, the necessary adaptations are specified in the third column. Suggested adaptation strategies that were either suggested by HABIT-CHANGE protected area managers or in adaptation literature and were evaluated positively are presented in the last column. They contain topics, strategies and policies that should gain more attention and efforts to adapt protected area management to climate change.

In the first category: recommended management measures and strategies for land and water protection and management the most habitat-specific strategies and measures are listed. The list contains management measures and adaptations for groups of habitat types that were found in HABIT-CHANGE investigation areas. Nevertheless, many of those measures can be transferred and applied in the missing groups of habitat types.

The strategies and measures in the lists in chapter 5.2 to 5.5 contain management activities that will help to mitigate impacts of climate change on the entire protected area. They help to improve the management effectiveness and to reduce climatic and non-climatic pressures on protected areas. They are not habitat-specific but address the different aspects of conservation management and planning.

## 5.1. Recommended management measures and strategies for land and water protection and management and adaptations to climate change

Coastal and halophytic habitats (1000)			
Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Maintenance of water regime</b>	<p>Install and operate sluices for neglected waterworks to ensure water supply for wet areas and/or drain drier areas.</p> <p>Install junction canals to allow alternative water supply from other water bodies (canals, lakes) in dry years.</p>	<p>Allow temporal flooding in spring and increase retention of remaining water in hollows until summer to avoid drought problems.</p> <p>Negotiate water use with other stakeholders and land users on local and regional scale.</p> <p>Install more locks in drainage channels to support maintenance of groundwater regime and improve retention.</p>	<p>Initiate coordinated and adapted water management in catchment area by involving all stakeholders that influence water regime.</p> <p>Install regional monitoring of water regime: continuous monitoring of groundwater and surface water levels, water quality.</p> <p>Protect tidal marshes from erosion with oyster breakwaters and rock sills.</p> <p>Plan, protected and restore estuarine habitats with room for retreat as sea level rises.</p> <p>Remove structures that harden the coastlines, impede natural regeneration of sediments, and prevent natural inland migration of sand and vegetation after disturbances, prohibit bulkheads and other engineered structures on estuarine shores.</p> <p>Continued below</p>

<p><b>Grazing</b></p>	<p>Grazing with cattle, sheep, horses or other animals to preserve open habitat quality. Grazing intensity depends on wetness of area.</p>	<p>Change grazing intensity (number of cattle per area) and grazing period (starting time and length) depending on seasonal climatic conditions (dry winters: less cattle, wet winters: later start)</p> <p>Change cattle breeds and introduce new breeds or grazing animals that are not sensitive to heat or cold. Introduce breeds that do or do not graze selectively to avoid establishment of stands of unwanted plant species.</p> <p>Test alternative cattle breeds to find most appropriate breeds for changing climatic conditions.</p> <p>Alternate grazing and mowing: if areas are too wet for grazing, change to mowing techniques. Test different combinations of grazing and mowing.</p>	<p>Maintain landscape complexity of salt marsh landscapes, maximize habitat heterogeneity in marine protected areas, protect full breadth of habitat types</p> <p>Monitor habitat state and phenology yearly and adapt planned management measures to observed state of habitat.</p> <p><b>Plus:</b> See additional suggested general strategies for adaptation at the end of this table.</p>
<p><b>Mowing</b></p>	<p>Mowing vegetation on wet areas once a year (late summer) around mid-June.</p> <p>Long-lasting mowing since late spring fractionally in favour of birds.</p>	<p>Increase flexibility in determining date of (first) mowing due to changing amounts of rainfall; consider needs of nesting birds and blooming orchids when determining mowing dates.</p> <p>Change timing for mowing depending on seasonal climate and/or combine mowing with grazing.</p>	

<p><b>Restriction and regulation for land use and access by humans</b></p>	<p>Strictly forbid driving across the area with any kind of machine under wet circumstances.</p>	<p>Closing additional area temporarily for access, depending on wetness, breeding activities and climatic conditions.</p>	
--	--	---	--

<p><b>Combat invasive species</b></p>	<p>Removal of selected invasive plants: mechanical or manual or by grazing with appropriate breeds that feed on invasive species.</p> <p>Removal with heavy machines during winter on frozen ground.</p>	<p>Shredding drier edges in later summer.</p> <p>Shredding bank vegetation with lighter machines in every September and/or winter (when wetlands are frozen).</p> <p>Switch to manual removal of invasive species under wet conditions when heavy machines cannot enter the area.</p> <p>Use lighter machines for removal.</p> <p>Temporarily increase grazing intensity until stands of invasive species are reduced.</p> <p>Handwork instead of machines is needed when machines cannot enter area (no ice in warm winters), and/or temporarily overgraze area to eradicate invasive stands.</p> <p>Develop a clear inventory of the existing invasive species. Evaluate and map their populations.</p>	
<p><b>Restoration of salt marshes</b></p>	<p>Installation of locks in the drainage channels to maintain water level.</p>	<p>Retain water longer in area before open locks to avoid summer droughts.</p>	

<b>Freshwater Habitats (3000)</b>			
<b>Management Strategy</b>	<b>Measures (Examples)</b>	<b>Required or possible adaptation measures</b>	<b>Additional strategies suggested</b>
<b>Maintenance of the natural dynamic and hydrology of streams and waters</b>	<p>Operate sluices and locks to maintain and management water level.</p> <p>Clearing excess vegetation blocking free outflow in the river and mowing of disturbing vegetation on river banks.</p>	<p>Install new sluices that can be operated by hand, solving the problem of water supply and excess water because of neglected waterworks.</p> <p>Organise alternative water supply for wet areas from other regional sources and construct necessary channel system to ensure water supply in extreme dry years.</p> <p>Reduce nutrient input into water bodies to reduce growth of excess vegetation.</p>	<p>Restoration of riparian and instream habitats, channel reconstruction, floodplain restoration; increase physical habitat heterogeneity in channels, conduct river restoration</p> <p>Protection of thermal refugia and for valued aquatic species at risk to the effects of early snowmelt on river flow</p> <p>Removal of sediment, removal of barriers to upstream migration in rivers and streams outside of protected area</p>
<b>Restoration of river habitats</b>	<p>Improve connectivity with adjoining terrestrial habitats by removing hard structures and river-bed constructions.</p>	<p>Coordinate and cooperate with institutions for flood protection. Emphasise benefits of restored rivers and alluvial areas for flood protection and biodiversity conservation under climate change.</p>	<p>Plant riparian vegetation, use drought-tolerant plant varieties to help protect riparian buffers and refugia</p> <p>Shift access points or move existing trails for active visitor management and protection of sensitive wildlife</p> <p>Continued below</p>

<b>Management of reed and/or riverine vegetation</b>	<p>Raise water level to avoid spreading of reed-belt towards central lake area.</p> <p>Reed cutting</p> <p>Maintenance of channel system in the reed belt by dredging or sediment transfer in order to improve the water supply.</p>	<p>Test if transition of surface water from other surface waters and rivers during drought periods to raise the water level is possible.</p> <p>Construction of a channel system to facilitate harvesting of the reed belt.</p> <p>Reconstruction of channel-system in the reed belt to improve the water supply</p>	<p>Initiate and support economic utilisation and processing of reed to allow economic maintenance of reed areas.</p> <p>Use Water Framework Directive to plan and implement climate change adapted measures.</p> <p>Improve water retention and supply in area and plan new flooding areas to buffer extreme oscillations of high and low-water levels.</p>
<b>Combat invasive species</b>	<p>Eradication of invasive species by park rangers with machines or by hand.</p> <p>Removing vegetation with heavy machines.</p>	<p>Increase eradication contributions from land users and stakeholders by education about effects of invasive species.</p> <p>Handwork instead of machines when machines cannot enter area (no ice in warm winters), and/or temporarily overgraze to eradicate invasive stands.</p> <p>Develop a clear inventory of the existing invasive species. Evaluate and map their populations.</p>	<p>Monitor habitat state and phenology yearly and adapt planned management measures to observed state of habitat.</p> <p><b>Plus:</b> See additional suggested general strategies for adaptation at the end of this table.</p>

<b>Minimize sediment- and nutrient pollution at inflows of lakes or protected water bodies</b>	Installation and construction of filter-fields and/or deposition areas that can be assessed and maintained easily.	Adapt timing for sediment removal from filter-fields depending on seasonal climate and flooding events.  Extent filter-fields if flooding events increase.	
<b>Maintenance and development of water quality</b>	Control of sediment-transport into the lake with improvement of flow-conditions.  Prevent waste water discharge to decrease nutrient pollution.	Consider more frequent extreme events and additional sediment transport. Plan larger buffer and flooding areas for sedimentation.  Manage groundwater levels in organic soils to prevent or reduce decomposition of organic matter.	
<b>Fishing control</b>	Limitation of number of fishing permits and temporal validity.	Adapt time, when fishing is allowed to yearly climatic conditions and seasonal water balance.  Reduce number of permits.	

Temperate heath and scrub (4000)			
Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Combat scrub encroachment</b>	<p>Manual removal of shrubs (mainly <i>Pinus sylvestris</i>), excluding birch groves and willow scrubs.</p> <p>Grazing (temporarily) to avoid scrub encroachment</p> <p>Burning: Strictly controlled burning of <i>Calluna</i> heaths in Jan-Feb (weather-dependent)</p>	<p>Test alternative measures like grazing, mowing, burning.</p> <p>Test different breeds and species of grazing animals.</p>	<p>Search for funds and incentives to utilize abandoned land again.</p> <p><b>Plus:</b> See additional suggested general strategies for adaptation at the end of this table.</p>

<b>Natural and semi-natural grassland (6000)</b>			
<b>Management Strategy</b>	<b>Measures (Examples)</b>	<b>Required or possible adaptation measures</b>	<b>Additional strategies suggested</b>
<b>Restoration of grasslands</b>	<p>Creation of grassland by sowing in abandoned arable land.</p> <p>Transforming hayfields into pastures.</p> <p>Helping natural succession processes on abandoned arable land by sowing or mulching with cut grass originated from a “good quality” habitat.</p> <p>Cleaning drier grasses and weedy mesophilous grasses by stem cutting, mowing and grazing.</p>	<p>Adaptation of seed mixtures to local and adapted species.</p> <p>Reintroduce traditional livestock keeping and development of regional products.</p>	<p>Control weeds and invasive species e.g. grazing with sheep or other animals.</p> <p>Restoration of natural water regime by closing drainage channels and raising ground water levels.</p> <p>Introduce active management of the water regime to buffer the fluctuation of water level during floods.</p> <p>Re-introduce traditional grazing activities.</p> <p>Monitor habitat state and phenology yearly and adapt planned management measures to observed state of habitat.</p> <p><b>Plus:</b> See additional suggested general strategies for adaptation at the end of this table.</p>

<p><b>Grazing</b></p>	<p>Grazing to avoid scrub encroachment.</p> <p>Grazing to convert areas into pastures with extensive livestock and appropriate cattle breeds.</p> <p>Maintaining areas without any grazing (in particular for species conservation)</p>	<p>Adapt grazing intensity such as the seasonal duration of grazing.</p> <p>Create more shelters that provide shade for cattle.</p> <p>Adapt grazing regime to avoid overgrazing, undergrazing and harmful grazing. Adapt length and frequency of grazing period to yearly and seasonal climatic conditions and water availability.</p> <p>Change to beef instead of milking cows. E.g. Holstein breeds move in groups and avoid several species, they graze selectively, Hungarian Grey cattle breed is more resistant to weather extremities and suitable for grasslands.</p> <p>Test combination of grazing and mowing to achieve conservation goals for habitat and species conservation.</p>	
-----------------------	---	---	--

<p><b>Mowing</b></p>	<p>Mowing every year in selected stands with appropriate mowing frequencies.</p> <p>Autumn clearing mowing of pastures, removing cut hay from the area.</p> <p>Mowing by hand after the ripening of seeds (from the end of August); mosaically if it is needed (e.g. because weeding or scrub encroachment).</p> <p>Mowing by hand or by machine and removal of biomass – once a year in late summer – to reduce nutrient content of the soil in areas where artificial fertilizer was used.</p>	<p>Adapting time and intensity of mowing according to changed climatic conditions. Mowing with clearly defined period (e.g. after the seed maturation of habitat typical plants or avoiding interference with grassland birds).</p> <p>Mowing should be avoided in extreme dry years, or postponed to autumn.</p> <p>Maintained unmowed patches to increase habitat diversity and/or mow patches at different dates (several weeks later) to react to changing phenology of particular species.</p> <p>Set date for mowing only after vegetation survey in habitats.</p>	
----------------------	--	--	--

<p><b>Combat scrub encroachment</b></p>	<p>Manual removal of trees, bushes and shrubs, every year in selected stands.</p> <p>Cutback of shrubs with machines or manually.</p>	<p>In cases of a milder climate the pressure of natural succession and regeneration of new trees, bushes and shrubs will become higher. Recurrence and removal techniques need to be adapted.</p> <p>Regrowth of some species can be more compact after cutting. These species should be pulled out.</p> <p>Soil protective measures help to prevent germination of trees and shrubs on meadows.</p>	
<p><b>Combat invasive species</b></p>	<p>Removal of Solidago stands: cut in the beginning of flowering, mowing or proper grazing by Hungarian Grey Cattles.</p> <p>Removal of Reynoutria japonica, Carex brizoides every year.</p>	<p>Adapt timing of removal yearly depending on phenology and climatic conditions.</p> <p>Intensify mowing up to 8 times a year, intensify grazing or test new biological control methods.</p> <p>Develop a clear inventory of the existing invasive species. Evaluate and map their populations.</p>	

<p><b>Management of water regime</b></p>	<p>Restoration of groundwater regime.</p>	<p>Install new sluices that can be operated by hand, solving the problem of water supply and excess water because of neglected waterworks.</p> <p>In extreme dry years provide water supply from external sources.</p> <p>Install more locks in drainage channels to improve water retention.</p>	
<p><b>Extensification of agricultural practices</b></p>	<p>Regulations and restrictions for the use of fertilizer and weed-control in protected habitats.</p> <p>Reintroduction of farming on mountain hay meadows.</p>	<p>Yearly adjustments of stocking rate, depending on climatic conditions, spreading of invasive species and scrub encroachment</p>	

<b>Raised bogs and mires and fens (7000)</b>			
<b>Management Strategy</b>	<b>Measures (Examples)</b>	<b>Required or possible adaptation measures</b>	<b>Additional strategies suggested</b>
<b>Grazing</b>	Re-introduce traditional grazing activities.	Adapt grazing regime to avoid overgrazing, undergrazing and harmful grazing with soil erosion.	<p>Improve water retention and water management to raise ground water levels and avoid drainage.</p> <p>Restore natural water regime of bogs, mires and fens</p> <p>Identify and protect current and predicted future refuges from climate change on all scales: acquire necessary land</p> <p>Focus on sensitive habitats and species</p> <p>Maintain viable ecosystems and populations of species</p> <p>Mitigation: protect carbon stores within protected areas, limit CO2 emissions, adopt and develop low emission management and farming methods</p> <p>Increase ecosystem redundancy and buffers in both natural environments and plantations</p> <p><b>Plus:</b> See additional suggested general strategies for adaptation at the end of this table.</p>
<b>Mowing</b>	Mowing, if habitats are threatened by scrub encroachment or afforestation.	<p>Adapt timing and frequency of mowing according to yearly and seasonal climatic conditions.</p> <p>Test combinations of mowing and grazing.</p>	
<b>Combat scrub encroachment</b>	<p>Manual or mechanical removal of trees, bushes and shrubs.</p> <p>Removal of spruce-regeneration and thinning remnants.</p>	<p>Raise groundwater level in bogs and mires to avoid scrub and tree encroachment.</p> <p>Adapt regular removal cycle to climatic and hydrological conditions.</p> <p>Install new sluices and locks to improve water retention and water supply.</p> <p>Dismantling of constructions for water canalisation, draining and outflow.</p>	

<b>Combat invasive species</b>	Cutback of invasive stands.	Increase frequency and use alternative methods to combat invasive stands.  Develop a clear inventory of the existing invasive species. Evaluate and map their populations.	
<b>Restoration of habitats</b>	Revitalisation of bogs by water management	Increase water availability by removal of spruce-regeneration, removal of thinning remnants.	
<b>Rocky habitats and caves (8000)</b>			
<b>Management Strategy</b>	<b>Measures (Examples)</b>	<b>Required or possible adaptation measures</b>	<b>Additional strategies suggested</b>
<b>Access restrictions</b>		Clear marking (blazing) of hiking paths and containment of shortcuts.	See additional suggested general strategies for adaptation at the end of this table.

<b>Forests (9000)</b>			
<b>Management Strategy</b>	<b>Measures (Examples)</b>	<b>Required or possible adaptation measures</b>	<b>Additional strategies suggested</b>
<b>Maintenance of forest habitats</b>	<p>Fostering and selective thinning of forest habitats outside the core zone</p> <p>Maintenance of mosaic patterns in the forest with old trees.</p>	<p>Transformation of forests with non-native species to native ones.</p> <p>Extension of conservation management to forest habitats outside the protected core zone.</p>	<p>Select appropriate mixes of species for afforestation</p> <p>Facilitate natural (evolutionary) adaptation by using e.g., prescribed fire, silvicultural treatments to shorten regeneration times and promote interspecific competition.</p> <p>Promote diverse age classes and species mixes, a variety of successional stages, and spatially complex and heterogeneous vegetation structure</p> <p>Reduce stand densities and abating fuels and widely spaced thinning and shelterwood cuts to prevent severe wildfires and insect outbreaks.</p> <p>Restore habitat and system dynamics, restore forest in protected areas.</p> <p><b>Plus:</b> See additional suggested general strategies for adaptation at the end of this table.</p>
<b>Regeneration of forest habitats</b>	<p>Leave deadwood on habitat-stand (xylobionts), possible on all forest-habitat-stands.</p>		
<b>Combat invasive species</b>	<p>Cutting invasive forest species every year in designated areas.</p>	<p>Increase efforts to remove invasive tree species from habitats.</p> <p>Develop a clear inventory of the existing invasive species. Evaluate and map their populations.</p>	

---

**Additional suggested strategies that apply for all habitat types and protected areas:**

- Validate effectiveness of different management measures by frequent monitoring of management results.
- Reduce existing non-climate-related threats and pressures from human use (i.e. fragmentation, pollution, human-wildlife conflicts)
- Identify and protect current and predicted future refuges from climate change on all scales: acquire necessary land
- Focus on sensitive habitats and species.
- Mitigation: protect carbon stores within protected areas, limit CO2 emissions, adopt and develop low emission management and farming methods
- Increase ecosystem redundancy and buffers in natural environment
- Increase stakeholder involvement in all planning and management activities.
- Increase environmental education and measures for awareness raising to improve acceptance for conservation measures.
- Improve and control enforcement of regulations. Raise awareness and understanding by informing public about conservation aims and reasons for access regulations.
- Request and support a national monitoring strategy for biodiversity and water regime.
- Request development of national and international conservation strategies for coastal and halophytic habitats and for the management of invasive species because uncoordinated local approaches are insufficient.
- Request increased involvement of different national ministries to solve land-use problems and enforce implementation of regulations in nature conservation.

## 5.2. Recommended management measures and strategies for monitoring and planning and adaptations to climate change

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Establish baseline for monitoring</b>	<p>Base-line documentation of the current distribution, abundances and conservation status of key habitat types, species, core populations in protected area and its surroundings.</p> <p>Base-line documentation of current land-use, infrastructure and the area's cultural heritage.</p> <p>Identification and documentation of main elements of landscape, flora and fauna, which are subject of tourism activities.</p> <p>Creating a GIS database as planning and management tool.</p> <p>Identification and mapping of land owners, land-use and status.</p>	<p>Establishing baselines for key conditions and species against which to measure future climatic induced changes.</p> <p>Extent baseline monitoring to climate parameters that are relevant for protected area.</p> <p>Coordinate baseline monitoring with other protected areas and on national level: standardise baseline monitoring.</p>	<p>Use monitoring results to design adaptive management strategies.</p> <p>Assess success and effectiveness of conservation measures; consider costs and benefits of adaptation measures in the context of the likelihood of success.</p> <p>Provide baseline data for climate impact assessments and for other institutions and sectors.</p> <p>Obtain or develop climatic projections, focusing on ecologically relevant variables and suitable spatial and temporal scales.</p> <p>Obtain or develop ecological response projections.</p> <p>Assess components of vulnerability: evaluate climate sensitivity, likely exposure of climatic and ecological change and consider adaptive capacity of protected area management.</p> <p>Continued below</p>

<p><b>Monitoring of natural resources</b></p>	<p>Selection and formulation of indicators to define the state of ecosystems.</p> <p>Surveys of water quality (ground and surface water), quantity and meteorological measurements for characterization and observation of changes in the region.</p> <p>Vegetation-ecological and faunistic pasturing monitoring</p> <p>Ornithological monitoring: stocktaking, breeding pairs, breeding success.</p> <p>Meteorological measurements.</p> <p>Monitoring water quality in the canals that supply water in dry years.</p> <p>Fish ecological monitoring using CPUE (catch per unit effort), echo sounding: semi-quantitative stocktaking, population structure of single species, trophic niches.</p> <p>Mapping of lake-bed morphology with hydro-acoustic methods.</p> <p>Monitoring studies in grasslands and reed communities, focussing on protected species.</p> <p>Long-time monitoring of weather and climate in protected area.</p>	<p>Integrate climate change and key indicators into monitoring programmes to monitor future changes in climate and ecosystem responses.</p> <p>Relate observed water quality to climatic parameters.</p> <p>Increase number of measuring points to improve data.</p> <p>Establish additional indicators and monitoring parameters to track climate change induced changes.</p> <p>Establish additional restrictions of hunting if necessary.</p> <p>Establish collaboration with specialised authorities for monitoring, biodiversity and climate change.</p> <p>Improvement of documentation of monitoring results, discussion and adaptation of management practices.</p> <p>Development and updating of GIS databases, intensified use of results for management decisions.</p> <p>Enlargement of the protected area management team with staff and specialists for climate change, monitoring and research.</p>	<p>Document level of confidence or uncertainty in assessments.</p> <p>Increase and maintain basic and long-term monitoring programs, monitor ecosystems, ecotones and gradients.</p> <p>Develop and integrate climate change and key indicators into monitoring programmes to monitor future changes in climate and ecosystem responses, use monitoring results to design adaptive management strategies.</p> <p>Engage national (state) monitoring institutions to support monitoring of climate change and its impacts.</p> <p>Update the existing regulations for different types of activities in protected area (e.g.: collection of medicinal plants, berries, mushrooms, grazing and logging) to the requirements of climate change.</p> <p>Develop a climate change integrated conservation strategy. Establish collaboration across disciplines in planning.</p> <p>Continued below</p>
---	---	---	--

	<p>Regular macrophyte mapping of lake bays and of the open lake margin.</p> <p>Mapping of bogs as preparation of restoration projects.</p> <p>Establishment of inventory of main elements of landscape, flora and fauna, which may be subject to future tourism activities.</p> <p>Repeating habitat mapping every 5/10 years.</p> <p>Development of a monitoring and implementation plan for management measures.</p> <p>Assess the invasive species and elaborate precautionary measures for their management.</p>		<p>Initiate and intensify cooperation with research institutions, universities and sectoral planning institutions to increase external support of protected area management.</p> <p>Coordinate monitoring activities with other protected areas, regional and national institutions and exchange monitoring data.</p>
--	--	--	---

<p><b>Monitoring of management effectiveness</b></p>	<p>Vegetation and invertebrate monitoring for planning and developing maintenance measures (e.g. grazing).</p> <p>Monitoring the effects of mowing and grazing on some characteristic grassland over at least 10 years to define the livestock-keeping capacity.</p> <p>Appraisal to determine whether temporary restrictions of uses and access to sensitive areas show expected positive effects.</p>	<p>Introduce systematic monitoring of effects of management measures as part of an adaptive management. Prepare evaluation of effectiveness and efficiency of different management practices.</p>	
<p><b>Monitoring of human activities (land use)</b></p>	<p>Monitoring the exploitation activities of natural resources.</p> <p>Monitoring of hunting management to conserve the optimal number and structure of game.</p> <p>Frequent monitoring of current livestock populations in protected habitats.</p> <p>Monitoring anthropogenic and recreational activities in sensitive and protected habitats and landscapes.</p>	<p>Increase number of rangers to control human activities.</p> <p>Develop strategic collaboration with different institutions (agriculture, tourism etc.) to reduce impacts of different land uses.</p> <p>Increase management and ranger staff to organise and participate in patrolling actions in the hunting fund and to combat poaching.</p> <p>Frequent up-dating of monitoring of land use intensity by farmers and herders.</p> <p>Plan and implement additional assess regulations and limitations in sensitive areas.</p>	

<p><b>Monitoring of touristic and recreational activities</b></p>	<p>Visitor monitoring of visitor frequency on selected areas and points of interest.</p> <p>Identification and monitoring of climbing routes and access paths.</p>	<p>Improve touristic infrastructure to reduce impacts: equip most frequented locations with ecological toilets, waste collection containers, parking and camping spaces.</p> <p>Reduction or restriction of sport activities in areas sensitive to climate change and touristic uses.</p> <p>Special regulation for passing and access inside the protected area.</p>	<p>Identification and development of areas where recreation and tourism will be possible without putting habitats under pressure.</p> <p>Develop tourism concept together with communes in and around protected area to allocate activities outside sensitive areas.</p> <p>Increase interdisciplinary collaboration; establish broad-scale planning at national and regional and trans-boundary level,; establish collaboration with local communities and indigenous people in and around protected areas.</p> <p>Review timing of management activities, have rapid-response strategy prepared to assess ecological effects of extreme events as they occur.</p>
---	--	---	---

<p><b>Land use and conservation planning</b></p>	<p>Support for development of the ecologic agriculture forms in the agricultural fields of the park or its vicinity.</p> <p>Participation and planning in projects supporting sustainable aquaculture development.</p> <p>Plan and assure corridors for species migration and reduction of habitat fragmentations to allow climate induced migration.</p> <p>Creation and adaption of a time table for mowing and grazing considering seasonal climatic conditions.</p> <p>Development of plans to regulate grazing and grassland: containing management measures, monitoring concept and evaluation criteria.</p> <p>Development of management plans for protected habitats to prevent conversion into intensively cultivated arable land and negative effects on conservation status.</p> <p>Determining zones suitable for renewable energies (wind power, solar, biomass) and plan exclusion zones inside protected area.</p>	<p>Include climate change and assessments of impacts of climate change into management planning.</p> <p>Develop and use climate change prognoses and models for all management planning in protected areas.</p> <p>Carry out assessment of needs and opportunities of land users and stakeholders. Strengthening the role of agriculture as a provider of ecosystem services.</p> <p>Establishment and maintenance of habitat corridors and reduction of human activities in potential migration corridor areas to allow climate induced migration.</p> <p>Adapt timing for management activities according to phonological stage of habitats and species.</p> <p>Adapt the number of animals to the support capacity of grasslands which are already under pressure from climate change.</p>	<p>Planning and implementing control measures against harmful invasive species and procedures for translocation of species that cannot move quickly enough.</p> <p>Make management experiments to improve adaptive management; use flexibility in the planning guidelines and explore new management models to develop management actions and maximise effectiveness; implement stabilising measures.</p> <p>Support incremental learning and gradual achievement of management goals.</p> <p>Intensify and improve management, define time-bound and measurable actions plans, prioritise actions, increase management effectiveness, conduct integrated management of nutrient sources.</p> <p>Increase management efficiency by using a management effectiveness assessment framework and building management capacities.</p> <p>Improve acceptance of conservation management by involving stakeholders into the planning process and increasing communication and education activities.</p> <p>Continued below</p>
--	---	---	---

			<p>Modification of management plans: integrate predicted climate change and its impacts into planning, adopt long-term and regional perspective in planning, modelling, impact assessments and management, develop adaptation strategy now, quantify potential impacts and adaptive capacity for conservation planning, focus on mitigation and adaptation</p> <p>Do vulnerability assessments: determine objectives and scope, gather relevant data and expertise, assess components of vulnerability, apply assessment in adaptation planning; Identify audience, user requirements, and needed products; engage key internal and external stakeholders; establish and agree on goals and objectives; identify suitable assessment targets; determine appropriate spatial and temporal scales; select assessment approach based on targets, user needs, and available resources.</p> <p>Initiate research activities to identify and validate measures needed for the improvement of the quality of grasslands.</p>
--	--	--	---

### 5.3. Recommended management measures and strategies for law and policy and adaptations to climate change

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Restrictions and regulations related to land-use practices</b>	<p>Regulation and control of grazing pressure in sensitive areas.</p> <p>Prohibition of grazing in certain areas or at certain times.</p> <p>Limitation of grazing and eutrophication in sensitive peat bogs.</p> <p>Prohibition or reduction of (certain types of) fertilizers, chemical weed-control and use of non-autochthon seeds and plants in sensitive habitats (e.g. alpine pastures).</p> <p>Control and reduction of fertilisation.</p> <p>Support of organic farming and extensive/traditional agricultural practices in protected area.</p> <p>Inclusion of objectives and measures for nature conservation in contracts for lending state-owned national park areas to farmers, defining land use restrictions.</p> <p>Continued below</p>	<p>Adaption of regulations and contracts with land users regarding grazing intensity and seasonal duration of grazing according to water availability and climatic conditions.</p> <p>Establishment of additional regulations to improve water regimes of core peat bog areas.</p> <p>Increase control of sport activities and pasture pressure and improve law enforcement by rangers and park authorities.</p> <p>Adapting regulations to reduce grazing intensity and sport activities in sensitive areas.</p> <p>Adapt land-use contracts with farmers, fishers and forestry to allow adaptation to climate change and adapted management (flexible timing and intensity of land-use practices)</p> <p>Integrate directives on adaptation to changes driven by climate change into contracts with land users.</p> <p>Continued below</p>	<p>Initiate and support integration of nature-conservation objectives in programmes and plans of other administrations and spatial planning.</p> <p>Initiate and increase coordination and cooperation with different stakeholder and land-user groups in steering committees to avoid conflicts and raise awareness.</p> <p>Release additional administrative measures like access regulations, prohibition of access outside of marked trails to protect climate sensitive areas.</p> <p>Edict traffic-speed regulations to reduce impacts of traffic in protected area.</p> <p>Establish special control of waste collection in cooperation with communes.</p> <p>Increase establishment of information boards.</p> <p>Introduce new management measures to monitor and assess the conservation status habitats.</p> <p>Continued below</p>

<p><b>Restrictions and regulations related to land-use practices</b></p>	<p>Restrictions of forest management in forest stands with protected habitats or nest- and hollow-trees for bats.</p> <p>Temporary restrictions of forestry activities: No wood deployment from March up to July in forest stands with woodpecker habitats.</p> <p>Establishing forest sections without forestry to maintain mosaic patterns in the forest with old trees with holes and enhancing the natural dynamics of forest ecosystems.</p> <p>Regulations to reduce disturbances from forestry activities, like noise and emissions from machines and to prevent erosion and vegetation degradation in all contracts with land-users in protected area.</p> <p>Regulation and limitation of salt use on icy roads in the surroundings of peat bog habitats.</p>	<p>Development of a traffic concept to reduce traffic around protected and sensitive areas.</p>	<p>Initiate and support stronger integration of socio-economic goals and needs of the local population in management plans.</p> <p>Plan and implement additional regulations and measures to avoid fragmentation and provide connectivity.</p> <p>Edict additional regulations to limit number of boats and speed limits for motor boats.</p> <p>Introduce monitoring of traffic within the protected area.</p> <p>Enhance promotion of new regulations to raise awareness, publicity and acceptance.</p> <p>Support funding of more compensatory measures and EU- and national subsidies for land-use restrictions.</p> <p>Increase stakeholder involvement and educational activities to improve the understanding of decisions and the importance of measures for biodiversity conservation.</p> <p>Edict additional land-use restrictions for recreational uses like skiing and biking.</p> <p>Continued below</p>
--	--	---	--

<p><b>Restrictions and regulations related to land-use practices</b></p>			<p>Choose conservation policies that engage local users; use multiple designations and management approaches, implemented with prior informed consent by local communities.</p> <p>Ensure strong political support for the maintenance and expansion of protected areas.</p> <p>Manage water resources and human stressors such as overfishing and excessive inputs of nutrients, sediments, and pollutants.</p> <p>Change legal status of (parts of) protected area if climate change impact assessments identified sensitive areas that more not protected sufficiently.</p>
--	--	--	--

<p><b>Restrictions and regulations related to human access</b></p>	<p>Restrictions of vehicle traffic beyond asphalt roads.</p> <p>Reduction of human disturbance by closing valuable and sensitive areas for access (fences, barriers etc.).</p> <p>Limit tourism activities and infrastructure (hotels, camping grounds, roads, and picnic areas in sensitive area.</p> <p>Restriction (temporary) of touristic and sportive activities around sensitive areas (e.g. skiing, mountain biking).</p> <p>Marking safety zones and buffer areas around protected areas.</p> <p>Establish and mark official camping sites.</p> <p>Identification of climbing routes and access paths, monitoring and setting up regulations for access.</p> <p>Supervision and enforcement of regulations of recreational activities.</p> <p>Banning the introduction of non-indigenous fish species.</p> <p>Regulations for fishing and combating fish poaching.</p> <p>Regulating the collection of medicinal plants, finding solutions for the production of rare medicinal plants in special arranged places.</p>	<p>Raise awareness and understanding for restrictions by communicating reasons and necessity of regulations.</p> <p>Increase public awareness by providing information materials.</p> <p>Develop a promoting campaign to increase understanding for conservation decisions and regulations and the importance of biodiversity conservation.</p> <p>Develop the supervision compartment of the park administration.</p> <p>Increase ranger staff to control compliance with regulations and inform park users about restrictions.</p> <p>Adapt list of medicinal plants for collection according to Red Lists and exclude those which are more sensitive to temperature increase and decrease of humidity.</p>	
--	---	---	--

<p><b>Compensation and subsidies</b></p>	<p>Provision of subsidies for extensification of land-use (e.g. compensations for grassland conservation) according to the law offered by the park administration.</p> <p>Implementation of programme of provincial government subsidies (Landscape Maintenance Fund) for habitat-network.</p> <p>Obtaining revenues for local communities in case of maintaining traditional grazing activities.</p> <p>Subventions for ecologically adapted agricultural practices.</p> <p>Compensation payments for preservation and networking of fallow sites.</p>	<p>The evaluation of income losses of land users and the development of adequate financial regulations, according to the existing law.</p> <p>Development of directives and standards on adaptation to climate change.</p> <p>Compensation of local population for land use restrictions due to nature conservation policies.</p> <p>Compensatory measures may range from financial help to providing seeds and/or resistant plant and animal species, in order to carry out agricultural activities in the conditions of habitat characteristic to protected area.</p>	<p>Establish regional institutions to support farmers and land users to acquire funding and subsidies from EU and national funds.</p>
--	---	---	---

<p><b>Financing of protected area network</b></p>	<p>Redemption or long-term lease of ecologically sensible areas - sustainable development of ecologically sensible areas.</p> <p>Valorification of natural resources with short regenerative period, within the limit of the support capacity: berries, mushrooms, fallen needle leaves and Christmas trees, medicinal plants etc.</p>	<p>Land acquisition in protected area to enable restoration and adaptation to climate change.</p>	<p>Land acquisition around sensitive protected areas to enable restoration</p>
<p><b>Creation of benefits for local communities</b></p>	<p>Support for development of the ethno-cultural identity of the local population.</p> <p>Facilitate the access of local communities to the financing programs for protected areas.</p> <p>Promotion of legal framework and funding programmes to local communities.</p> <p>Approval of investment projects for hostels and hotels in protected area in compliance with the strategy of sustainable development and biodiversity conservation in the park.</p>	<p>Ensure access to natural resources and services by means of law and include access into strategies and measures.</p> <p>Promote the sustainable use of resources to ensure harmonization of socio-economic development of the local population with objectives of nature conservation.</p> <p>Involve local stakeholders and land users when planning administrative measures to regulate passing and access and land use intensity.</p>	<p>Balance objectives for socio-economic development of protected area with objectives and measures for nature conservation.</p> <p>Ensure strong political support from local population for the maintenance and expansion of protected areas.</p>

#### 5.4. Recommended management measures and strategies for stakeholder and land user, public relation and awareness and adaptations to climate change

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<p><b>Communication and cooperation with local stakeholders and land users</b></p>	<p>Participating in forums organised for farmers by agricultural authorities to spread knowledge about conservation objectives.</p> <p>Involvement of NGOs, members of the mountain rescue team and the mountain guides in educational programs for tourists.</p> <p>Maintenance of partnerships with local authorities, citizens and entrepreneurs for a sustainable management of protected sites to increase the number of beneficiaries and supporters of the area.</p> <p>Maintenance of partnerships and collaborations with educational, research and public institutions (museums, etc.) to increase the number of beneficiaries and supporters in the area.</p> <p>Partnerships and exchanges with administrations of other protected areas for information exchange.</p>	<p>Development of a network of potential contributors and donors to support the implementation of the conservation strategies and measures.</p> <p>Actively integrate information about climate change and expected impacts on protected area in all communication and cooperation process. Raise awareness for climate change and need for adaptation.</p> <p>Increase collaboration with agricultural sector and streamline adaptation to climate change.</p> <p>Create coalitions and partnerships with stakeholders that will be affected severely by climate change.</p> <p>Increase communication of knowledge about climate change impacts to policymakers and stakeholders.</p> <p>Continued below</p>	<p>Improve inter-agency, regional coordination and multi-sector approaches at different scales.</p> <p>Establish watershed coalitions that bring together all relevant stakeholders and parties in an area relevant for water management.</p> <p>Establish cross-national collaboration.</p> <p>Implementation of the full range of governance types to encourage more stakeholders to involve in active management of protected areas and adaptation to climate change.</p> <p>Inform public and promote consensus-building for adaptation strategies.</p> <p>Use minimum standards for stakeholder consultation and active involvement in REDD schemes.</p> <p>Integrate adaptation to climate change and mitigation of greenhouse gases in all communication processes and information materials. Show synergies between adaptation and mitigation.</p> <p>Continued below</p>

		<p>Initiate and moderate dialogue among different groups of stakeholders and protected area management.</p> <p>Share information about climate change and expected impacts on protected area with all stakeholders and local communities.</p>	<p>Initiate national and international cooperation with conservation agencies to develop and exchange information and educational materials on the topic of climate change (adaptation and mitigation).</p> <p>Participate in and join existing international networks and alliances for nature conservation and adaptation to climate change.</p>
--	--	---	--

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Foster regional and international cooperation</b>	<p>Participation of park administration in the development and approval of urban and regional plans for the areas in and round the protected area.</p> <p>Establishment of transnational, cross-border cooperation in neighboured protected areas: coordination of management activities, visitor guidance and monitoring.</p>	<p>Initiate and participate in coordinated transnational projects with climate change concern.</p> <p>Start consultations with regional administrations and planners to streamline methods, projections and assessments for climate change and its impacts. Build common understanding of climate change topic.</p>	See above for additional strategies
<b>Provision of information material</b>	<p>Creation of a public database available on internet to collect and distribute information and suggestions from civil society.</p> <p>Creation and regular updating of Park website. Provision of complete and operational information on the opportunities and activities in the park.</p> <p>Provision of ecological data from protected area on website or in print.</p> <p>Design and distribution of printed flyers, leaflets and brochures to present and promote conservation objectives and measures and information on Natura 2000 Network.</p> <p>Provision of information on obligations and restrictions in protected area on information boards and signs.</p>	<p>Update database periodically according to changes occurred in the territory as consequence of climate changes. Make climate change and its impacts a new topic in databases.</p> <p>Up-to-date information and knowledge transfer with emphasis on climate change and its impacts.</p> <p>Re-editing and publishing of periodicals to highlight modifications occurred in time within protected area due to climate change and adaptation to it.</p> <p>Provide more information about the</p>	See above for additional strategies

<p><b>Provision of information material</b></p>	<p>Production and distribution of a newsletter with information from the park.</p> <p>Organisation of symposiums, conferences and events on conservation topics in protected area and local communities.</p> <p>Elaboration and distribution of flyers with behaviour and good practice codes for users and visitors.</p> <p>Organisation of touring exhibitions that can be shown in towns and villages in around protected area.</p> <p>Publication of an atlas of aquatic and terrestrial plants in the protected area.</p> <p>Publication of a periodical magazine with information from the protected area.</p> <p>Publication and dissemination of informative and educational materials (maps, posters, postcards, flyers, videos, movie DVDs etc.), specific for different target groups: children, adults, fishermen, hunters, farmers etc.</p> <p>Publication of brochures about the sustainable and traditional form of (agricultural) land management and nature conservation.</p> <p>Cooperation with local media to promote conservational activities and reach as many local stakeholders and inhabitants as possible.</p>	<p>potential impact of climate change on the elements of the natural diversity of the park.</p> <p>Develop a dissemination network inside and around the protected area to develop coordinated adaptation strategies and measures to climate change.</p> <p>Include not only adaptation to climate change in information materials but also on mitigation of greenhouse gases.</p> <p>Increase activities to “translate” scientific findings on climate change and its impacts into “simple” language to provide information to a wider spectrum of visitors and stakeholders.</p> <p>Use new media (e.g. web-based applications for smartphones etc.) to inform visitors with simple messages and attractive design.</p>	
---	---	---	--

<p><b>Educational activities</b></p>	<p>Development and implementation of an educational and awareness programme in the school camps settled in the park and surrounding areas.</p> <p>Provision of formal and non-formal education materials and activities in and around protected area, considering the specific ecological education requirements and curricula.</p> <p>Development and publication of educational materials (leaflets, posters, brochures) on fauna and flora of protected area, invasive species, impacts of recreational activities etc.</p> <p>Organisation of activities and events accompanying important environmental events (international conventions anniversaries, establishment of park day, earth day etc.)</p> <p>Demonstration of local nature in open-air schools and summer camps, nature schools and visitor centre.</p> <p>Participation in local festivities and events in villages and towns in and around protected area to improve knowledge about protected area and its natural assets.</p> <p>Establishment of an education centre in protected area.</p> <p>Offering educational programmes and guided tours for school-classes. Hand out diplomas for successful participation.</p> <p>Publication of popular scientific articles on research in protected area.</p> <p>Continued below</p>	<p>Increase efforts to include conservation and climate change adaptation into school curricula and the education strategy.</p> <p>Translation and dissemination of the most relevant documents on nature conservation and adaptation to climate change produced by different international conventions.</p> <p>Include information on how climate change influences ecosystems and species in all educational materials and programmes.</p> <p>Up-to-date information and knowledge transfer with emphasis on climate change.</p> <p>Plan and design special exhibitions, information materials and poster on climate change and its impacts on biodiversity.</p> <p>Develop new educational programmes on adaptation to climate change.</p>	<p>Create education programs for public about land-use practices and effects on and with climate to raise awareness; provide education opportunities for management staff to learn and network about climate change; use social networks for education about climate change.</p>
--------------------------------------	---	---	--

	<p>Offering programmes for adult education: excursions, lecture series and articles in media, cooperation with adult education institutions/ summer school.</p> <p>Preparation and organization of presentations, lectures, demonstrations, exhibitions, workshops.</p> <p>Involving media (TV, radio, newspapers, and journals) to promote conservation activities of protected area.</p>		
--	--	--	--

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Management of tourism and recreation</b>	<p>Development and distribution of an eco-tourist guide explaining responsible behaviour of visitors in protected area.</p> <p>Set up rules for tourism practices in order to protect the natural heritage (assess restrictions). Establish touristic routes around sensitive areas.</p> <p>Avoiding tourist developments and recreation in ecologically sensitive areas - reducing noise, trampling of vegetation, disturbances during winter.</p> <p>Development of a strategy for sustainable tourism together with all relevant stakeholders.</p> <p>Development and implementation of eco-touristic certification system to develop the eco-touristic offer (e.g. in cooperation with EUROPARC).</p> <p>Diversify the use of landscape resources for recreation, leisure and environmental education to reduce pressures in most frequented areas.</p>	<p>Adjust assignment of camping areas and develop new ones to direct tourism flow in areas that not sensitive to climate change.</p> <p>Limit camping sites in areas with high impacts of climate change.</p> <p>Develop a system to measure tourism circulation to provide a clear image of tourism flows in the area.</p> <p>Adapt touristic zonation of the protected area.</p> <p>Limit intensity of recreational and sportive activities (e.g. number of boats, speed limitations etc.) in climate sensitive areas.</p> <p>Develop a strategic plan for sustainable tourism development under climate change.</p> <p>Establish more information centres and environmental education in ecotourism to raise public awareness and environmental education</p> <p>Develop and introduce a local brand for sustainable (eco) tourism within the protected area. Define criteria and standards for nature tourism for tourism brand for protected areas.</p> <p>Develop strategies and measures for nature friendly tourism under climate change.</p> <p>Enforcement of park regulations by more rangers.</p>	<p>Avoid fragmentation caused by touristic infrastructures and roads to improve connectivity and allow climate induced migration.</p> <p>Enhance acceptance for protected area in local population by creating additional income in the area by developing ecotourism and education.</p> <p>Include aspects of climate change in eco-tourism certification and visitor guidelines.</p> <p>Initiate and support regional concepts for tourism to allocate touristic infrastructure in less sensitive areas.</p> <p>Stronger integration of socio-economic objectives and activities of local communities into protected area management to integrate climate change topics.</p> <p>Quality standard for sustainable tourism have to be elaborated together with stakeholder and implemented in protected area region.</p>

<p><b>Visitor management and guidance</b></p>	<p>Elaborate and disseminate a behaviour guide for visitors.</p> <p>Develop and offer visitor programmes: travelling, exhibitions, events, info points, guided tours, excursions, hikes.</p> <p>Promoting the rules and regulations with billboard signs, posters, leaflets, etc. in the main touristic attractions, access roads and information points.</p> <p>Training and accreditation of professional guides and rangers.</p> <p>Provision of visitor information at touristic hot spots.</p> <p>Development and/or improvement of visitor information system.</p> <p>Marking of hiking routes and trails, management of camping areas and access points.</p> <p>Development and maintenance of infrastructure for visitors - information and education facilities, high stands, hides, view towers, info tables, info desks, access, paths, educational paths, study trails, nature trails etc.</p> <p>Visitor channelling and dismantling of ways and streets to protect sensitive areas.</p> <p>Making and publication of maps for touristic routes of climbing and mountain biking, indicating also the degree of difficulty.</p>	<p>Establishment of a visitor monitoring to analyse impacts on nature, integration of results into climate change adaptation planning.</p> <p>Integrate results of climate change vulnerability assessment into concepts and strategies for visitor management and guidance.</p> <p>Adapt zoning for recreational uses according to the results of climate change impacts assessments.</p> <p>Adapt all management measures related to visitor management to climate change and its impacts.</p> <p>Update information and guidance for visitors with emphasis on climate change and its impacts.</p> <p>Plan and construct additional touristic infrastructure like shelters or drinking fountains on trails to adapt to changing climatic and weather conditions.</p> <p>Develop an information system available 24 hours/a day, easily accessible through internet and adapted to smart phones and other mobile devices.</p> <p>Integrate information on climate change and its impacts into information systems.</p> <p>Make information available in several languages and full time.</p> <p>Reduction or restriction of sport activities in sensitive areas.</p> <p>Control compliance of regulations and restrictions with rangers and nature guards.</p>	<p>See adaptations above</p>
---	---	--	------------------------------

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Development of infrastructure for arrival and departure</b>	<p>Construction of toilets and information centre in most frequented “hot spots” of the area.</p> <p>Establishment of public transportation to reduce individual motorised traffic in protected area.</p> <p>Construction of simple shelters or refuges for bad weather conditions along tourist routes, ensuring the safety of tourists.</p> <p>Monitor, classify and organize the network of touristic routes.</p>	<p>Construction of more refuges for bad weather conditions.</p> <p>Monitor and evaluate the impacts of touristic routes on natural assets.</p> <p>Increase of public transportation as well as development of further measures for the seasonal reduction in recreation traffic.</p> <p>Remove of paths and trails in areas sensitive to climate changes.</p>	<p>Plan and implement strategies and measures for mitigation, addressing especially traffic-induced emissions.</p>

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<p><b>Promotion of traditional and sustainable cultural practices products, fostering cultural identity.</b></p>	<p>Promotion of traditional sustainable activities, restoration works and in situ conservation of buildings with historical and cultural value.</p> <p>Promotion of local products specific to the area.</p> <p>Support of local communities in producing and trading of traditional artefacts or food: honey, medicinal plants, etc.</p> <p>Promotion of economic activities that are sustainable and help adapting to climate change.</p> <p>Support and promotion of (ecological) tourism activities in local communities.</p> <p>Organisation of events and actions to promote and highlight local traditions. Increased stability of communities with rich traditions and a desire to preserve the traditional lifestyle..</p>	<p>Improve and update regulations to control land use and use of natural resources for economic aims, eliminating excessive and harsh interventions considering expected and observed impacts of climate change.</p> <p>The promotion of activities that employ efficient methods to provide access to resources and services needs to be adjusted to the modifications occurred within climate changes.</p> <p>Develop strategies for short, medium and long term planning to solve the local environment problems, considering expected impacts of climate change.</p> <p>Monitoring of touristic activities in protected areas, assessment of impacts of recreational uses and adaptation of regulatory measures.</p>	<p>See all above</p>

### 5.5. Recommended management measures and strategies for knowledge and research, science and technology and adaptations to climate change

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<p><b>Research studies on natural resources and assets</b></p>	<p>Research study about dynamics in natural ecosystems, temporal changes in water quality etc.</p> <p>Hydrological studies to support and plan future water management (operational regulation of sluices and gates).</p> <p>Geological and geomorphological research studies in caves.</p> <p>Measurements, observations and studies to understand the genesis, structure and dynamics of protected ecosystems.</p> <p>Qualitative and quantitative studies on biodiversity.</p> <p>Studies on species and habitat diversity in protected area.</p> <p>Continued below</p>	<p>Introduce new models to assess impacts of climate change on lake-river system, point sources, water quality etc.</p> <p>Additional investments for research to increase climate change research.</p> <p>Include climate change prognosis into studies and impact assessments.</p> <p>Involve more specialists in evaluation and monitoring of the species diversity and impacts of climate change.</p> <p>Apply vulnerability assessment for ecosystems, Resilience of protected habitats and ecosystems.</p> <p>Initiate cooperation and research studies with regard to the potential effects of climate changes and on ecosystem services.</p> <p>Implementation of research results in action plans and management: adapt protected area management planning.</p> <p>Continued below</p>	<p>Increase overall research activities in protected area to produce a better data basis and reduce knowledge gaps about species, habitats, ecosystems and their reaction to changing climates.</p> <p>Intensify cooperation and collaboration the research institutions and universities: offer topics for exams, diplomas and projects.</p> <p>Make attractive offers for interested students: provide lodging and data access.</p> <p>Intensify collaboration with specialized institutions, specialists and authorities.</p> <p>Engage more in transnational, EU-funded research and development projects (e.g. Interreg-Projects etc.).</p> <p>Acquire additional funding for research from national and international institutions.</p> <p>Continued below</p>

<p><b>Research studies on natural resources and assets</b></p>	<p>Research studies for understanding of functions and services assured by freshwater, brackish and marine deltaic ecosystems (production, regulation, support).</p> <p>Research on carrying capacity of pastures.</p> <p>Development of digital elevation models (laser-scan, geodetic measurements, topographic map vectorization).</p> <p>Development of ground water models for protected area or catchment.</p>	<p>Involvement of specialists in the development and implementation of a biodiversity monitoring plan and management under conditions of climate change.</p>	<p>Integrate findings from research projects into educational programs and information materials of the protected area.</p> <p>Use results of research projects to develop a climate change adapted monitoring concept, visitor concept and adapt management planning for protected species and habitats.</p> <p>Publish and present research results in information materials of protected area: newsletters, website, brochures etc.</p> <p>Integrate climate change topics in all research projects to make sure that expected changes are considered sufficiently.</p>
--	--	--	--

Management Strategy	Measures (Examples)	Required or possible adaptation measures	Additional strategies suggested
<b>Research studies on human impacts on biodiversity and natural assets</b>	<p>Research on the influence of land use practices in protected area on the biodiversity.</p> <p>Assessments of impacts of touristic and recreational activities on biodiversity.</p> <p>Research on the structure, impacts and dynamics of socio-economic and cultural activities.</p> <p>Evaluation study regarding the opportunities of sustainable socio-economic development.</p> <p>Research studies to improve administration and management effectiveness of protected areas.</p>	<p>Increase technical and human infrastructure of protected area administration to support research concerning climate change.</p> <p>Initiation of studies to evaluate the opportunities for sustainable socio-economic development as part of adapted conservation strategies for protected area.</p> <p>Adapt management measures and monitoring program: include monitoring of renewable natural resources regarding their sustainable use.</p> <p>Initiate evaluation studies for the sustainable development of renewable energies (zoning, restrictions areas, the number of tools, permits, etc.).</p>	
<b>Development of indicators of monitoring</b>	<p>Selection and formulation of indicators to define the state of ecosystems.</p> <p>Definition of indicators for Natura 2000 monitoring (evaluation of conservation status).</p>	<p>Integration of indicators to monitor climate induced changes.</p> <p>Introduction of a monitoring system which sums up all the data and information different several institutions with monitoring and research activity (climate and the air quality, biodiversity, the water and the soil quality, the waste, hydrology, natural resources, economic activities, human population, knowledge of permanent status and evolution of renewable natural resources etc.)</p>	

